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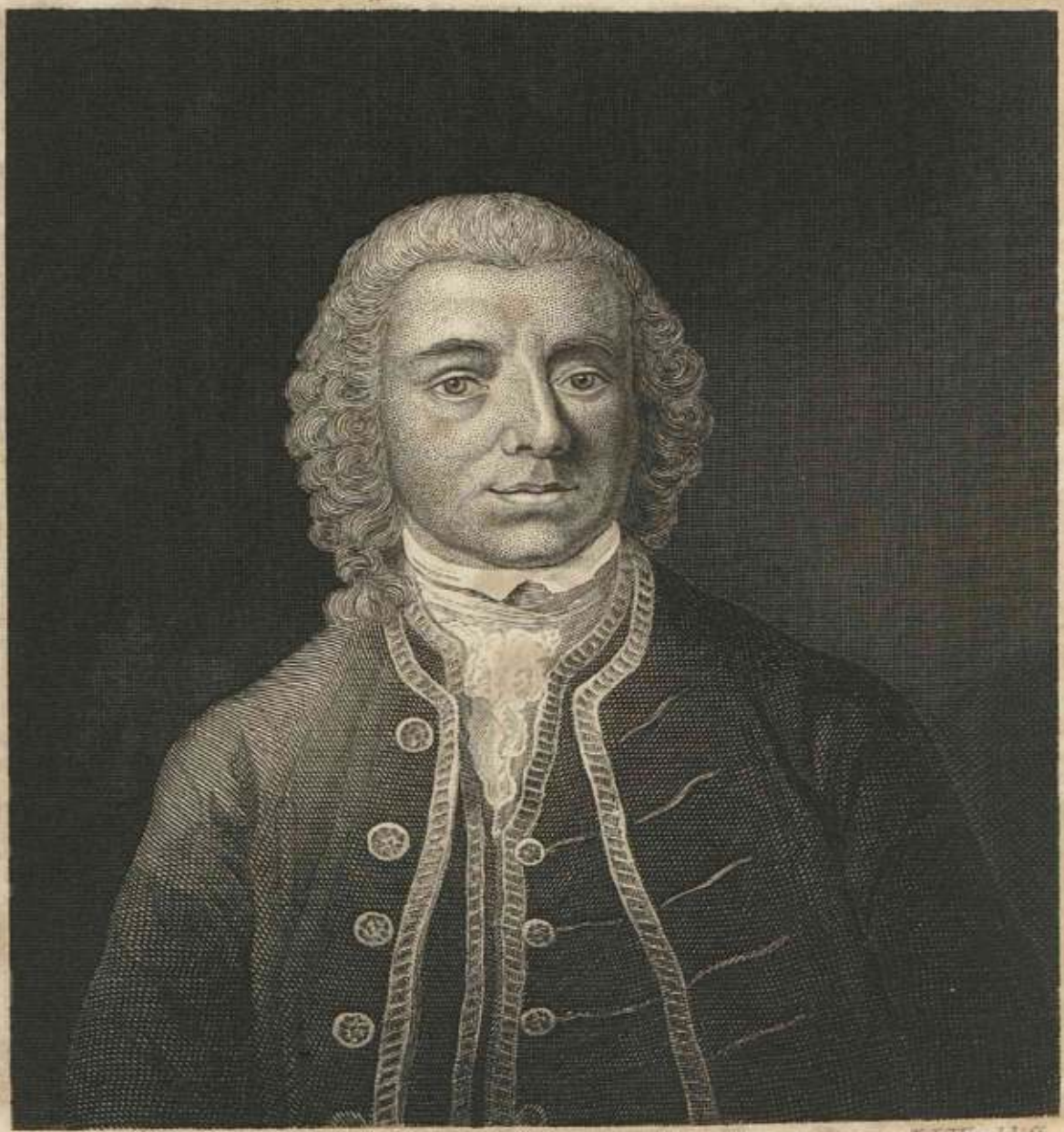
# BECKMANN'S
# HISTORY OF INVENTIONS,
## DISCOVERIES, AND ORIGINS.

"Were I to pray for a taste which should stand me in stead under every variety of circumstances, and be a source of happiness and cheerfulness to me during life, and a shield against its ills, however things might go amiss and the world frown upon me, it would be a taste for reading.....Give a man this taste, and the means of gratifying it, and you can hardly fail of making him a happy man; unless, indeed, you put into his hands a most perverse selection of books. You place him in contact with the best society in every period of history,—with the wisest, the wittiest, the tenderest, the bravest, and the purest characters who have adorned humanity. You make him a denizen of all nations, a contemporary of all ages. The world has been created for him."—Sir John Herschel. *Address on the opening of the Eton Library*, 1833.



Lud. Schmidt J.J.Hinchloff

John Beckmann.

A

# HISTORY

OF

# INVENTIONS, DISCOVERIES,

## AND ORIGINS.

By JOHN BECKMANN,

PROFESSOR OF ŒCONOMY IN THE UNIVERSITY OF GÖTTINGEN.

TRANSLATED FROM THE GERMAN,

By WILLIAM JOHNSTON.

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*Fourth Edition,*

CAREFULLY REVISED AND ENLARGED BY

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# ADVERTISEMENT.

In revising Beckmann's celebrated Work, we have endeavoured to improve it principally by altering such names, characters, descriptions, and opinions as have become obsolete, or are now known to be erroneous; and by such additions as seemed necessary to bring the accounts of the subjects treated of to the present state of knowledge. In some cases, these additions may appear to diverge from the declared object of the work; but in this we have only followed the example of Beckmann himself, who frequently deviates from a strict historical path, and we think advantageously, for the purpose of introducing curious, instructive, or amusing information. In most cases, where the subject under consideration is a process of manufacture, we have given a brief outline of its practice or theory, unless this had previously been done by the author. The translation, also, has been carefully compared with the German, but in only a very few cases could we detect errors which rendered the passages contradictory or unintelligible: on the whole, it is extremely well executed; and too much praise cannot be given to Johnston, for the judicious manner in which he has embodied in one article, detached essays on the same subject, which Beck-

mann published at different periods, as he acquired fresh information. The only instances in which this had been omitted, are the articles on *Turf*, *Cork*, and *Quarantine*, which were still encumbered with addenda; in the present edition, these have been incorporated. All such quotations from Latin and Greek authors, as might be deemed essential to the understanding of the text, have been given in English; those of a mere critical and philological character, it has been thought advisable to leave untranslated. The book may be classed as a compound of learned research and light reading, suitable both to the popular reader and the scholar; and that character has been preserved in the present edition. To the kindness of John Frodsham, Esq., the present proprietor of Arnold's Chronometer Establishment, we are indebted for much of the interesting information added to the article on 'Clocks and Watches;' and we have also to return our thanks to the publisher, Mr. H. G. Bohn, for the assistance he has constantly afforded us, as well as for his Memoir of the author.

W. Francis.
J. W. Griffith.

# TRANSLATOR'S PREFACE.

THAT the arts had their rise in the East, and that they were conveyed thence to the Greeks, and from them to the Romans, is universally admitted. Respecting the inventions and discoveries however of the earliest ages, nothing certain is known. Many of those most useful in common life must have been the production of periods when men were little acquainted with letters, or any sure mode of transmitting an account of their improvements to succeeding generations. The taste which then prevailed of giving to every thing a divine origin, rendered traditional accounts fabulous; and the exaggeration of poets tended more and more to make such authorities less worthy of credit. A variety of works also, which might have supplied us with information on this subject, have been lost; and the relations of some of those preserved are so corrupted and obscure, that the best commentators have not been able to illustrate them. This in particular is the case with many passages in Pliny, an author who appears to have collected with the utmost diligence whatever he thought useful or curious, and whose desire of communicating knowledge seems to have been equal to his thirst for acquiring it.

Of all those nations whose history has been preserved, the most distinguished are certainly the Greeks and the Romans; but, as far as can be judged at this remote period, the former were superior to the latter in point of invention. The Romans indeed seem to have known little, except what they borrowed from the Grecians; and it is evident, by their sending their

young men of rank to finish their education in Greece, that they considered that country as the seat of the arts and the sciences, and as a school where genius would be excited by the finest models, while the taste was corrected and formed. From some hints given however by Pliny and other writers, we have reason to conclude that the Romans possessed more knowledge of the arts than the moderns perhaps are willing to allow, and that some inventions, considered as new, may be only old ones revived and again rendered useful.

When Rome, abandoned to luxury and vice, became an easy prey to those hordes of barbarians who overran the empire, her arts shared in the general wreck, and were either entirely lost, or for a time forgotten. The deplorable state of ignorance in which Europe was afterwards plunged during several centuries, retarded their revival; and it was not till a late period, when favoured and protected by a few men of superior genius, that they began to be again cultivated. It cannot however be denied, that several important discoveries, altogether unknown to the ancients, which must have had considerable influence on the general state of society, were made in ages that can hardly be exempted from the appellation of barbarous. As a proof of this may be mentioned the invention of paper[1], painting in oil[2], the mariner's com

[1] Montfaucon, notwithstanding all his researches in France and Italy, was not able to discover any charter or diploma written on common paper, older than the year 1270. Paper, however, made of cotton, is said to be much older, and to have been introduced into Europe by the Arabs. If we can believe an Arabian author, who wrote in the thirteenth century, quoted by Casiri, in Biblioth. Arabico-Hispana, vol. ii. p. 9, paper (doubtless of cotton) was invented at Mecca by one Joseph Amru, about the year of the Hegira 88, or of the Christian æra 706. According to other Arabian authors, quoted by Casiri and Abulfeda, the Arabs found a manufactory of paper at Samarcand in Bucharia, when they conquered that country in the year of the Hegira 85, or of our æra 704. The art of making paper from silk was, as some pretend, known to the Chinese 180 years before Jesus Christ. See a letter from Father de Mailla to Father Etienne Souciet, in Mémoires des Inscript. et des Belles Lettres, vol. xv. 520.

[2] The oldest picture, known at present, painted in oil-colours on wood is preserved in the Imperial Gallery at Vienna. It was painted in the year 1297, by a painter named Thomas de Mutina, or de Muttersdorf, in Bohe-

pass[1], gunpowder[2], printing[3], and engraving on copper[4]. After the invention of the compass and printing, two grand sources

mia. Two other paintings in the same gallery are of the year 1357; one of them is by Nicholas Wurmser of Strasburg, and the other by Thierry of Prague. It appears therefore that painting in oil was known long before the epoch at which that invention is generally fixed; and that it is erroneously ascribed to Hubert van Eyck and his brother and pupil, John van Eyck, otherwise called John of Bruges, who lived about the end of the fourteenth century, and not the beginning of the fifteenth, as is commonly supposed. [There is evidence in the books of the Painters' Company, under the date of the 11th of Edward I. (1283), that oil painting was in use at that time. See a communication from Sir Francis Palgrave given in the new edition of Carter's Ancient Sculpture and Paintings in England, page 80.]

[1] The person who first speaks of the magnetic needle and its use in navigation, is a Provençal poet, who lived in the beginning of the thirteenth century, and who wrote a poem entitled Bible Guyot. This work is a satire, in which the author lashes with great freedom the vices of that age. Comparing the Pope to the polar star, he introduces a description of the compass, such as it appears to have been in its infancy. This invention however is claimed by the Italians, who maintain that we are indebted for it to a citizen of Amalphi, named Flavius Gioja, and in support of this assertion quote commonly the following line of Panormitanus:

Prima dedit nautis usum magnetis Amalfis.

[2] Of the use of gunpowder in Europe no certain traces occur till towards the middle of the fourteenth century. It seems pretty well proved, that artillery was known in France after the year 1345. In 1356, the city of Nuremberg purchased the first gunpowder and cannon. The same year the city of Louvain employed thirty cannon at the battle of Santfliet against the Flemings. In 1361, a fire broke out at Lubec, occasioned by the negligence of those employed in making gunpowder. In 1363, the Hans-towns used cannon for the first time, in a naval combat which they fought against the Danes. After 1367, the use of fire-arms became general throughout Italy, into which they had been introduced from Germany.

[3] The invention of printing has given rise to many researches. Meermann in his Origines Typographicæ, published in 1768, endeavours to prove that Laurence Coster of Haarlem was the inventor, about the year 1430. Most authors however agree that John Gutenberg was the inventor of moveable types, but they differ respecting the place of the invention. Some make it to be Strasburg, others Mentz, and some fix the epoch of the invention at 1440, and others at 1450.

[4] Vasari, in Vite de' Pittori, vol. iv. p. 264, ascribes the invention of engraving on copper to a goldsmith of Florence, named Maso Finiguerra, about 1460. The oldest engravers whose names and marks are known, were Israel de Mecheln, of Bokholt, in the bishopric of Munster; Martin Schœn, who worked at Colmar in Alsace, where he died in 1486; and Michael Wolgemuth of Nuremberg, who was preceptor to the famous Albert Durer, and engraved the plates in the well-known Nuremberg Chronicle. It may be proper here to observe, that the art of engraving on wood

were opened for the improvement of science. In proportion as navigation was extended, new objects were discovered to awaken the curiosity and excite the attention of the learned; and the ready means of diffusing knowledge, afforded by the press, enabled the ingenious to make them publicly known. Ignorance and superstition, the formidable enemies of philosophy in every age, began soon to lose some of that power which they had usurped; and states, forgetting their former blind policy, adopted improvements which their prejudice had before condemned.

Though it might be expected that the great share which new inventions and discoveries have at all times had in effecting such happy changes among mankind would have secured them a distinguished place in the annals of nations, we find with regret, that the pen of history has been more employed in recording the crimes of ambition and the ravage of conquerors, than in preserving the remembrance of those who, by improving science and the arts, contributed to increase the conveniences of life, and to heighten its enjoyments. So little indeed has hitherto been done towards a history of inventions and discoveries, that the rise and progress of part of those even of modern times is involved in considerable darkness and obscurity: of some the names of the inventors are not so much as known, and the honour of others is disputed by different nations; while the evidences on both sides are so imperfect, that it is almost impossible to determine to which the palm is due. To Professor Beckmann, therefore, those fond of such researches are much indebted for the pains he has been at to collect information on this subject; and though he has perhaps not been able to clear up every doubt respecting the objects on which he treats, he has certainly thrown

seems to be older than the invention of printing, to which perhaps it gave rise. The names of the first engravers on wood are however not known. [In the Athenæum Journal for 1845, page 965, is given a fac-simile of a large wood-engraving, bearing the date of 1418, which was discovered at Malines in 1844, and is now preserved in the public library at Brussels.]

much light on many curious circumstances hitherto buried in oblivion.

The author, with much modesty, gives to this work in the original the title of only Collections towards a History of Inventions: but as he has carefully traced out the rise and progress of all those objects which form the subject of his inquiry, from the earliest periods of their being known, as far as books supplied information, and arranged his matter in chronological order, the original title may admit, without being liable to much criticism, of the small variation adopted in the translation. The author, indeed, has not in these volumes comprehended every invention and discovery, but he has given an account of a great many, most of them very important.

Should any one be disposed to find fault with the author for introducing into his work some articles which on the first view may appear trifling, his own words, taken from the short preface prefixed to the first volume of the original, will perhaps be considered as a better exculpation than anything the translator might advance in his favour. "I am sensible," says he, "that many here will find circumstances which they may think unworthy of the labour I have bestowed upon them; but those who know how different our judgements are respecting utility, will not make theirs a rule for mine. Those whose self-conceit would never allow them to be sensible of this truth, and who reject as useless all ore in which they do not observe pure gold, as they display very little acuteness, must be often duped by the tinsel glare of false metal; and they give me as little uneasiness as those who have no desire to know the origin of inventions, or how they were brought to their present utility. If my extending the term Invention farther than is perhaps usual, by comprehending under it several police-establishments, be a fault, it is at any rate harmless, and on that account may be pardoned without much apology."

# MEMOIR OF THE AUTHOR.

JOHN BECKMANN, Professor of Œconomy at Göttingen during a period of forty-five years, was born at Hoye, a small town in the kingdom of Hanover, in 1739. His father held the appointment of postmaster and receiver of taxes in that place, and at the same time cultivated a small farm, which appears to have inspired his son with a taste for agricultural pursuits. The superintendence of his education devolved principally on his mother, a woman of great prudence and strength of mind, who was left a widow when young Beckmann was scarcely seven years old. In a lonely house, amid examples of industry and daily labour, he passed his youth in the perusal of works, which, although of a common-place description, were not without their use, as they led him to contract a methodical habit of mind, and afforded considerable information on various subjects, which in the sequel greatly assisted him in the pursuits to which he owed his celebrity. He himself relates that, when quite a boy, he was in the habit of making extracts of all the striking passages he met with in the course of his reading, by which means he acquired a ready use of the pen. The insufficient circumstances of his family prevented his education being cultivated in the schools till nearly fifteen; at which age he was sent to the Gymnasium of Stade, then under the direction of Gehlen, where in a short time he highly distinguished himself in classical literature. Intended for the clerical profession, he entered the university of Göttingen in 1759, for the purpose of completing his theological studies; but whether the advice of Hollmann (afterwards his father-in-law), with whom he had formed a close intimacy, produced a change in his plans, or that the mathematical instructions of

Professors Kaestner and Mayer were more congenial to his mind than divinity, he abandoned the career marked out for him, and devoted himself to the natural sciences and their application, as well as to mathematics; whilst he cultivated philology with such zeal, that he ultimately made himself master of ten different languages. In order to gain greater proficiency in these pursuits, he made a journey in 1762 to the Netherlands, but returned to Hoye in the following year, in consequence of the serious indisposition of his mother, who dying shortly afterwards, left him destitute of guidance, and in the greatest anxiety respecting his future prospects. At this juncture Büsching advised him to travel to St. Petersburg, where, upon the strong recommendations with which he was provided, he was speedily appointed to the chair of Natural Philosophy. Shortly after, Büsching, quitting the institution, returned to Germany, and dissensions having arisen among the directors, Beckmann likewise resigned his office. He then proceeded to Sweden, with the view of acquiring a detailed knowledge of the working of the mines in that country; making his principal sojourn at Upsal, where he became acquainted with Linnæus, and enjoyed the friendship and hospitality, as well as the instructions, of that eminent naturalist[1]. Leaving Sweden, he directed his course to Denmark, visiting Copenhagen and other towns, where he examined the various museums, libraries and manufacturing establishments. On arriving at Altona, he found there his friend Büsching, who recommended him to Münchhausen, curator of the Academy of Göttingen. After paying a visit to his brother at Marburgh, he proceeded to Hanover; and being approved of by Struve, then president of Göttingen under Münchhausen, he was appointed, in 1766, Professor Extraordinary of Philosophy

[1] Heyne, in his funeral oration, says Beckmann was so struck with admiration at the vast knowledge of Linnæus, that he became ensnared, like the companions of Ulysses in the island of Circe, and was disheartened from proceeding any further in his own botanical studies. To this circumstance is attributed the coolness with which he afterwards cultivated this department of science.

to that university, of which he eventually became one of the brightest ornaments.

His lectures upon œconomy had the recommendation of novelty, and produced so much applause, that in 1770 he was made ordinary professor of that science. They were attended by the flower of the studious youth of all countries, Göttingen being at that period one of the most popular universities in Europe; and many even of the distinguished statesmen and public functionaries of Germany did not disdain to be ranked among his auditors. He was in the habit of accompanying them himself into the workshops, to give them a practical knowledge of the different processes and handicrafts of which he had explained the theory. Once a week, also, he held a *Practicum Camerale*, a scientific meeting, at which he explained subjects of œconomy, administration, and finance, illustrating them by readings from a great variety of sources. He composed, to serve as a guide in this course of instruction, treatises on rural œconomy, policy, finance, commerce, and other departments of knowledge; which, though since carried to a higher degree of perfection, owed to Beckmann their first systematic form. He never entirely relinquished these public lectures, but insensibly his private studies took a direction altogether historical, the motives for which it may not be uninteresting to point out.

It is indispensably requisite at Göttingen that every professor should be able to give account of the progress and existing state of the science to which he is appointed. Any one, who two years after the publication of a work of importance in his department should not have read and analysed it, with a view of enriching his own observations, would not be regarded as a worthy successor to the chair of Haller, of Mosheim, of Gessner and Michaelis. Beckmann, who had studied at Göttingen at a time when the example of these great men dictated the law and gave the tone to the University, and perhaps to the literature of Europe, was determined to

keep pace with the spirit of the age, and not to remain ignorant of the great advances then making throughout Europe, in the numerous sciences which furnished the subjects of his practical investigations. But this was a task of no slight magnitude: and indeed when the immense additions to so many different sciences are considered, can it be wondered at, that, notwithstanding his utmost zeal and application, he found it impossible to read up all the important works which had appeared since 1770, in chemistry, physics, natural history and mathematics? Despairing of success in so Herculean an undertaking, he began to entertain feelings of aversion towards what he deemed the innovations, which were then changing the face and enlarging the scope of science. But his course of lectures, turning principally on practical matters, was not materially affected; he was, however, so fearful of falling under the imputation of being behind the progress of the age, that he devoted his mind, peculiarly fitted for this kind of study, almost exclusively to the history of arts and trades; employing in the illustration of his subjects, the materials to which he had access in the very extensive library belonging to the university; and it is to his consequent labours and researches that we owe the "History of Inventions and Discoveries." In this work, Beckmann traces their first germs from the remotest periods of antiquity, and following their gradual development, exhibits the latest improvements among civilized nations with almost unequalled acumen and ability. It abounds with invaluable materials respecting the general history of the origin and progress of the mechanic arts, which are so important a branch in civilization; and what must give it an additional value in the eyes of all who are unwilling to place reliance on assertions unsupported by authority, or may be anxious to investigate the subject more deeply, the most scrupulous references to original authorities accompany each article. Among the numerous other works of merit for which we are indebted to the literary industry of Beckmann, are,

"A History and Analysis of early Voyages and Travels," a highly interesting collection, which occupied the last years of his life, and was left unfinished at the eighth number; elaborate editions of "De Mirabilibus Auscultationibus," attributed to Aristotle, 1786; "Antigoni Carystii Historiæ Mirabiles," 1791; and "Marbodi Liber de Gemmis," 1799; publications which required the rare combination of physical knowledge with philological learning.

The Royal Society of Göttingen had, in the year 1772, admitted him one of its members, and from that period to 1783 he continued to supply their proceedings with interesting memoirs (all written in Latin), among which are the following: "On the Reduction of Fossils to their original substances;" "On the History of Alum;" "On the Sap of Madder;" "On Meerschaum, from which are formed the heads for tobacco pipes;" "On the History of Sugar," &c. After this period, however, he declined participating any longer in the labours of this learned body; owing, probably, to a change in the objects of his own particular studies. In 1784 he was created an aulic councillor of Hanover; in addition to which he was elected member of the Imperial Academy of Naturalists, of the Swedish Society of Science, of the Academies of Norway and Mayence, of the Physiographical Society of Lund, and of almost all the learned societies in Germany and the North of Europe.

With a copious knowledge of the principal sciences, Beckmann united extensive reading in the works of ancient and modern writers, not only in reference to their immediate connection with his main studies, but in respect also to their application generally to every other branch. Convinced that every professor ought, as much as possible, to have thoroughly searched into all matters relating to the subject on which he treats, he spared no expense in forming a most extensive, as well as choice library; at the same time he did not fail to avail himself of the rich intellectual stores contained in that

belonging to the university. His mind being wholly directed to all that is practical in human knowledge, it was his especial endeavour to bring it into systematic rules, based upon fundamental principles. To him particularly is to be ascribed the merit of having been the first to give to agriculture its scientific form, and to have separated it more distinctly than heretofore from the administrative and financial departments. The number of pupils indebted to him for their education, and who, eventually,—whether filling offices of state or following his footsteps as professors,—brought into effect the principles he had taught them, formed a very numerous body; and whilst he was thus the means of considerably enlarging the circle of academic subjects for the instruction of the student, he contributed not a little towards the prosperity of the university itself. His activity likewise as a writer was as persevering as it was meritorious; he united an extensive knowledge of nature, with a decided turn for applying it to practical purposes; and he published several works in German, which show this tendency of mind; among others, "Principles of German Agriculture," "Introduction to Technology," "Introduction to the Science of Commerce," &c.

To assist his literary researches, he issued a periodical work called "Physico-Œconomical Library," in which quarterly information was communicated respecting the newest works connected with the arts, manufactures, and agriculture, giving short extracts of whatever was valuable, instead of severe criticisms, of which he did not approve. It was commenced in 1770, and continued, with some little interruption, until 1807, forming 23 volumes.

Having said thus much respecting his abilities and genius, we will in conclusion take a brief glance at his private character, which, amiable and virtuous as it was, cannot fail to command the world's estimation. Honest and unpretending, a lover of peace and justice, he lived quite retired, devoted to

the conscientious performance of his duties; his candour, his sincerity in friendship, his affability to the students, have been celebrated with one accord by his coadjutors and auditors. In the domestic relations of life, he presented an example of the most exact system of order and œconomy, and enjoyed the reputation of being one of the richest professors of the university; which enabled him to exercise his ready benevolence during a period of severe dearth and suffering. Among his colleagues, Schlœtzer, the distinguished historian, with whom in his youth he had become acquainted in Russia, was the one with whom he maintained the most uninterrupted intimacy, arising, no doubt, from the congeniality of their pursuits. Few were better qualified than Schlœtzer to appreciate the researches of Beckmann, as he had himself insisted with so much force on the necessity of introducing into history a simultaneous view of the influence exercised on social institutions by the efforts of industry, and the rise and maturity of domestic arts. Beckmann married the daughter of Hollmann, his tutor and friend, with whom he enjoyed a long and uninterrupted course of happiness; she survived him only a few weeks, leaving a son and daughter who had arrived at years of maturity. His decease took place on the 3rd of February, 1811, in the 72nd year of his age. His illustrious colleague, Heyne, pronounced an eloquent eulogium on him before the Academy, which was published in the Göttingen Transactions, from which we subjoin a few extracts.

"O colleagues, if we indulge in deep sorrow at this new diminution of our fraternity by the death of one of its seniors, it must be forgiven, as consonant to our duty and piety, as well as to the affections of human nature. Indeed, when his death was announced, and when I afterwards beheld the mournful pomp of his funeral, I was afflicted with the utmost grief. Nor can this be wondered at, when it is borne in mind that he was nearly of my own age, and next to me the eldest of our Society; the habit, too, of friendly intercourse enjoyed for

many years, has great influence in riveting the affections of the mind.

"There is a narrative in Herodotus, concerning Psammenitus king of Egypt, who was conquered by Cambyses king of Persia. The city of Memphis being taken by storm, he had fallen into the hands of Cambyses; who, enraged at the vigorous defence he had encountered, commanded the royal family to be brought forth and put to death. In the first place, his daughter was paraded before him, with many maidens of noble birth, clothed as slaves; and though the other parents uttered piteous lamentations, yet Psammenitus kept his eyes fixed on the ground: in like manner, when his sons, together with two thousand of the principal youths, their necks bound with ropes, with bridles in their mouths, were ignominiously led to death, the king did not even utter a groan; but on seeing an aged man approach, one of his old friends, who had formerly partaken of the royal table, walking in the dress of a mendicant, and imploring mercy through the different ranks of the army, then indeed the king could restrain his emotions no longer, but broke forth into the most bitter wailings. The cause of this strange grief it would be foreign to our present purpose to discuss; I only wish to draw this conclusion—that the death of an old friend and companion was alone able to subdue his mind, even after it had supported him against the severest calamities. For the force of habit and friendly intercourse is most powerful: we bring to recollection many things which prey upon our feelings; they rush upon our memory with one impetus, and swell the rising grief; we dwell on early struggles, on proofs of mental power, and instances of benevolence, which formerly we had passed unheeded.

"What is known favourably of the character of him who is taken away from us, it is our pleasing duty to bring before you; what is otherwise, if anything exist, it is not our province to remember.

"The studies of Beckmann were applied to other branches

of learning, quite distinct from those in which I am occupied: but it was this very circumstance which cemented our acquaintance. His conversations on scientific subjects could not but prove profitable; especially as he blended them with a feeling for ancient literature. I was accustomed to consult him concerning subjects of nature and art, which I did not sufficiently understand; and he sometimes referred to me respecting philological matters, of which he wished to gain further information. But the varied talents of this illustrious man were wonderful: an unceasing desire to search into the origin of arts and sciences, and the history and success of inventors, was united with an insatiable thirst for general knowledge and classical learning. He was incessantly in our public library, eagerly investigating and comparing rare books in pursuit of his object; seizing their hidden treasures, and then contributing his booty to the mental improvement of the million."

*The remainder of this elegant oration concerns the details of his career, which are already embodied in the preceding sketch.*

H. G. B.

# HISTORY OF INVENTIONS

AND

# DISCOVERIES.

## ITALIAN BOOK-KEEPING.

Those who are acquainted with the Italian method of book-keeping must allow that it is an ingenious invention, of great utility to men in business, and that it has contributed to extend commerce and to facilitate its operations. It requires no less attention, care, and accuracy, than many works which are styled learned: but it is undoubtedly true, that most mercantile people, without knowing the foundation of the rules on which they proceed, conduct their books in as mechanical a manner as many of the literati do their writings.

The name, Italian book-keeping, *Doppia scrittura*, with several words employed in this branch of science and still retained in all languages, make it probable that it was invented by the Italians; and that other nations borrowed it, as well as various short methods of reckoning, from their mercantile houses, at the time when all the East-India trade passed through Italy.

De la Porte says [1], "About the year 1495, brother Luke, an Italian, published a treatise of it in his own language. He is the oldest author I have seen upon the subject." Anderson, in his Historical and Chronological Deduction of the Origin of Commerce [2], gives the following account: "In all probability, this art of double-entry accounts had its rise, or at least its

[1] La science des négocians et teneurs de livres. Paris 1754.
[2] Vol. i. p. 408.

revival, amongst the mercantile cities of Italy: possibly it might be first known at Venice, about the time that numeral algebra was taught there; from the principles of which science double-entry, or what we call merchants' accounts, seems to have been deduced. It is said that Lucas de Burgo, a friar, was the first European author who published his algebraic work at Venice, anno 1494."

This author, who was one of the greatest mathematicians of the fifteenth century, and who is supposed to be the first person who acquired a knowledge of algebra from the writings of the Arabians, was called Lucas Paciolus, e Burgo S. Sepulchri. He was a Franciscan, and so surnamed from a town in the duchy of Urbino, on the Florentine confines, called Burgo S. Sepulchro [1].

Anderson tells us [2], that he had in his possession the oldest book published in England in which any account is given of the method of book-keeping by double-entry. It was printed at London, in 1569, in folio. The author, whose name is James Peele, says, in his preface, that he had instructed many mercantile people in this art, which had been long practised in other countries, though in England it was then undoubtedly new. One may readily believe that Mr. Anderson was not ignorant of the difference between the method of book-keeping by single and that by double-entry; but he produce, nothing to induce us to believe that Peele taught the latters and not the former; for what he says of debit and credit is of no importance, as it may be applied also to the method by single-entry.

Of this Peele no mention is made in Ames's Typographical Antiquities; but in that work (p. 410) there is an account of a still older treatise of book-keeping, entitled A briefe instruction and manner how to keepe bookes of accompts, after the order of debitor and creditor, and as well for proper accompts, partible, &c. by three bookes, named the memoriall, journall, and leager. Newly augmented and set forth by John Mellis schole maister. London 1588, 12mo. Mellis, in his preface,

[1] Those who are desirous of further information respecting Lucas de Borgo, may consult Scriptores ordinis Minorum, recensuit Fr. Lucas Waddingus, Romæ 1650;—Heilbronneri Historia Matheseos universæ, Lipsiæ 1742;—Histoire des Mathématiques, par Montucla, Paris 1758.

[2] Vol. i. p. 409.

says that he is only the re-publisher of this treatise, which was before published at London in 1543 by a schoolmaster named Hugh Oldcastle. From the above title, and particularly from the three account books mentioned in it, I am inclined to believe that this work contained the true principles of book-keeping by double-entry.

The oldest German work on book-keeping by double-entry with which I am at present acquainted, is one written by John Gotlieb, and printed at Nuremberg, by Frederick Peypus, in 1531[1]. The author in his preface calls himself a citizen of Nuremberg, and says that he means to give to the public a clear and intelligible method of book-keeping, such as was never before printed. It appears, therefore, that he considered his book as the first of the kind ever published in Germany.

It is worthy of remark, that even at the end of the sixteenth century, the Italian method of book-keeping began to be applied to finances and public accounts. In the works of the celebrated Simon Stevin, published at Leyden in Dutch, and the same year in Latin, we find a system of book-keeping, as applied to finances, drawn up it appears for the use of Maurice prince of Orange. To this treatise is prefixed, in Dutch and Latin, a dedication to the duke of Sully, in which the author says, that his reason for dedicating the work to Sully was because the French had paid the greatest attention to improve the method of keeping public accounts. The work begins with a conversation, which took place between Stevin and prince Maurice, respecting the application of book-keeping to public accounts, and in which he explains to the prince the principles of mercantile book-keeping. This conversation commences with explaining the nature of debit and credit, and the principal accounts. Then follow a short journal and ledger, in which occur only the most common transactions; and the whole concludes with an account of the other books necessary for regular book-keeping, and of the manner of balancing. Stevin expressly says, that prince Maurice, in the year 1604, caused the treasury accounts to be made out after the Italian method, by an experienced book-keeper, with the best success; but how long this regulation continued I have not been able to learn. Stevin supposes, in this system, three

[1] The title runs thus: Ein Teutsch verstendig Buchhalten für Herren oder Gesellschafter inhalt wellischem Process.

ministers, and three different accounts: a *quæstor*, who receives the revenues of the domains; an *acceptor*, who receives all the other revenues of the prince; and a *thesaurarius* (treasurer), who has the care of the expenditure. All inferior offices for receiving or disbursing are to send from their books monthly extracts, which are to be doubly-entered in a principal ledger; so that it may be seen at all times how much remains in the hands of each receiver, and how much each has to collect from the debtors. One cannot help admiring the ingenuity of the Latin translator[1], who has found out, or at least invented, words to express so many new terms unknown to the ancient Romans. The learned reader may, perhaps, not be displeased with the following specimen. Book-keeping is called *apologistica* or *apologismus*; a book-keeper *apologista*; the ledger *codex accepti expensique*; the cash-book *arcarii liber*; the expense-book *impensarum liber*; the waste-book *liber deletitius*; accounts are called *nomina*; stock account *sors*; profit and loss account *lucri damnique ratiocinium, contentio* or *sortium comparatio*; the final balance *epilogismus*; the chamber of accounts, or counting-house, *logisterium*, &c.

In the end of this work Stevin endeavours to show that the Romans, or rather the Grecians (for the former knew scarcely anything but what the latter had discovered), were in some measure acquainted with book-keeping, and supports his conjecture by quoting Cicero's oration for Roscius. I confess that the following passage in Pliny, *Fortunæ omnia expensa, huic omnia feruntur accepta, et in tota ratione mortalium sola utramque paginam facit*[2], as well as the terms *tabulæ accepti et expensi*; *nomina translata in tabulas*, seem to indicate that the Romans entered debit and credit in their books on two different pages; but it appears to me not yet proved, and improbable, that they were acquainted with our scientific method of book-keeping; with the mode of opening various accounts; of comparing them together, and of bringing them to a final balance. As bills of exchange and insurance were not known in the commerce of the ancients, the business of merchants was not so intricate and complex as to require such a variety of books and accounts as is necessary in that of the moderns.

[1] Bayle says, that the Latin translation of Stevin's works was executed principally by Willebrord Snellius.

[2] Lib. ii. cap. 7.

Klipstein is of opinion that attempts were made in France to apply book-keeping, by double-entry, to the public accounts, under Henry IV., afterwards under Colbert, and again in the year 1716. That attempts were made, for this purpose, under Henry IV., he concludes from a work entitled An Inquiry into the Finances of France; but I do not know whether what the author says be sufficient to support this opinion.

[The system of double-entry began from the commencement of the present century to be adopted by several governments in the management of the public accounts, among others by those of Austria, France and Holland, with highly beneficial effects. Some attempts have been more recently made in this country to introduce it into the government offices, and from the great success which has attended them, this system will probably soon be generally used.]

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## ODOMETER.

An Odometer, Pedometer, Perambulator, or Way-measurer, is an instrument or machine by which the steps of a person who walks, or the revolutions made by the wheel of a carriage, can be counted, and by which the distance that one has travelled can be ascertained. Vitruvius, in his tenth book[1], describes a machine of this kind for a carriage, and which, in his opinion, would answer for a ship. We are told by Capitolinus, in the life of the emperor Pertinax, that among the effects of the emperor Commodus exposed to sale, there were carriages of various kinds, some of which "measured the road, and pointed out the hours;" but whether by these words we are to understand an odometer, cannot with certainty be determined.

That this instrument was known even in the fifteenth century, can be proved from the carving on the ducal palace at Urbino —an edifice erected in an uncommon style of magnificence,

[1] C. 14. Nicolai, in the first part of his Travels, has translated this description of an odometer, and illustrated it with a figure by H. Catel.

by duke Frederic, who died in 1482. The ornaments here employed form, almost, a complete representation of all the warlike apparatus used at that period. both by sea and land; and among these is the figure of a ship, which seems to be furnished with an odometer; but whether the wheels and springs, carved out apart, be intended to show the construction of it, I will not venture to decide[1].

The celebrated John Fernel, physician to Catherine of Medici, queen of France, measured with an instrument of this kind, in 1550, a degree of the meridian between Paris and Amiens, and found it to be 68,096 geometrical paces, or about 56,747 toises (364,960 English feet); that is, 303 toises less than Picard found it to be; or about 300 toises less than later measurements have made it. Picard himself, in his mathematical measurement, assisted by the newest improvements, erred 123 toises. It is therefore very surprising that Fernel should approach so near the truth with such an instrument. The manner of constructing it however, as far as I know, appears to be lost[2].

Levin Hulsius, in his Treatise of mechanical instruments, published at Frankfort in 1604, describes an odometer, but without naming the inventor. It appears, however, that it was the production of Paul Pfinzing, born at Nuremberg in 1554[3]; and who, besides other works, published, in 1598, Methodus Geometrica, or a Treatise on measuring land, and how to use proper instruments for that purpose, on foot, on horseback, or in a carriage. This treatise, which was never

[1] This palace, with its ornaments, is described in the Memorie concernenti la citta di Urbino. Roma, 1724. fol. The figure to which I allude is in plate 53. Bernardino Baldi, the author of the descriptive part, considers it as an odometer.

[2] In Joannis Fernelii Ambianatis Cosmotheoria, Parisiis 1528, we find only the following passage respecting this invention :—" Nec vulgi supputatione satiatus, vehiculum, quod Parisios recta via petebat, conscendi, in eoque residens tota via 17024 fere rotæ circumvolutiones collegi, vallibus et montibus ad equalitatem, quoad facultas nostra ferebat, redactis. Erat autem rotæ diameter." In Almagesti novi parte posteriori, tomi primi, Bononiæ 1651. fol. the author, Riccioli, says that Fernel contrived his carriage in such a manner, that the revolutions of the wheels were shown by a hammer striking on a bell. Where that jesuit discovered this I cannot learn.

[3] Doppelmayer, Nachricht von Nurnberg Künstlern, p. 82. Will, Nurnbergisches Gelehrten-Lexicon, iii. p. 156.

sold, but given away by the author, contains a description of the same instrument described by Hulsius, and which, as Nicolai says, is still preserved in the collection of curiosities at Dresden.

In the same collection is an odometer which Augustus, elector of Saxony, who reigned between the years 1553 and 1586, employed in measuring his territories. This instrument is mentioned by Beutel[1], without naming the inventor; but I think it very probable that it was made by Martin Feyhel, who was born at Naumburg, and resided at Augsburg; as Von Stetten[2] relates, in his History of the Arts at Augsburg, that Feyhel made a way-measurer (probably odometer) for the elector of Saxony, and that he himself called it a new instrument never before heard of. This artist was an intimate friend of the celebrated Christopher Schissler, also of Augsburg, who in 1579 constructed a quadrant, still to be found at Oxford; and in 1606 an armillary sphere, still preserved at Augsburg.

The emperor Rudolphus II., who reigned from 1576 to 1612, and who was fond of, and acquainted with, the mechanical arts, possessed two very curious odometers, which not only pointed out distances, but also marked them down on paper by the way. The description and use of one of these is given by De Boot[3], who was that prince's librarian; and what he says has been copied by Kircher[4], and illustrated with a coarse figure. It is not improbable that the before-mentioned Schissler was the maker of this instrument, as we are informed by Stetten that he constructed a great many machines and automata for the emperor Rudolphus II. The other odometer, which was much more curious, appears to have been constructed by that emperor himself[5].

About the end of the 17th century, an artist in England, named Butterfield, invented an odometer which met with great approbation. In the first volume of the Philosophical Transactions there are two papers written by this ingenious man; but of his odometer I have not yet been able to find a description.

In the beginning of the last century, Adam Frederick Zur-

[1] Cimelium Geographicum Tripartitum. Dresden, 1680.
[2] Kunstgeschichte von Augsburg, p. 167.
[3] Gemmarum et Lapidum Historia. Lugd. Bat. 1647, 8vo, p. 468.
[4] Magnes, sive De arte magnetica. Coloniæ, 1643, 4to, p. 221.
[5] Boot. Hist. Gemmarum, p. 473.

ner, to whom we are indebted for good maps of the electorate of Saxony, invented also an odometer, or geometrical carriage, a description and figure of which, taken from Schramm's Saxonia Monumentis Viarum illustrata, is given by Nicolai. This instrument is not now to be found in the Dresden collection.

In Bion's Treatise on the construction of mathematical instruments, improved by Doppelmayer, there is a description of a pedometer, and the author praises a new invention by one Sauveur.

In the year 1724 Meynier laid before the Royal Academy of Sciences at Paris an odometer, a short account of which, without a figure, is given in the history of the Academy for that year. This machine was afterwards improved by Outhier; and a description of the improvements, but without any figure, is to be found in the history of the Academy for 1742. A full description, together with a figure, may however be seen in a work, entitled Machines et Inventions approuvées par l'Académie, t. vii.

Perhaps the most perfect machine of this kind was that made at Berlin by an artist named Hohlfeld, a short account of which may be found in the ninth volume of the Hamburg Magazine. A complete description I have not seen; but I learn from Professor Bernoulli's Tour through Brandenburg, Pomerania, &c., that a model of it is preserved in the excellent collection of Count de Podewils at Gusow[1]. The inventor of it was a man of such rare talents, and rendered such benefit to the public, that the following anecdotes of his life may prove not unacceptable to many readers. It was written by Professor Muller at Berlin, and transmitted to me by Dr. Bloch.

Hohlfeld was born of poor parents at Hennerndorf in the mountains of Saxony, in 1711. He learned the trade of lace-making at Dresden, and early discovered a turn for mechanics by constructing various kinds of clocks. From Dresden he removed to Berlin to follow his occupation. As he was an excellent workman, and invented several machines for shorten-

[1] This machine was used by Sulzer during his tour. See his Journal, published at Leipsic, 1780, 8vo, p. 3. It has been since improved by Schumacher, a clergyman at Elbing, by Klindworth, Catel at Berlin, and by an anonymous clergyman in the Schwabisches Magazin, 1777, p. 306.

ing his labour, he found sufficient time to indulge his inclination for mechanics; and he made there, at the same time that he pursued his usual business, air-guns and clocks.

In the year 1748 he became acquainted with the celebrated Sulzer, at whose desire he undertook the construction of a machine for noting down any piece of music when played on a harpsichord. A machine of this kind had been before invented by Von Unger; but Hohlfeld, from a very imperfect description, completed one without any other assistance than that of his own genius. Of this machine, now in the possession of the Academy of Sciences at Berlin, Sulzer gave a figure, from which it was afterwards constructed in England. This ingenious piece of mechanism was universally approved, though several things may be wanting to render it complete; but no one was so generous as to indemnify the artist for his expenses, or to reward him for his labour.

About the year 1756, the Prussian minister, Count de Podewils, took him into his service, chiefly for the purpose of constructing water-works in his magnificent gardens at Gusow. There he invented his well-known thrashing machine, and another for chopping straw more expeditiously. He also displayed his talent for invention by constructing an apparatus, which, being fastened to a carriage, indicates the revolutions made by the wheels. Such machines had been made before, but his far exceeded every thing of the kind. Having lost this machine by a fire, he invented another still simpler, which was so contrived as to be buckled between the spokes of the wheel. This piece of mechanism was in the possession of Sulzer, who used it on his tour, and found that it answered the intended purpose.

In the year 1765, when the duke of Courland, then hereditary prince, resided at Berlin, he paid a visit to Hohlfeld, and endeavoured to prevail on him to go to Courland, by offering him a pension of 800 rix-dollars; but this ingenious man was so contented with his condition, and so attached to his friends, that he would not, merely for self-interest, quit Berlin. His refusal, however, obtained for him a pension of 150 dollars from the king.

Besides the before-mentioned machines, he constructed, occasionally, several useful models. Among these were a loom for weaving figured stuffs, so contrived that the weaver

had no need of anything to shoot through the woof[1]; a pedometer for putting in the pocket; a convenient and simple bed for a sick person, which was of such a nature, that the patient, with the least effort, could at any time raise or lower the breast, and when necessary convert the bed into a stool; and a carriage so formed, that if the horses took fright or ran away, the person in it could, by a single push, loosen the pole and set them at liberty. The two last models have been lost.

Every machine that this singular man saw, he altered and improved in the simplest manner. All his own instruments he made himself, and repaired them when damaged. But as he was fonder of inventing than of following the plans of others, he made them in such a manner that no one except himself could use them. Several of his improvements were, however, imitated by common workmen, though in a very clumsy manner. It is worthy of remark, that he never bestowed study upon anything; but when he had once conceived an idea, he immediately executed it. He comprehended in a moment whatever was proposed, and at the same time saw how it was to be accomplished. He could therefore tell in an instant whether a thing was practicable; if he thought it was not, no persuasion or offer of money could induce him to attempt it. He never pursued chimæras like those mechanics who have not had the benefit of education or instruction; and though this may be ascribed to the intercourse he had with great mathematicians and philosophers, there is every reason to believe that he would have equally guarded against them, even if he had not enjoyed that advantage. The same quickness of apprehension which he manifested in mechanics he showed also in other things. His observations on most subjects were judicious, and peculiar to himself; so that it may be said, without exaggeration, that he was born with a philosophical mind.

A little before his death he had the pleasure of seeing a curious harpsichord he had made, which was purchased by his Prussian Majesty, and placed in an elegant apartment in the new palace at Potsdam. As he had for some time neglected this instrument, the too great attention which he bestowed on putting it in order contributed not a little to bring on that disease which at last proved fatal to him. His clock

[1] This model is preserved in the collection of the Academy.

having become deranged during his illness, he could not be prevented, notwithstanding the admonition of his friend and physician Dr. Stahls, from repairing it. Close application occasioned some obstructions which were not observed till too late; and an inflammation taking place, he died in 1771, at the house of Count de Podewils, in the 60th year of his age.

[The instrument now generally used in this country for measuring the distance gone over, is that invented by Mr. Payne, watchmaker, of Bond-street. In this ingenious contrivance motion is communicated from the traveller to the machinery of the pedometer, by means of a horizontal lever, which is furnished with a weight at one end and a pivot or axis at the other; under the lever is a spring, which keeps the lever when at rest close up to a regulating screw; the spring is so arranged as to be only just sufficiently strong to overcome the weight of the lever and to prevent its falling downwards.

When the body of the traveller is raised in progression, the lever is impelled downwards by the jerk, and immediately returned to its place by the spring, and so long as the motion is continued the lever is constantly in a state of vibration. A small ratchet-wheel is fixed to the axis of the lever, and beneath it is another and larger ratchet-wheel which fits on the same axis, but is not attached to it. These two wheels are connected by a ratchet or pale in such a manner, that when the lever falls, both wheels are moved forward one or more teeth, but when the lever rises again from the force of the spring, the larger ratchet-wheel is held stationary by a ratchet. The larger wheel is connected with a series of toothed wheels and pinions, by means of a pinion fixed on its under-surface. The centre wheel carries an index or hand, which points to figures on the dial-plate. The whole apparatus packs into the case of a watch[1].]

[1] There is a figure of it in the Penny Cyclopædia, vol. xvii. p. 367.

## MACHINE FOR NOTING DOWN MUSIC.

As I have occasionally mentioned in the preceding article, a machine for noting down any piece of music played on a harpsichord or other musical instrument, I shall here add a short history of the invention of it, as far as I know; and with the greater pleasure, as another nation has laid claim to it, though it belongs to my countrymen.

It appears incontestable, that a proposal for inventing such a machine was first made known by an Englishman. In the month of March 1747, John Freke transmitted to the Royal Society a paper written by a clergyman of the name of Creed, which was printed in the Philosophical Transactions under the following title:—A Demonstration of the possibility of making a machine that shall write extempore voluntaries, or other pieces of music, as fast as any master shall be able to play them upon an organ, harpsichord, &c.; and that in a character more natural and more intelligible, and more expressive of all the varieties those instruments are capable of exhibiting, than the character now in use[1]. The author of this paper however points out the possibility only of making such a machine, without giving directions how to construct it.

In the year 1745, John Frederic Unger, then land-bailiff and burgomaster of Einbec, and who is known by several learned works, fell upon the same invention without the smallest knowledge of the idea published in England. This invention however, owing to the variety of his occupations, he did not make known till the year 1752, when he transmitted a short account of it, accompanied with figures, to the Academy of Sciences at Berlin. The Academy highly approved of it, and it was soon celebrated in several gazettes, but a description of it was never printed.

A few days after Euler had read this paper of Unger's before the Academy, M. Sulzer informed Hohlfeld of the invention, and advised him to exert his ingenuity in constructing such a machine. In two weeks this untaught mechanic, without having read Unger's paper, and even without inspecting the figures, completed the machine, which Unger himself had

[1] Phil. Trans. vol. xliv. p. ii. No. 483, p. 446.

not been able to execute through want of an artist capable of following his ideas.

Unger's own description of his invention was printed, with copper-plates, at Brunswick, in the year 1774, together with the correspondence between him and Euler, and other documents. A description of Hohlfeld's machine, illustrated with figures, was published after his death by Sulzer, in the new memoirs of the Academy of Berlin, 1771, under the title of 'Description of a machine for noting down pieces of music as fast as they are played upon the harpsichord.' Sulzer there remarks, that Hohlfeld had not followed the plan sketched out by Unger, and that the two machines differed in this—that Unger's formed one piece with the harpsichord, while that of Hohlfeld could be applied to any harpsichord whatever.

When Dr. Burney visited Berlin, he was made acquainted with Hohlfeld's machine by M. Marpurg; and has been so ungenerous, or rather unjust, as to say in his Musical Travels, that it is an English invention, and that it had been before fully described in the Philosophical Transactions. This falsehood M. Unger has sufficiently refuted. Without repeating his proofs, I shall here content myself with quoting his own words, in the following passage:—"How can Burney wish to deprive our ingenious Hohlfeld of the honour of being the sole author of that invention, and to make an Englishman share it with him, because our German happened to execute successfully what his countryman Creed only suggested? Such an attempt is as unjust in its consequences as it is dishonourable to the English nation and the English artists. When we reflect on the high estimation in which music is held in England, the liberality of the English nobility, and their readiness to spare no expenses in bringing forward any useful invention, a property peculiar to the English, it affords just matter of surprise that the English artists should have suffered themselves to be anticipated by a German journeyman lace-maker. To our Hohlfeld, therefore, will incontestably remain the lasting honour of having executed a German invention; and the Germans may contentedly wait to see whether Burney will find an English mechanic capable of constructing this machine, from the information given by his countryman Creed."

## REFINING GOLD AND SILVER ORE BY QUICKSILVER.

### AMALGAMATION.

It is well known that quicksilver unites very readily with almost all metals, and when added in a considerable quantity forms with them a paste which can be kneaded, and which is called amalgam. On the other hand, as it does not unite with the earths, being a metallic substance, it furnishes an excellent medium for separating gold and silver from the substances with which they are found. The amalgam is squeezed through a piece of leather, in which these precious metals remain with a certain portion of the quicksilver; and the former are freed from the latter by means of fire, which volatilizes the mercury. This amalgam made with gold serves also for gilding metals (water-gilding)[1], if it be rubbed over them, and afterwards heated till the quicksilver be driven off.

[1] [Among the improvements of recent date there are perhaps none of greater importance than those of electro-gilding and gilding by immersion, which have almost entirely superseded the process of gilding by an amalgam of mercury and gold, so fatal to the workmen exposed to the deleterious effects of the mercurial vapours. It is not our intention to enter at present into a history of the invention of these processes; they will more properly be reserved for a future volume, in which the discoveries of the present century will be treated of. The following short outline may however not prove uninteresting to the reader:—It had long been known to experimentalists on the chemical action of voltaic electricity, that solutions of several metallic salts were decomposed by its agency, and the metal produced in its free state. The precipitation of copper by the voltaic current was noticed by Mr. Nicholson[a] in a paper entitled 'Account of the new Electrical Apparatus of Sig. Alex. Volta, and experiments performed with the same;' but the earliest recorded process in electro-gilding is probably that contained in a letter from Brugnatelli to Van Mons[b], in which he states that he had deposited a film of gold on ten silver medals by bringing them into communication by means of a steel wire with the negative pole of a voltaic pile, and keeping them one after the other immersed in ammoniuret of gold newly made and well-saturated. This announcement of a process identical with those now extensively used, attracted no attention at the time it was made, and no further experiments

[a] Nicholson's Journal, July 1800, p. 179.
[b] Philosophical Magazine, 1805.

The first use of quicksilver is commonly reckoned a Spanish invention, discovered about the middle of the sixteenth century; but it appears from Pliny, that the ancients were acquainted with amalgam and its use, not only for separating gold and silver from earthy particles, but also for gilding[1]. Vitruvius describes the manner of recovering gold from cloth in which it has been interwoven. The cloth, he says, is to be put into an earthen vessel, and placed over the fire, in order that it may be burnt. The ashes are to be thrown into water, and quicksilver added to them. The latter attracts the particles of the gold, and unites with them. The water is then to be poured off, and the residue put into a piece of cloth; which being squeezed with the hands, the quicksilver, on account of its fluidity, oozes through the pores, and the gold is left pure in a compressed mass[2]. Isidore of Seville says also, that quicksilver is best preserved in vessels of glass, as it penetrates all other substances; and that without it neither silver nor brass can be gilded[3]. Modern mineralogists however have this advantage over the ancient, that they know how to separate the quicksilver from gold and silver without losing it. Instead of exposing the amalgam to an open fire, as for-

on the application of electricity to the deposition of metals for the purposes of the arts were published until the year 1830, when Mr. E. Davy read a paper before the Royal Society, in which he distinctly states that he had gilded, silvered, coppered and tinned various metals by the voltaic battery[a]. The experiments of Brugnatelli and Davy were however completely lost sight of, and the art may be said to date its origin from the period when the late Professor Daniell described his constant battery. Since that time the art has continued to advance most rapidly, either in the perfecting of the apparatus or in the pointing out of more suitable salts of gold and silver, from which the metals might be precipitated. Among those who have contributed to its advancement we may particularly instance the names of our countrymen, Woolrich, Spencer, Jordan, Mason, Murray, Smee, Elkington, Fox Talbot, and Tuck. Nearly all the gilt articles manufactured at Birmingham are now gilded by the process patented by Mr. Elkington, in which, after the articles have been cleansed by a weak acid, they are placed in a hot solution of nitro-muriate of gold, to which a considerable excess of bicarbonate of potash has been added; in the course of a few seconds they thus receive a beautiful and permanent coating of gold.]

[a] Phil. Trans. 1831, p. 147.

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[1] Lib. xxxiii. cap. 6.

[2] Vit. lib. vii. c. 8

[3] In Origin. lib. xvi. c. 18.

merly, and driving off the volatile metal, it is now put into a retort, and the quicksilver is collected in a receiver for further use.

Those also who wash gold from the sand found near rivers, use quicksilver before their work is completed; and I am strongly inclined to believe that this method prevailed in Germany long before the discovery of the mines in America. In the year 1582, John Michael Heberer described the washing of gold as he saw it practised at Selz, not far from Strasburg; and at that time quicksilver had been long employed for that purpose. In Treitlinger's Dissertation, also, concerning the collecting of gold, and particularly in the Rhine, there is a description of the manner in which gold sand is washed by means of quicksilver, but no date is mentioned[1].

The history of employing mercury in procuring the American silver is, as far as I know, most fully given by the jesuit Acosta[2], whose relation of the Indies abounds with curious and useful information. The quicksilver mines of Peru are situated in an extensive ridge of mountains near Guamanga, on the south side of Lima, and at no great distance from it. They are called Guancabelica, or Guancavilia. The mines were discovered about the year 1566 or 1567, when Castro was viceroy of Peru, by Henry Garces, or Graces, as he is called by the Portuguese. This man was a native of Porto, went to Peru in the Spanish service, and after the death of his wife became canon of the cathedral of Mexico. He translated the Lusiad of Camoens from the Portuguese into Spanish, and this has procured him a place in Professor Dieze's translation of Velasquez's History of Spanish Poetry. He caused a law to be enacted that no silver bullion should be suffered to circulate in Peru; but his greatest service was the discovery of the quicksilver mines. As he was one day examining the red earth, which the Indians use for paint, and call *limpi*, he observed that it was native cinnabar; and as he knew that quicksilver was extracted from it in Europe, he went to the place where it was dug up, made some experiments, and thus laid a foundation for the most important works. No one however thought of employing this metal in the silver mines till the year 1571, when Francis de Toledo

[1] De Aurilegio, præcipue in Rheno. Argent. 1776.
[2] Historia naturale e morale delle Indie. Venetia, 1596.

being viceroy, one Pero Fernandes de Velasco came to Peru, and offered to refine the silver by mercury, as he had learnt at the smelting-houses in Mexico. His proposal being accepted, and his attempts proving successful, the old methods were abandoned, and that of amalgamation was adopted in its stead [1]. From this account it appears that Garces was not the inventor of amalgamation, that it was introduced into Peru in the year 1571, and that it had been long before practised in Mexico; but at what period it was first used there I have not been able to learn. The abbé Raynal says, that quicksilver was a free article of trade till the year 1571, when it was declared to belong exclusively to the crown; and this regulation was made in consequence of its being employed in refining. Robertson, in his History of America, tells us that the mines of Guanacabelica were discovered in 1563, and that amalgamation was introduced in 1574.

Anderson says, in his History of Commerce [2], that in the second volume of Hakluyt there is a letter which shows the use of quicksilver to have been a new invention in the year 1572. This letter I found, not in the second, but in the third and last volume of the Voyages collected by Hakluyt [3]. It was written in the above year by a merchant named Henry Hawks, and contains only the following information: "A good owner of mines must have much quicksilver; and as for this charge of quicksilver, it is a new invention, which they find more profitable than to fine their ore with lead."

Gobet, in a work entitled The Ancient Mineralogists of France, accuses Alphonso Barba of asserting that he found out amalgamation in the year 1609. To examine this charge, it will be necessary to give some account of the metallurgic works of that Spaniard, which, perhaps, may not prove unacceptable to those who are fond of metallurgy and mineralogy. Alvaro Alphonso Barba was born at Lepe, a small town in Andalusia, and officiated many years as clergyman of the church of St. Bernard, at Potosi. The first edition of this

[1] The same account as that given by Acosta may be seen in Garcilasso de la Vega, Commentarios reales; Lisboa 1609, p. 225; in Rycaut's English translation, London 1688, fol. i. p. 347; and in De Laet, Novus Orbis, Lugd. Bat. 1633, fol. p. 447.

[2] Vol. i. p. 414.

[3] Hakluyt's Collection of Voyages. London, 1600, fol. vol. iii. p. 466.

work was printed in quarto, at Madrid, in 1640, in the Spanish language, and illustrated with cuts. This book the Spaniards for a long time concealed, because they considered it as containing all their metallurgic secrets; though at that time there were much better works of the kind in Germany, and though amalgamation had been long known and practised. Edward earl of Sandwich, being ambassador to Spain, found however an opportunity of procuring a copy of it, as a great rarity; and he began a translation of it into English, but translated only the first two books. This translation was published at London in octavo, in 1674, after the earl's death, and entitled The First Book of the Art of Metals, in which is declared the manner of their generation, and the concomitants of them. Written in Spanish by Albaro Alonso Barba, translated by the earl of Sandwich. From this English edition several German translations have been made, of which I am acquainted with the following: two at Hamburg, one printed in 1676, and the other in 1696; and two at Frankfort, one in 1726, and another in 1739. In the year 1749 a new edition appeared at Vienna. This edition, which is very different from any of the former, was translated from the French by one Godar, who was not a German, and who on that account apologises in the preface for the badness of his style. All these editions however are imperfect; for the original contains five books, as we learn from Leibnitz, who caused them to be transcribed. In the year 1751 a new translation came out at Paris, entitled Metallurgy, or the art of extracting and purifying metals, translated from the Spanish of Alphonso Barba, by M. Gosfort, with the most curious dissertations on mines and metallic operations; of this translation the celebrated abbé Lenglet de Fresnoy is said to have been the editor[1].

To judge by two of the German editions, Gobet has done Barba an injustice. In that of 1676, I find Barba expressly says he does not believe the ancients were acquainted with the art of extracting silver from pounded ore by the means of quicksilver. This certainly does not indicate that he laid claim to the invention; besides, he everywhere speaks of amalgamation as an art long used in America, but complains

[1] See La France littéraire. Paris, 1769, 2 vols. 8vo, vol. ii. p. 410.

of the negligence with which it was practised. In a passage however in the Vienna edition, and which has probably been added by Gobet, we are told that in the year 1609, Barba attempted to fix quicksilver, and with that view bethought himself of mixing it with finely pounded silver ore; that he at first imagined, with surprise, that he had obtained a mass of silver, but that he soon perceived that the mercury was not changed into silver, but had only attracted the particles of that metal. "I was," adds Barba, "highly pleased with my new discovery of managing ore, of extracting its contents, and of refining it; and this method I continued to practise." I imagine that Barba was still in Europe in 1609, and made that experiment before he was acquainted with the smelting-works in America. I am however of opinion, that one will see by the original that Barba did not wish to claim the invention of amalgamation as practised in the mines of America.

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## COLD OR DRY GILDING.

Dry gilding, as it is called by some workmen, is a light method of gilding, by steeping linen rags in a solution of gold, then burning them; and with a piece of cloth dipped in salt water, rubbing the ashes over silver intended to be gilt. This method requires neither much labour nor much gold, and may be employed with advantage for carved work and ornaments. It is however not durable.

I am of opinion that this manner of gilding is a German invention, and that foreigners, at least the English, were first made acquainted with it about the end of the last century; for Robert Southwell describes it in the Philosophical Transactions for the year 1698, and says that it was known to very few goldsmiths in Germany.

## GOLD VARNISH.

As mankind could not have everything that they wished for of gold, they were contented with incrusting many articles with this precious metal. For that purpose the gold was beat into plates, with which the walls of apartments, dishes, and other vessels were covered. In early ages these plates were thick, so that gilding in this manner was very expensive[1]; but in process of time the expense was much lessened, because the art was discovered of making these gold plates thinner, and of laying them on with a size. Articles however ornamented in this manner were still costly, and the valuable metal was always lost. Yellow golden colours of all kinds were then tried; but these did not fully produce the required effect, as they wanted that splendour peculiar to metals, and appeared always languid and dull. It was not till modern times that artists conceived the idea of overlaying with silver, or some cheaper white metal, such things as they wished to have the appearance of gold, and then daubing them over with a yellow transparent varnish, in order to give to the white metal the colour of gold, and to the colour the splendour of metal. "When we cover our houses with gold," says Seneca, "do we not show that we delight in deception? for we know that coarse wood is concealed under that gold[2]."

This ingenious process, which at present is employed all over Europe in gilding wooden frames, coaches, and various articles, and which was formerly used in the preparation of the now old-fashioned leather tapestry, was invented towards the end of the 17th century. Anderson, in his Historical and chronological deduction of the Origin of Commerce, says that it was introduced into England by one Evelyn in the year 1633; and quotes, in support of this assertion, The Present State of England, printed in 1683.

This invention, however, does not belong to the English, but to the Italians, and properly to the Sicilians. Antonino

[1] One may see in Homer's Odyssey, book iii. v. 432, the process employed for gilding in this manner, the horns of the cow brought by Nestor as an offering to Minerva.

[2] Epist. 115.

Cento, an artist of Palermo, found out the gold varnish, and in the year 1680 published there an account of the method of preparing it. That work I have never seen; but I found this information in a book printed at Palermo in 1704, and entitled The Inventions of the Sicilians[1]. Among the few important things contained in this book, the greater part of which is compiled from old Latin writers, there is, in the additions, a receipt how to prepare the gold varnish (*vernice d'oro*). The whole account I shall transcribe, as the authors of the French Journal of Agriculture, Commerce, and the Arts, thought it worth their trouble to make it known in that work in 1778.

"Take shell-lac, and having freed it from the filth and bits of wood with which it is mixed, put it into a small linen bag, and wash it in pure water, till the water no longer becomes red; then take it from the bag and suffer it to dry. When it is perfectly dry, pound it very fine; because the finer it is pounded the more readily will it dissolve. Then take four parts of spirit of wine, and one of the lac, reduced, as before directed, to an impalpable powder, so that for every four pounds of spirit you may have one of lac: mix these together, and, having put them into an alembic, graduate the fire so that the lac may dissolve in the spirit. When dissolved, strain the whole through a strong piece of linen cloth; throw away what remains in the cloth, as of no use, and preserve the liquor in a glass bottle closely corked. This is the gold varnish which may be employed for gilding any kind of wood.

"When you wish to use it, you must, in order that the work may be done with more smoothness, employ a brush made of the tail of a certain quadruped called the vari, well-known to those who sell colours for painting; and with this instrument dipped in the liquor wash gently over, three times, the wood which has been silvered. You must, however, remember every time you pass the brush over the wood to let it dry; and thus your work will be extremely beautiful, and have a resemblance to the finest gold."

After this invention was made known, it was not difficult to vary, by several methods, the manner of preparing it. Different receipts, therefore, have for that purpose been given in a number of books, such as Croker's Painter, and others: and, on this account, young artists are frequently at a loss which

[1] La Sicilia inventrice. Palermo, 1704, 4to.

to choose; and when a receipt is found better than another, experienced artists keep it always secret.

With the preparation of that varnish used for gilding leather tapestry Reaumur was acquainted, and from his papers it was made known by Fougeroux de Bondaroy. The method of making the English varnish was communicated by Scarlet to Hellot, in the year 1720; and by Graham to Du Fay, in 1738. In the year 1761, Hellot gave the receipt to the Academy of Sciences at Paris, who published it in their memoirs for that year.

If it be true, as Fougeroux says, that gilded tapestry was made above two hundred years ago, it might be worth the little trouble that such an examination would require to investigate the method used to gild it.

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## TULIPS.

The greater part of the flowers which adorn our gardens have been brought to us from the Levant. A few have been procured from other parts of the world; and some of our own indigenous plants, that grow wild, have, by care and cultivation, been so much improved as to merit a place in our parterres. Our ancestors, perhaps, some centuries ago paid attention to flowers; but it appears that the Orientals, and particularly the Turks, who in other respects are not very susceptible of the inanimate beauties of nature, were the first people who cultivated a variety of them in their gardens for ornament and pleasure. From their gardens, therefore, have been procured the most of those which decorate ours; and amongst these is the tulip.

Few plants acquire through accident, weakness, or disease, so many tints, variegations, and figures, as the tulip. When uncultivated, and in its natural state, it is almost of one colour, has large leaves, and an extraordinary long stem. When it has been weakened by culture, it becomes more agreeable in the eyes of the florist. The petals are then paler, more variegated, and smaller; the leaves assume a fainter or softer green

colour: and this masterpiece of culture, the more beautiful it turns, grows so much the weaker; so that, with the most careful skill and attention, it can with difficulty be transplanted, and even scarcely kept alive.

That the tulip grows wild in the Levant, and was thence brought to us, may be proved by the testimony of many writers. Busbequius found it on the road between Adrianople and Constantinople[1]; Shaw found it in Syria, in the plains between Jaffa and Rama; and Chardin on the northern confines of Arabia. The early-blowing kinds, it appears, were brought to Constantinople from Cavala, and the late-blowing from Caffa; and on this account the former are called by the Turks *Cavalá lalé*, and the latter *Café lalé*. Caval is a town on the eastern coast of Macedonia, of which Paul Lucas gives some account; and Caffa is a town in the Crimea, or peninsula of Gazaria, as it was called, in the middle ages, from the Gazares, a people very little known[2].

Though florists have published numerous catalogues of the species of the tulip, botanists are acquainted only with two, or at most three, of which scarcely one is indigenous in Europe[3].

[1] "As we passed, we saw everywhere abundance of flowers, such as the narcissus, hyacinth, and those called by the Turks tulipan, not without great astonishment, on account of the time of the year, as it was then the middle of winter, a season unfriendly to flowers. Greece abounds with narcissuses and hyacinths, which have a remarkably fragrant smell: it is, indeed, so strong as to hurt those who are not accustomed to it. The tulipan, however, have little or no smell, but are admired for their beauty and variety of their colour. The Turks pay great attention to the cultivation of flowers; nor do they hesitate, though by no means extravagant, to expend several aspers for one that is beautiful. I received several presents of these flowers, which cost me not a little."—*Busbequii Ep.*, Basiliæ, 1740, 8vo, p. 36.

[2] See some account of them in Memoriæ populorum ad Danubium by Stritter.

[3] The *Tulipa sylvestris*, Linn. grows wild in the southern parts of France. Dodonæus says, in his Florum coronariarum herbarum historia, Antverpiæ 1569, 8vo, p. 204, "In Thracia et Cappadocia tulipa exit; Italiæ et Belgio peregrinus est flos. Minores alicubi in Gallia Narbonensi nasci feruntur." Linnæus reckons it among the Swedish plants, and Haller names it among those of Switzerland, but says, afterwards, I do not believe it to be indigenous, though it is found here and there in the meads.—*Hist. Stirp.* ii. p. 115. It appears that this species is earlier than the common *Tulipa Gesneriana*, though propagated from it. The useless roots thrown perhaps from Gesner's garden have grown up in a wild state, and become naturalized, as the European cattle have in America. See Miller's Gardener's Dictionary, iv. p. 518.

All those found in our gardens have been propagated from the species named after that learned man, to whom natural history is so much indebted, the Linnæus of the sixteenth century, Conrad Gesner, who first made the tulip known by a botanical description and a figure. In his additions to the works of Valerius Cordus, he tells us that he saw the first in the beginning of April 1559, at Augsburg, in the garden of the learned and ingenious counsellor John Henry Herwart. The seeds had been brought from Constantinople, or, according to others, from Cappadocia. This flower was then known in Italy under the name of tulipa, or tulip, which is said to be of Turkish extraction, and given to it on account of its resembling a turban[1].

Balbinus asserts that Busbequius brought the first tulip-roots to Prague, from which they were afterwards spread all over Germany[2]. This is not improbable; for Busbequius says, in a letter written in 1554, that this flower was then new to him; and it is known that besides coins and manuscripts he collected also natural curiosities, and brought them with him from the Levant. Nay, he tells us that he paid very dear to the Turks for these tulips; but I do not find he anywhere says that he was the first who brought them from the East.

In the year 1565 there were tulips in the garden of M. Fugger, from whom Gesner wished to procure some[3]. They first appeared in Provence, in France, in the garden of the celebrated Peyresc, in the year 1611[4].

After the tulip was known, Dutch merchants, and rich people at Vienna, who were fond of flowers, sent at different times to Constantinople for various kinds. The first roots planted in England were sent thither from Vienna, about the end of the sixteenth century, according to Hakluyt[5]; who is,

[1] See Martini Lexicon Philologicum, and Megiseri Diction. Turcico-Lat., where the word *tulbent*, a turban, is derived from the Chaldaic.

[2] Balbini Miscellanea Bohemiæ, p. 100.

[3] Gesneri Epistolæ Medicinales. Tiguri, 1577, 8vo, p. 79 and 80.

[4] Vita Peirescii, auctore Gassendo. 1655, 4to, p. 80.

[5] Hakluyt says, "And now within these four years there have been brought into England from Vienna in Austria, divers kind of flowers called tulipas, and those and others procured thither a little before, from Constantinople, by an excellent man, Carolus Clusius." See Biographia Britannica, ii. p. 164. [Gerarde in his Herbal, 1597, speaks of the Tulip in the following manner:—" My loving friend Mr. James Garret, a curious searcher of

however, wrong in ascribing to Clusius the honour of having first introduced them into Europe; for that naturalist only collected and described all the then known species.

These flowers, which are of no further use than to ornament gardens, which are exceeded in beauty by many other plants, and whose duration is short and very precarious, became, in the middle of the 17th century, the object of a trade such as is not to be met with in the history of commerce, and by which their price rose above that of the most precious metals. An account of this trade has been given by many authors; but by all late ones it has been misrepresented. People laugh at the Tulipomania[1], because they believe that the beauty and rarity of the flowers induced florists to give such extravagant prices: they imagine that the tulips were purchased so excessively dear in order to ornament gardens; but this supposition is false, as I shall show hereafter.

This trade was not carried on throughout all Europe, but in some cities of the Netherlands, particularly Amsterdam, Haarlem, Utrecht, Alkmaar, Leyden, Rotterdam, Hoorn, Enkhuysen, and Meedenblick; and rose to the greatest height in the years 1634–37[2]. Munting has given, from some of the books kept during that trade, a few of the prices then paid, of which I shall present the reader with the following. For a

simples, and learned apothecary in London, hath undertaken to find out, if it were possible, the infinite sorts by diligent sowing of their seeds, and by planting those of his own propagation, and by others received from his friends beyond the seas for the space of twenty years, not being yet able to attain to the end of his travail, for that each new year bringeth forth new plants of sundry colours not before seen; all of which, to describe particularly, were to roll Sisyphus' stone, or number the sands."]

[1] This word was coined by Menage.

[2] The principal works in which an account of this Tulipomania is to be found are,—Eerste Tzamenspraak tuschen Waermondt en Gaargoed nopens deopkomst en ondergang van Flora. Amsterdam, 1643, 12mo.—Meterani Novi, or New History of the Netherlands, part fourth. Amsterdam, 1640, folio, p. 518, from which Marquard, De Jure Mercatorum, p. 181, has taken his information.—Naauwkeurige beschryving der Aardgewassen, door Abraham Munting. Leyden en Utrecht, 1696, folio, p. 907.—De Koophandel van Amsterdam, door Le Long, ii. p. 307.—Le Negoce d'Amsterdam, par J. P. Ricard. A Rouen, 1723, 4to, p. 11.—Breslauer Samlung von Natur- und Kunst-Geschichten, 1721, May, p. 521.—Francisci Schaubühne, vol. ii. p. 639.—Tenzel, Monatliche Unterredungen, 1690, November, p. 1039.—Année Littéraire, 1773, xv. p. 16.—Martini Zeiler Miscellanea, p. 29.—Christ. Funcii Orbis Politicus, p. 879.

root of that species called the Viceroy the after-mentioned articles, valued as below expressed, were agreed to be delivered :—

| | Florins. |
|---|---|
| 2 lasts of wheat | 448 |
| 4 ditto rye | 558 |
| 4 fat oxen | 480 |
| 3 fat swine | 240 |
| 12 fat sheep | 120 |
| 2 hogsheads of wine | 70 |
| 4 tons of beer | 32 |
| 2 ditto butter | 192 |
| 1000 pounds of cheese | 120 |
| a complete bed | 100 |
| a suit of clothes | 80 |
| a silver beaker | 60 |
| Sum | 2500 |

These tulips afterwards were sold according to the weight of the roots. Four hundred perits [1] of Admiral Leifken cost 4400 florins ; 446 ditto of Admiral Von der Eyk, 1620 florins ; 106 perits Schilder cost 1615 florins ; 200 ditto Semper Augustus, 5500 florins ; 410 ditto Viceroy, 3000 florins, &c. The species Semper Augustus has been often sold for 2000 florins ; and it once happened that there were only two roots of it to be had, the one at Amsterdam and the other at Haarlem. For a root of this species, one agreed to give 4600 florins, together with a new carriage, two gray horses, and a complete harness. Another agreed to give for a root twelve acres of land ; for those who had not ready money, promised their moveable and immoveable goods, houses and lands, cattle and clothes. A man whose name Munting once knew, but could not recollect, won by this trade more than 60,000 florins in the course of four months. It was followed not only by mercantile people, but also by the first noblemen, citizens of every description, mechanics, seamen, farmers, turf-diggers, chimney-sweeps, footmen, maid-servants and old clothes-women, &c. At first, every one won and no one lost. Some of the poorest people gained in a few months houses, coaches and horses, and

[1] A perit is a small weight less than a grain.—TRANS.

figured away like the first characters in the land. In every town some tavern was selected which served as a 'Change, where high and low traded in flowers, and confirmed their bargains with the most sumptuous entertainments. They formed laws for themselves, and had their notaries and clerks.

When the nature of this trade is considered, it will readily be perceived, that to get possession of these flowers was not the real object of it, though many have represented it in that light. The price of tulips rose always higher from the year 1634 to the year 1637; but had the object of the purchaser been to get possession of the flowers, the price in such a length of time must have fallen instead of risen. "Raise the prices of the productions of agriculture, when you wish to reduce them," says Young; and in this he is undoubtedly right, for a great consumption causes a greater reproduction. This has been sufficiently proved by the price of asparagus at Göttingen. As it was much sought after, and large prices paid for it, more of it was planted, and the price has fallen. In like manner plantations of tulips would have in a short time been formed in Holland, and florists would have been able to purchase flowers at a much lower price. But this was not done; and the chimney-sweeper, who threw aside his besom, did not become a gardener, though he was a dealer in flowers. Roots would have been imported from distant countries, as asparagus was from Hanover and Brunswick to Göttingen; the high price would have induced people to go to Constantinople to purchase roots, as the Europeans travel to Golconda and Visapour to procure precious stones; but the dealers in tulips confined themselves to their own country, without thinking of long journeys. I will allow that a flower might have become scarce, and consequently dearer; but it would have been impossible for the price to rise to a great height, and continue so for a year. How ridiculous would it have been to purchase useless roots with their weight of gold, if the possession of the flower had been the only object! Great is the folly of mankind; but they are not fools without a cause, as they would have been under such circumstances.

During the time of the Tulipomania, a speculator often offered and paid large sums for a root which he never received, and never wished to receive. Another sold roots which he never possessed or delivered. Oft did a nobleman

purchase of a chimney-sweep tulips to the amount of 2000 florins, and sell them at the same time to a farmer; and neither the nobleman, chimney-sweep or farmer had roots in their possession, or wished to possess them. Before the tulip season was over, more roots were sold and purchased, bespoke and promised to be delivered, than in all probability were to be found in the gardens of Holland; and when Semper Augustus was not to be had, which happened twice, no species perhaps was oftener purchased and sold. In the space of three years, as Munting tells us, more than ten millions were expended in this trade in only one town of Holland.

To understand this gambling traffic, it may be necessary to make the following supposition. A nobleman bespoke of a merchant a tulip-root, to be delivered in six months, at the price of 1000 florins. During these six months the price of that species of tulip must have risen or fallen, or remained as it was. We shall suppose that at the expiration of that time the price was 1500 florins; in that case the nobleman did not wish to have the tulip, and the merchant paid him 500 florins, which the latter lost and the former won. If the price was fallen when the six months were expired, so that a root could be purchased for 800 florins, the nobleman then paid to the merchant 200 florins, which he received as so much gain; but if the price continued the same, that is 1000 florins, neither party gained or lost. In all these circumstances, however, no one ever thought of delivering the roots or of receiving them. Henry Munting, in 1636, sold to a merchant at Alkmaar, a tulip-root for 7000 florins, to be delivered in six months; but as the price during that time had fallen, the merchant paid, according to agreement, only ten per cent. "So that my father," says the son, "received 700 florins for nothing; but he would much rather have delivered the root itself for 7000." The term of these contracts was often much shorter, and on that account the trade became brisker. In proportion as more gained by this traffic, more engaged in it; and those who had money to pay to one, had soon money to receive of another; as at faro, one loses upon one card, and at the same time wins on another. The tulip-dealers often discounted sums also, and transferred their debts to one another; so that large sums were paid without cash, without bills, and without goods, as by the *Virements* at Lyons. The

whole of this trade was a game at hazard, as the Mississippi trade was afterwards, and as stock-jobbing is at present. The only difference between the tulip-trade and stock-jobbing is, that at the end of the contract the price in the latter is determined by the Stock-exchange; whereas in the former it was determined by that at which most bargains were made. High- and low-priced kinds of tulips were procured, in order that both the rich and the poor might gamble with them; and the roots were weighed by perits, that an imagined whole might be divided, and that people might not only have whole, but half and quarter lots. Whoever is surprised that such a traffic should become general, needs only to reflect upon what is done where lotteries are established, by which trades are often neglected, and even abandoned, because a speedier mode of getting fortunes is pointed out to the lower classes. In short, the tulip-trade may very well serve to explain stock-jobbing, of which so much is written in gazettes, and of which so many talk in company without understanding it; and I hope, on that account, I shall be forgiven for employing so much time in illustrating what I should otherwise have considered as below my notice[1].

At length, however, this trade fell all of a sudden. Among such a number of contracts many were broken; many had engaged to pay more than they were able; the whole stock of the adventurers was consumed by the extravagance of the winners; new adventurers no more engaged in it; and many, becoming sensible of the odious traffic in which they had been concerned, returned to their former occupations. By these means, as the value of tulips still fell, and never rose, the sellers wished to deliver the roots *in natura* to the purchasers at the prices agreed on; but as the latter had no desire for tulips at even such a low rate, they refused to take them or to pay for them. To end this dispute, the tulip-dealers of Alkmaar sent in the year 1637 deputies to Amsterdam; and a resolution was passed on the 24th of February, that all contracts made prior to the last of November 1636 should be null and void; and that, in those made after that date, purchasers should be free on paying ten per cent. to the vender.

The more people became disgusted with this trade, the

[1] [How well the author's remarks apply to the recent mania in railway scrip!]

more did complaints increase to the magistrates of the different towns; but as the courts there would take no cognizance of it, the complainants applied to the states of Holland and West Friesland. These referred the business to the determination of the provincial council at the Hague, which on the 27th of April 1637 declared that it would not deliver its opinion on this traffic until it had received more information on the subject; that in the mean time every vender should offer his tulips to the purchaser; and, in case he refused to receive them, the vender should either keep them, or sell them to another, and have recourse on the purchaser for any loss he might sustain. It was ordered also, that all contracts should remain in force till further inquiry was made. But as no one could foresee what judgement would be given respecting the validity of each contract, the buyers were more obstinate in refusing payment than before; and venders, thinking it much safer to accommodate matters amicably, were at length satisfied with a small profit instead of exorbitant gain; and thus ended this extraordinary traffic, or rather gambling.

It is however certain, that persons fond of flowers, particularly in Holland, have paid, and still pay, very high prices for tulips, as the catalogues of florists show[1]. This may be called the lesser Tulipomania, which has given occasion to many laughable circumstances. When John Balthasar Schuppe was in Holland, a merchant gave a herring to a sailor who had brought him some goods. The sailor, seeing some valuable tulip-roots lying about, which he considered as of little consequence, thinking them to be onions, took some of them unperceived, and ate them with his herring. Through this mistake the sailor's breakfast cost the merchant a much greater sum than if he had treated the prince of Orange. No less laughable is the anecdote of an Englishman who travelled with Matthews. Being in a Dutchman's garden, he pulled a

[1] In the year 1769, the dearest kinds in England were *Don Quevedo* and *Valentinier*; the former cost 2*l.* 2*s.* and the latter 2*l.* 12*s.* 6*d.* See Weston's Botanicus Universalis, part 2. In the German catalogues none of the prices are so high. The name *Semper Augustus* is not once to be found in new catalogues. [They still remain flowers of considerable value among florists; for, according to Mr. Hogg, a moderate collection of choice bulbs cannot now be purchased for a sum much less than 1000*l.*, at the usual prices.—See Chambers' Journal, March 15, 1845.

couple of tulips, on which he wished to make some botanical observations, and put them in his pocket; but he was apprehended as a thief, and obliged to pay a considerable sum before he could obtain his liberty[1].

Reimman and others accuse Just. Lipsius of the Tulipomania[2]; but if by this word we understand that gambling traffic which I have described, the accusation is unfounded. Lipsius was fond of scarce and beautiful flowers, which he endeavoured to procure by the assistance of his friends, and which he cultivated himself with great care in his garden; but this taste can by no means be called a mania[3]. Other learned men of the same age were fond of flowers, such as John Barclay[4], Pompeius de Angelis, and others, who would probably have been so, even though the cultivation of flowers had not been the prevailing taste. It however cannot be denied, that learned men may be infected with epidemical follies. In the present age, many have become physiognomists because physiognomy is in fashion; and even animal magnetism has met with partisans to support it.

[1] Blainville's Travels.

[2] Introd. in Hist. Lit. iii. 3, p. 92.

[3] That he might relax and refresh his mind, worn out by study, he amused himself with the cultivation of his garden and of flowers, and particularly of tulips, the roots of which he was at great pains to procure from all parts of the world, by means of Dodonæus, Clusius, and Boisotus, men singularly well-skilled in horticulture, and by others of his friends. Here, at a distance from civil tumult, with a cheerful countenance and placid eye, he sauntered through his plants and flowers, contemplating sometimes one declining, sometimes another springing up, and forgetting all his cares amidst the pleasure which these objects afforded him. See the Life of Lipsius, prefixed to the edition of his works printed at Antwerp in 1637. This is confirmed by what Lipsius says himself in his book De Constantia, ii. 2, 3, in praise of gardening.

[4] He rented a house near to the Vatican, with a garden, in which he had planted the choicest flowers, and those chiefly which are not propagated from seeds or roots, but from bulbs. These flowers were not known about thirty years before, nor had they been ever seen at Rome, but lay neglected in the Alps.—Of these flowers, which have no smell, but are esteemed only on account of their colours, Barclay was remarkably fond, and purchased their bulbs at a great price. Erythræi Pinacotheca. Lips. 1712, 8vo, iii. 17, p. 623. See also Freheri Theatrum, p. 1515.

## CANARY BIRD.

This little bird, highly esteemed for its song, which is reared with so much care, particularly by the fair sex, and which affords an innocent amusement to those who are fond of the wild notes of nature, is a native of those islands from which it takes its name. As it was not known in Europe till the fifteenth century, no account of it is to be met with in any of the works of the old ornithologists. Bellon, who about the year 1555 described all the birds then known, does not so much as mention it. At that period it was brought from the Canary Islands. It was therefore so dear that it could be procured only by people of fortune, and those who purchased were even often imposed on[1]. It was called the sugar-bird, because it was said to be fond of the sugar-cane, and that it could eat sugar in great abundance. This circumstance seems to be very singular; for that substance is to many birds a poison. Experiments have shown, that a pigeon to which four drachms of sugar were given died in four hours, and that a duck which had swallowed five drachms did not live seven hours after. It is certain, therefore, that the power of poison is relative.

The first figure of this bird is given by Aldrovandus, but it is small and inaccurate. That naturalist reckons the Canary bird among the number of those which were scarce and expensive, as it was brought from a distant country with great care and attention. The first good figure of it is to be found in Olina[2]: it has been copied by both Johnston and Willughby.

In the middle of the seventeenth century these birds began to be bred in Europe, and to this the following circumstance, related by Olina, seems to have given occasion. A vessel, which, among other commodities, was carrying a number of Canary birds to Leghorn, was wrecked on the coast of Italy; and these birds, being thus set at liberty, flew to the nearest land, which was the Island of Elba, where they found the climate so favourable, that they multiplied, and perhaps would

[1] Gesneri Historiæ Animalium, liber tertius. Tiguri, 1555, fol. p. 234.
[2] Uccelliera, overo Discorso della natura di diversi Uccelli. Roma, 1622, 4to.

have become domesticated, had they not been caught in snares; for it appears that the breed of them there has been long since destroyed. Olina says that the breed soon degenerated; but it is probable that these Canary birds, which were perhaps all males, did at the Island of Elba what the European sailors do in India. By coupling with the birds of the island, they may have produced mules. Such hybrids are described by Gesner and other naturalists[1].

The breeding of these birds was at first attended with great difficulty; partly because the treatment and attention they required were not known, and partly because males chiefly, and few females, were brought to Europe. We are told that the Spaniards once forbade the exportation of males, that they might secure to themselves the trade carried on in these birds, and that they ordered the bird-catchers either to strangle the females or to set them at liberty[2]. But this order seems to have been unnecessary; for, as the females commonly do not sing, or are much inferior in the strength of their notes to the males, the latter only were sought after as objects of trade. In the like manner, as the male parrots are much superior in colour to the females, the males are more esteemed, and more of them are brought to Europe than of the females. It is probable, therefore, that in our system of ornithology, many female parrots belonging to species already well-known are considered as distinct species. It was at first believed that those Canary birds bred in the Canary Islands were much better singers than those reared in Europe; but this at present is doubted[3]. In latter times various treatises have been published in different languages, on the manner of breeding these birds, and many people have made it a trade, by which they have acquired considerable gain. It does no discredit to the industry of the Tyrolese that they have carried it to the greatest extent. At Ymst there is a company who, after the breeding season is over, send out persons to different parts of Germany and Switzerland to purchase birds from those who breed them.

[1] Gesneri redivivi, aucti et emendati, tomus ii. Franc. 1669, fol. p. 62. More information respecting hybrids may be found in Brisson, Ornithologie, t. iii. p. 187; and Frisch, Vorstellung der Vögel in Teutschland, the twelfth plate of which contains several good figures.

[2] Coleri Œconomia ruralis et domestica. Franc. 1680, folio.

[3] Barrington's paper in the Phil. Trans. vol. lxiii. p. 249.

Each person brings with him commonly from three to four hundred, which are afterwards carried for sale, not only through every part of Germany, but also to England, Russia, and even Constantinople. About sixteen hundred are brought every year to England; where the dealers in them, notwithstanding the considerable expense they are at, and after carrying them about on their backs, perhaps a hundred miles, sell them for five shillings apiece. This trade, hitherto neglected, is now carried on in Schwarzwalde; and at present there is a citizen here at Göttingen, who takes with him every year to England several Canary birds and bullfinches (*Loxia pyrrhula*), with the produce of which he purchases such small wares as he has occasion for.

The principal food of these birds is the Canary seed, which, as is commonly affirmed, and not improbably, was first brought, for this purpose, from the Canary Islands to Spain, and thence dispersed all over Europe. Most of the old botanists, however, are of opinion that the plant which produces it is the same as that called *Phalaris* by Dioscorides[1]. Should this be true, it will follow that this kind of grass must have grown wild in other places besides the island it takes its name from; which is not improbable. But those who read the different descriptions which the ancients have given of *Phalaris*, will, in my opinion, observe that they may be equally applied to more plants; and Pliny seems to have used this name for more than one species of grass[2].

However this may be, it is certain that this seed, when it was used as food for these birds, began to be cultivated first in Spain, and afterwards in the southern parts of France. At present it is cultivated in various parts, and forms no inconsiderable branch of trade, particularly in the island of Sicily, where the plant is called *Scagliuola*, or *Scaghiola*. The seed is sold principally to the French and the Genoese. In England, the industrious inhabitants of the Isle of Thanet, particularly those around Margate and Sandwich, gain considerably by this article, as they can easily transport it to London by water.

That this plant might be cultivated with little trouble

[1] *Phalaris Canariensis*. The best figure and description of it are to be found in Schreber's Beschreibung der Gräser, ii. p. 83, tab. x. 2.

[2] Lib. iii. c. 159, and lib. xxvii. c. 12.

in Germany, is shown by the yearly experience of those who raise it in their gardens, and by its having become so naturalized in some parts of Hesse, that it propagates by seed of itself in the fields. The use of the seed might also be extended, for it yields a good meal; but the grains are not easily freed from the husks.

I shall here take occasion to remark, that Savary[1] has been guilty of an error, when he says that archil is cultivated in the Canary Islands in order to be sold as food for Canary birds. One may easily perceive that this mistake has arisen from his confounding that lichen used for dyeing with this kind of grass; and I should not have considered it worth notice, had it not been copied into Ludovici's Dictionary of Trade, from which, perhaps, it may be copied into the works of others.

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## ARCHIL.

Under the names Orseille, Orceille, Orsolle, Ursolle, Orcheil, Orchel, in Italian Oricello[2], Orcella, Roccella, in Dutch Orchillie, and in English Archil, Canary weed or Orchilla weed, is understood a lichen used for dyeing, and from which a kind of paint is also prepared. This species of lichen, of which the best figure and a full description may be seen in Dillenius[3], is by Linnæus called *Lichen roccella*. It is found in abundance in some of the islands near the African coast, particularly in the Canaries, and in several of the islands in the Archipelago. It grows upright, partly in single partly in double stems, which are about two inches in height. When it is old these stems are crowned with a button, sometimes round and sometimes of a flat form, which Tournefort very properly

[1] Dictionnaire de Commerce, t. v. 1765, fol. p. 1149.

[2] In the Dictionary of the Academy della Crusca the word *oricello* is thus explained: Tintura colla quale si tingono i panni, che si fa con orina d'uomo, e con altri ingredienti.

[3] Historia Muscorum, Ox. 1741, 4to, p. 120.

compares to the excrescences on the arms of the Sepia. Its colour is sometimes a light, and sometimes a dark gray. Of this lichen with lime, urine, ammoniacal salts, or a solution of ammonia prepared by distillation, is formed a dark red paste, which in commerce has the same name, and which is much used in dyeing. That well-known substance called litmus is also made of it.

Theophrastus[1], Dioscorides[2], and their transcriber Pliny[3], give the name of *Phycos thalassion* or *pontion* to a plant which, notwithstanding its name, is not a sea-weed but a lichen, as it grew on the rocks of different islands, and particularly on those of Crete or Candia. It had in their time been long used for dyeing wool, and the colour it gave when fresh was so beautiful, that it excelled the ancient purple, which was not red, as many suppose, but violet. Pliny tells us, that with this lichen dyers gave the ground or first tint to those cloths which they intended to dye with the costly purple. At least I so understand, with Hardouin and others, the words *conchyliis substernitur*, which the French dyers express by the phrase *donner le pied.*

Though several kinds of lichen produce a similar red dye, I agree in opinion with Dillenius, that *Phycos thalassion* is our archil; for at present no species is known which communicates so excellent a colour, and which corresponds so nearly with the description of Theophrastus. Besides, it is still collected in the Grecian islands, and it appears that it has been used there since the earliest ages[4].

Tournefort[5] found this lichen in the island Amorgos, which lies on the eastern side of Naxos, and which at present is called Morgo. In his time it was sent to England and Alexandria, at the rate of ten rix-dollars per hundred weight; and he says expressly that it was common in the other islands.

[1] Hist. Plant. iv. c. 7. [2] Lib. iv. c. 95.

[3] Lib. xxvi. c. 10; xxxii. c. 6.

[4] Hardouin quotes Aristot. Hist. Animal. vi. c. 9. But that naturalist speaks of a sea-weed which was cast on shore by the Hellespont. A dye or paint was made of it, and the people in the neighbourhood imagined that the purple of this sea-weed, which served as food to certain shell-fish, communicated to them their beautiful dye. A proof that sea-weeds (*fuci*) can communicate a red colour may be found in the Transactions of the Swedish Academy, iv. p. 29.

[5] Voyage du Levant. Amsterd. 1718, 4to, i. p. 89.

He shows from Suidas, Julius Pollux[1], and other ancient writers, that this island was once celebrated for a kind of red linen cloth, which in commerce had the name of the island; and he conjectures, not without probability, that it might have been dyed with this lichen.

Imperati[2] says, that the *roccella*, of which he gives a figure, was procured from the Levant. This naturalist gives the figure also of a lichen from Candia, used for dyeing, which was then called *rubicula*, and which, as may be seen in Bauhinus[3], is comprehended under the name of Roccella. Dillenius and Linnæus, however, make it a distinct species; and the latter names it *Lichen fuciformis*. This distinction is, perhaps, not improper: for the *rubicula* does not grow like a shrub or bush, as the *roccella*, but belongs rather to the foliaceous lichens. Be this as it may, it is certain, as Dillenius has remarked, and as I know from my own observation, that *L. fuciformis* is often mixed with the real roccella, and particularly with that brought from the Canary Islands; but whether it be equally good, experience has not yet taught us.

From what has been said, I think I may venture to conclude that our archil was not unknown to the ancient Grecias. But when was it first employed as a dye by the moderns, and introduced into our commerce? Some writers are of opinion that this drug was first found in the Canary Islands, and afterwards in the Levant. The use of it, therefore, is not older than the last discovery of that island. That this opinion is false, will appear from what follows.

Among the oldest and principal Florentine families is that known under the name of the Oricellarii or Rucellarii, Ruscellai or Rucellai, several of whom have distinguished themselves as statesmen and men of letters. This family are descended from a German nobleman named Ferro or Frederigo, who lived in the beginning of the twelfth century[4]. One of

[1] "Præterea Amorgina, optima quidem in Amorgo fiunt, sed et hæc e lino esse asserunt. Tunica autem Amorgina etiam amorgis nuncupatur." —Onomasticon, vii. c. 16.

[2] Histor. Nat. lib. xxvii. c. 11.

[3] Pinax Plant. p. 365. Hist. Plant. iii. 2. p. 796.

[4] Other accounts say that he was an Englishman; but the name Fredorigo confirms his German extraction.

his descendants in the year 1300 carried on a great trade in the Levant, by which he acquired considerable riches, and returning at length to Florence with his fortune, first made known in Europe the art of dyeing with archil. It is said that a little before his return from the Levant, happening to make water on a rock covered with this lichen, he observed that the plant, which was there called *respio* or *respo*, and in Spain *orciglia*, acquired by the urine a purple, or, as others say, a red colour. He therefore tried several experiments; and when he had brought to perfection the art of dyeing wool with this plant, he made it known at Florence, where he alone practised it for a considerable time, to the great benefit of the state. From this useful invention the family received the name of Oricellarii, from which at last was formed Rucellai[1].

As several documents, still preserved among the Florentine archives, confirm the above account of the origin of this family name, from the discovery of dyeing with oricello[2], we may,

[1] Giornale de' Letterati d' Italia, t. xxxiii. parte i. p. 231.

[2] These documents from the Florentine records may be found in Dominici Mariæ Manni de Florentinis Inventis Commentarium. Ferrariæ, 1731, p. 37, from which I have extracted the following:—"One of this family resided formerly a long time in the Levant, where he carried on trade, according to the custom of the Florentine nation. Being one day in the fields, and happening to make water on a plant, of which there was great abundance, he observed that it immediately became extraordinarily red. Like a prudent man, therefore, he resolved to make use of this secret of nature, which till that time had lain hid; and having made several experiments on that herb, and finding it proper to dye cloth, he sent some of it to Florence, where, being mixed with human urine and other things, it has always been employed to dye cloth purple. This plant, which is called *respo*, is in Spain named *orciglia*, and by botanists commonly *corallina*. The mixture made with it is called *oricello*, and has been of great utility and advantage to the woollen manufacture, which is carried on to greater extent in Florence than in any other city. From this circumstance the individuals of that family, by being the inventors of oricello, have been called Oricellai, and have been beloved by the people for having procured to them this particular benefit. Thus has written John di Paolo Rucellai (*Manni says that this learned and opulent man wrote in the year* 1451); and the same account is still given by dyers in our city, who relate and affirm that their ancestors have for a century exercised the art of dyeing, and that they know the above from tradition."

This is confirmed by another passage:—"One of this family, on account

in my opinion, consider it as certain that the Europeans, and first the Florentines, were made acquainted with this dye-stuff and its use in the beginning of the fourteenth century. At that time the Italians brought from the East the seeds of many arts and sciences, which, afterwards sown and nurtured in Europe, produced the richest harvests; and nothing is more certain than that the art of dyeing was brought to us from the East by the Italians. I do not believe that the merit of having discovered this dye by the above-mentioned accident is due to that Florentine; but I am of opinion that he learnt the art in the Levant, and on his return taught it to his countrymen, which was doing them no small service[1]. After that period the Italians long procured archil from the Levant for themselves, and afterwards for all Europe. I say for a long time, because since the discovery of the Canary Islands the greater part of that substance has been procured from them.

These islands, after being a considerable time lost and forgotten, were again discovered about the end of the fourteenth or the beginning of the fifteenth century, and since that time they have been much frequented by the Europeans. One of the first who endeavoured to obtain an establishment there, was John de Betancourt, a gentleman of Normandy, who in 1400, or, as others say, in 1417, landed on Lancerotta. Amongst the principal commodities which this gentleman and other Europeans brought back with them was archil, which was found there more beautiful and in greater abundance than anywhere else; and Betancourt enjoyed in idea the great profit which he hoped to derive from this article in commerce. Glass is surprised that the Europeans, immediately upon their arrival, sought after this lichen with as much eagerness and skill as

of the trade carried on faithfully and honestly by the Florentines, travelled to the Levant, and brought thence to Florence the art, or rather secret, of dyeing in oricello."

[1] In the genealogical history of the noble families of Tuscany and Umbria, written by P. D. Eugenio Gamurrini, and published at Florence 1668–1673, 3 vols. in folio, is the following account, vol. i. p. 274, of the origin of this family:—"This family acquired their name from a secret brought by one of them from the Levant, which was that of dyeing in oricello, never before used in this country. On that account they were afterwards called Oricellari, as appears from several records among the archives of Florence, and then by corruption Rucellari and Rucellai. Of their origin many speak, and all agree that they came into Tuscany from Britain."

they did after gold in America, though they were not so well acquainted with the former as the latter before the discovery of these new lands [1]. But as this is not true, the wonder will cease.

According to information procured in the year 1731, the island of Teneriffe produced annually five hundred quintals of this moss; Canary, four hundred; Forteventura, Lancerotta, and Gomera, three hundred each; and Fero, eight hundred; making in all two thousand six hundred quintals. In the islands of Canary, Teneriffe and Palma, the moss belongs to the crown; and in the year 1730 it was let by the king of Spain for one thousand five hundred piastres. The farmers paid then for collecting it from fifteen to twenty rials per hundred weight [2]. In the rest of the islands it belongs to private proprietors, who cause it to be collected on their own account. In the beginning of the last century a hundred weight, delivered on board at Santa Cruz, the capital of Teneriffe, was worth from only three to four piastres; but since 1725 it has cost labour amounting to ten piastres, because it has been in great request at London, Amsterdam, Marseilles, and throughout all Italy [3]. In the year 1726 this lichen cost at London eighty pounds sterling per ton, as we are told by Dillenius, and in 1730 it bore the same price.

Towards the end of the year 1730, the captain of an English vessel, which came from the Cape de Verde islands, brought a bag of archil to Santa Cruz by way of trial. He discovered his secret to some Spanish and Genoese merchants, who, in the month of July 1731, resolved to send a ship to these islands. They landed on that of St. Anthony and St. Vincent, where in a few days they obtained five hundred quintals of this lichen, which they found in such abundance, that it cost them nothing more than a piastre per cent. by way of present to the governor. The archil of the Cape de Verde islands

[1] The History of the Discovery and Conquest of the Canary Islands, by George Glass. London, 1764, 4to.

[2] [Dr. Ure copies this information in his Dictionary, but gives it as the return of an official report for the year 1831 !]

[3] This information is to be found in Hellot's Art of Dyeing, into which it has been copied, as appears by the Dictionnaire d'Histoire Naturelle, par Valmont de Bomare, from an account written by M. Porlier, who was consul at Teneriffe in 1731.

appears larger, richer, and longer than that of the Canaries, and this, perhaps, is owing to its not being collected every year[1]. Adanson, in 1749, found also the greater part of the rocks in Magdalen island, near Senegal, covered with this lichen. Though the greater part of our archil is at present procured from the Canary and Cape de Verde islands, a considerable quantity is procured also from the Levant, from Sicily, as Glass says, and from the coast of Barbary; and some years ago the English merchants at Leghorn caused this lichen to be collected in the island of Elba, and paid a high price for it[2].

Our dyers do not purchase raw archil, but a paste made of it, which the French call *orseille en pâte*. The preparation of it was for a long time kept a secret by the Florentines. The person who, as far as I know, made it first known was Rosetti; who, as he himself tells us, carried on the trade of a dyer at Florence. Some information was afterwards published concerning it by Imperati[3] and Micheli the botanist[4]. In later times this art has been much practised in France, England, and Holland. Many druggists, instead of keeping this paste in a moist state with urine, as they ought, suffer it to dry, in order to save a little dirty work. It then has the appearance of a dark violet-coloured earth, with here and there some white spots in it.

The Dutch, who have found out better methods than other nations of manufacturing many commodities, so as to render them cheaper, and thereby to hurt the trade of their neighbours, are the inventors also of lacmus[5], a preparation of archil called *orseille en pierre*, which has greatly lessened the use of that *en pâte*, as it is more easily transported and preserved, and fitter for use; and as it is besides, if not cheaper, at least not dearer. This art consists, undoubtedly, in mixing with that commodity some less valuable substance, which either

[1] As the archil grows in the African islands, and on the coast of Africa, Glass supposes that the Getulian purple of the ancients was dyed with it; but this opinion is improbable, for Horace praises "Gætula *murice* tinctas vestes."

[2] Lettres sur l'Histoire Naturelle de l'Isle d'Elbe, par Koestlin. Vienne, 1780, 8vo p. 100.

[3] Lib. xxvii. c. 9.

[4] Nova Plantarum Genera. Flor. 1729.

[5] Some translate this word *lacca musica, musiva.*

improves or does not much impair its quality, and which at the same time increases its weight[1]. Thus they pound cinnabar and smalt finer than other nations, and yet sell both these articles cheaper. In like manner they sift cochineal, and sell it at a less price than what is unsifted.

It was for a long time believed that the Dutch prepared their lacmus from those linen rags which in the south of France are dipped in the juice of the *Croton tinctorium*[2]; and this idea appeared the more probable, as most of this *tournesol en drapeaux* was bought up by the Hollanders: but, as they are the greatest adulterators of wine in Europe, they may perhaps have used these rags to colour Pontack and other wines. It is however not improbable that they at first made lacmus of them, as their dye approaches very near to that of archil. At present it is almost certainly known that *orseille en pâte* is the principal ingredient in *orseille en pierre*, that is in lacmus[3]: and for this curious information we are indebted to Ferber[4]. But whence arises the smell of the lacmus, which appears to me like that of the Florentine iris? Some of the latter may,

[1] [According to Dr. Ure, the Dutch first reduce the lichen to a fine powder by means of a mill, then mix a certain proportion of potash with it. The mixture is watered with urine and allowed to undergo a species of fermentation. When this has arrived at a certain degree, carbonate of lime in powder is added to give consistence and weight to the paste, which is afterwards reduced into small parallelopipeds, which are carefully dried.]

[2] This plant grows in the neighbourhood of Montpelier, and above all, in the flats of Languedoc. In harvest, the time when it is collected, the peasants assemble from the distance of fifteen or twenty leagues around, and each gathers on his own account. It is bruised in a mill, and the juice must be immediately used; some mix with it a thirtieth part of urine. It is poured over pieces of canvas, which they take care to provide, and which they rub between their hands. These rags are dried in the sun, and then exposed, above a stone stove, to the vapour of urine mixed with quick-lime or alum. After they have imbibed the juice of the plant, the same operations are repeated till the pieces of cloth appear of a deep blue colour. They are called in commerce *tournesol en drapeaux*. Large quantities of them are bought up by the Dutch, who make use of them to colour wines and the rinds of their cheese.—TRANS.

[3] [Lacmus or litmus is now prepared from *Lecanora tartarea*, the famous *Cudbear*, so called after a Mr. Cuthbert, who first brought it into use. It is imported largely from Norway, where it grows more abundantly than with us; yet in the Highland districts many an industrious peasant gets a living by scraping off this lichen with an iron hoop, and sending it to the Glasgow market.]

[4] Linn. Mantissa Plantarum, i. p. 132.

perhaps, be mixed with it; for I think I have observed in it small insoluble particles, which may have been pieces of the roots. The addition of this substance can be of no use to improve the dye; but it may increase the weight, and give the lac more body; and perhaps it may be employed to render imperceptible some unpleasant smell, for which purpose the roots of that plant are used on many other occasions.

Another kind of lichen, different from the roccella, which in commerce is known by the names *orseille de terre*, *orseille d'Auvergne*, is used also for the like purpose; but it contains fewer and weaker colouring particles. This species, in botany, is called *Lichen Parellus* (*Lecanora Parella*), and is distinguished from the roccella by its figure, as it grows only in a thin rind on the rocks It is collected in Auvergne, on rocks of granite and volcanic productions, and in some parts of Languedoc; the greater part of it is brought from St. Flour. Its name, *perelle*, comes from an old Languedocian word *pére* (*pierre*, a rock); as *roccella*, afterwards transformed into *orseille*, is derived from *rocca*. The use of *perelle* is very trifling: the Dutch purchase it to make lacmus, perhaps on account of its low price. This lichen has been found also in Northumberland[1] and other mountainous districts of Great Britain, but it is not collected there for any purpose.

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## MAGNETIC CURES.

THE external use of the magnet, to cure the tooth-ache and other disorders, is a remedy brought into fashion in modern times, but not a new discovery, as supposed by Lessing, who ascribes it to Paracelsus[2]. It was known to Aëtius, who lived so early as the year 500. That author says, "We are assured that those who are troubled with the gout in their hands or

[1] See Wallis's Natural History and Antiquities of Northumberland, 1769, 2 vols 4to, i. p. 279.

[2] In his Kollektaneen. Berlin, 1790, ii. p. 117.

their feet, or with convulsions, find relief when they hold a magnet in their hand[1]." He does not however give any proof of this from his own experience: and perhaps he doubted the truth of it. The above passage contains the oldest account known at present respecting this virtue; for the more ancient writers speak only of the internal use of the magnet.

It is evident therefore that this cure has not been discovered in later times, but that it has been preserved by the old physicians copying it from each other into their works. In like manner, many things are mentioned in the Materia Medica which were used or proposed by the ancients, but into the properties of which they never made sufficient inquiry.

Paracelsus recommended the magnet in a number of diseases, as fluxes, hæmorrhages, &c. Marcellus, who lived in the fifteenth century, assures us that it cures the tooth-ache[2]. The same virtue is ascribed to it by Leonard Camillus[3], who lived in the sixteenth century: and Wecker[4], who was nearly cotemporary, says that the magnet when applied to the head, cures the head-ache; and adds that Holler had taken this cure from the works of the ancients[5]. We read also in Porta[6], that it was recommended for the head-ache; and in Kircher[7], that it was worn about the neck as a preventive against convulsions, and affections of the nerves. About the end of the 17th century magnetic tooth-picks and ear-pickers were made, and extolled as a secret preventive against pains in the teeth, eyes and ears[8].

[In addition to these external uses of the magnet, in which it was supposed to act by a peculiar power over the nervous system, it has been employed on account of its true magnetic properties. Thus Kirkringius, Fabricius Hildanus, and subsequently Morgagni, have used it to remove particles of iron which had accidentally fallen into the eyes. Kircher employed

[1] Aëtii Op. l. ii. c. 25.
[2] In Stephani Artis Med. Princip. ii. p. 253.
[3] De Lapidibus, lib. ii. p. 131.
[4] J. J. Wecker, De Secretis.
[5] I took the trouble to search for this passage in Jac. Hollerii lib. de morbis internis, Parisiis 1711, 4to, but I could not find it, though the beginning of the book treats expressly of head-aches.
[6] Magia Naturalis, lib. vii.
[7] Kircheri Magnes, sive De Arte Magnetica, lib. iii. c. i.
[8] P. Borrelli, Hist. et Observ. Medico-physic. cent. 4. obs. 75.

it also to cure hernia. The patient took iron-filings internally; and the loadstone in the state of powder mixed with some vegetable substance, thus forming a magnetic plaster, was applied to the hernia. Even Ambrose Paré states on the authority of a surgeon, that several patients had been thus cured.

About the 16th and early in the 17th century, two cases occurred, one near Prague in Bohemia, the other in Prussia, in which a knife was swallowed, but it unfortunately got too far and passed into the stomach. By the application of these magnetic plasters, the point became attracted towards the surface, so that it could be removed by incision [1].

In the 18th century, after the properties of magnets had begun to be scientifically investigated, they were made of various forms and their effects studied in numerous parts of Europe, and many treatises were published on their supposed properties. Perhaps the most important and best authenticated, are those of MM. Audry and Thouret. These experimenters believed that they were effective agents.

Since that time, the use of magnets as remedial agents has been almost entirely laid aside and forgotten, it having been found that no constancy was exhibited in the results of their application, and that their occasional supposed efficacy depended upon other circumstances, which were overlooked from the sufferers' attention being engrossed by the magnet. The application of the magnet to remove small particles of iron or steel which have accidentally fallen into the eyes, has been lately revived. In some manufactories, where these minute particles are constantly thrown off in the grinding of hardware and driven into the eyes, large magnets are kept fixed at a proper height, so that the workmen can resort to them immediately. Such is the case for instance at Fairbairne in Belgium, and we believe the same has been adopted in some of our own manufactories to catch the floating particles, and thus to prevent their being drawn into the lungs during respiration. The reader may form some idea of the effective manner in which magnets can be applied, from the following incident which occurred to Prof. Faraday, whilst experimenting with a powerful (electro-) magnet; an iron candlestick which happened to be standing near its poles on the table at which

[1] Observations sur l'usage de l'aimant en médecine, par MM. Audry et Thouret.

he was at work flew to them, attracted with such violence as to displace or break everything in its way.

In the 18th century, a new supposed magnetic power was discovered, and with various success has continued to be applied to the delusion of the public. About 1770, Father Hehl, a jesuit, the Professor of Astronomy at Vienna, who had great faith in the influence of the loadstone on human diseases, and had invented steel plates of a peculiar form, which he impregnated with magnetic virtues and applied to the cure of diseases, communicated his discoveries to Anton Mesmer, who subsequently invented animal magnetism or mesmerism. Mesmer made use of his friend Hehl's plates to employ the magnet according to certain notions of his own. In his subsequent experiments magnets were gradually dispensed with, and as practised in modern times, they have been found unnecessary. Hence mesmerism or animal magnetism has no relation to the magnetism of the magnet, and may therefore form the subject of a future article.

About the year 1798, a man named Perkins invented a method of treating various diseases with metallic bars called tractors; these were applied to and drawn over various parts of the body, and were supposed to cure numerous maladies, such as ulcers, head-aches, &c. These instruments were patented. A few years afterwards, Dr. Falconer had wooden tractors made so exactly to resemble those of Perkins, that they could not be distinguished by the eye; on employing these on a large scale at the Bath hospital, he found that exactly the same effects and cures were produced by one as the other. Since that time these tractors have hardly been heard of, and are now forgotten.

Quite recently, a new means has been contrived in England for deluding the public, in the form of rings, which are to be worn upon the fingers or toes, and are said to prevent the occurrence of, and cure various diseases. They are called galvanic rings. But this invention may be with propriety classed with the real magnet, animal magnetism and tractation.

What has been stated relative to the metallic tractors, equally applies to the magnetic rings; for although by the contact of the two metals of which they are composed an infinitesimally minute current of electricity, hence also of magnetism, is generated, still from the absurd manner in which the

pieces of metal composing the ring are arranged, and which displays the most profound ignorance of the laws of electricity and magnetism, no trace of the minute current traverses the finger or toe on which the ring is worn; so that a wooden, any other ring, or none at all, would have exactly the same effect, as regards the magnetism or galvanism.]

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## SECRET POISON.

UNDER this name are generally understood all poisons which can be administered imperceptibly, and which gradually shorten the life of man, like a lingering disease. They were not first discovered in the 17th century in France and Italy as many believe, but were known to the ancient Greeks and Romans, by whom they were used. I must however allow, that they were never prepared with more art at any period, or in any country, or employed oftener and with more success, than they were in these countries, and at that time. If it be true that they can be prepared in such a manner as to occasion death at a certain period previously determined, or that the person to whom they are given will die within a certain time limited, it must be confessed that the ancient poisoners have been far exceeded by the modern. But this advantage will be considered as scarcely possible, when one reflects upon the many variable circumstances which have an influence on the operation of medicines and poisons; and it has often happened that a company have swallowed the same poison, at the same time, and in the same quantity, some of whom have died sooner and some later, while some have survived. Thus died Pope Alexander VI. in the year 1503, and Cæsar Borgia recovered without any loss of health, though, by the bottles being changed through mistake, he drank of the poison that had been prepared for the other guests alone. At any rate, I am of opinion that the celebrated Tophania, when she engaged to free wives from disagreeable husbands within stated weeks

and days, must have had certain and very accurate information respecting their contitution and manner of living, or, as the physicians say, their idiosyncrasy

Some physicians have doubted respecting secret poison[1]; and others have only denied that its effects can with certainty be regulated to a fixed time[2]. I agree in opinion with the latter; but the former can be confuted by many examples both of ancient and modern times; for that the ancients were acquainted with this kind of poison, can be proved by the testimony of Plutarch, Quintilian, and other respectable authors. We are told by Plutarch, that a slow poison, which occasioned heat, a cough, spitting of blood, consumption, and a weakness of intellect, was administered to Aratus of Sicyon[3]; and Quintilian in his Declamations, speaks of this poison in such a manner as proves that it must then have been well known[4]. It cannot be said that such an invention was too great for that period, or that it required more knowledge of chemistry than any one possessed; for the Indians in America are acquainted with a most perfect poison of this kind, and can employ it with so much skill, that the person to whom it is given cannot guard against the treachery, even with the utmost precaution, but infallibly dies, though in a lingering manner, often after the expiration of some years[5].

[1] Heberden in the Neue Hamburg. Mag. xvii. p. 219. I am convinced that many of the accounts we have of the extraordinary effects of poison are fabricated, like those mentioned in Frid. Hoffmanni Dissert. de Læsionibus externis, abortivis Venenis ac Philtris. Francof. 1729, et recusa Lips. 1755. That author, however, denies some which are true. It is, for example, certain that camphor and rue do not produce the effects ascribed to them by Dioscorides, Paulus Ægineta, and others; but there are without doubt other substances which will produce these effects.

[2] Sennerti Instit. Med. ii. 2, 12.

[3] He gave to Aratus a poison, not speedy and violent, but of that kind which at first occasions a slow heat in the body, with a slight cough, and then gradually brings on a consumption. One time, when Aratus spat up blood, he said, "This is the effect of royal friendship." See Plutarch, Vit. Arati.

[4] Quint. Declamat. xvii. 11.

[5] With the poison of the Indians, however, the ancients could not be acquainted, as it is prepared from a plant unknown in Europe before the discovery of America. Kalm, in his Travels, does not name it, and in that he has done right; for, as the plant is now to be found everywhere, no government could guard against a misapplication of it, were it publicly known.

Theophrastus speaks of a poison which could be moderated in such a manner as to have effect in two or three months, or at the end of a year, or two years; and he remarks that the death, the more lingering it was, became the more miserable. This poison was prepared from aconitum, a plant which, on that account, people were forbidden to have in their possession, under pain of capital punishment[1]. He relates also, that Thrasyas had discovered a method of preparing from other plants a poison which, given in small doses of a drachm, occasioned an easy but certain death, without any pain, and which could be kept back for a long time without causing weakness or corruption. This Thrasyas, whose scholar Alexias carried the art still further, was a native of Mantinea, a city in Arcadia, and is celebrated by Theophrastus on account of his abilities, and particularly his knowledge of botany; but those are mistaken who ascribe to him the discovery of secret poison.

This poison was much used at Rome about two hundred years before the Christian æra. As several persons of distinction died the same year at that period, and of the like distemper, an inquiry being made into the cause, a maid-servant gave evidence against some ladies of the first families, who, she said, prepared and distributed poison; and above a hundred and fifty of them were convicted and punished[2]. As so many had learnt this destructive art, it could not be suppressed; and we find sufficient proofs in the Roman history that it was continually preserved. Sejanus caused such a secret poison to be administered by an eunuch to Drusus, who gradually declined afterwards, as by a consumptive disorder, and at length died[3]. Agrippina, being desirous of getting rid of Claudius, but not daring to despatch him suddenly, and yet wishing not to leave him sufficient time to make new regulations respecting the succession to the throne, made choice of a poison which should deprive him of his reason, and gradually consume him. This she caused to be prepared by an

[1] They say a poison can be prepared from aconite so as to occasion death within a certain period, such as two, three, or six months, a year, and even sometimes two years. Those, we are told, whose constitutions are able to hold out longest, die in the greatest misery; for the body is gradually consumed, and must perish by continual wasting. Those die easiest who die speedily. No remedy has been found out for this poison.—Theophr. Hist. Plant. ix. c. 16.

[2] Livius, lib. viii. c. 18.

[3] Taciti Annal. lib. iv. c. 8.

expert poisoner, named Locusta, who had been condemned to death for her infamous actions, but saved that she might be employed as a state engine. The poison was given to the emperor in a dish of mushrooms; but as, on account of his irregular manner of living, it did not produce the desired effect, it was assisted by some of a stronger nature[1]. This Locusta prepared also the poison with which Nero despatched Britannicus, the son of Agrippina, whom his father Claudius wished to succeed him on the throne. As this poison occasioned only a dysentery, and was too slow in its operation, the emperor compelled Locusta by blows, and by threatening her with death, to prepare in his presence one more powerful. It was first tried on a kid; but as the animal did not die till the end of five hours, she boiled it a little longer, until it instantaneously killed a pig to which it had been given, and this poison despatched Britannicus as soon as he had tasted it[2]. For this service the emperor pardoned Locusta, rewarded her liberally, and gave her pupils whom she was to instruct in her art, in order that it might not be lost.

The art of preparing this poison must have been well understood also at Carthage. When M. Attilius Regulus, the Roman general, who had been taken by the Carthaginians, was sent to Rome to propose to the senate that the Carthaginian prisoners might be restored in exchange for him, he prevented this negotiation, because he knew that a poison had been administered to him, by which the state would soon be deprived of his services. He returned, therefore, to Carthage, in compliance with the promise he had made to the enemy, who put him to death with the most exquisite torture[3].

All these poisons were prepared from plants, particularly aconite, hemlock and poppy, or extracted from animal substances. Among those made from the latter, none is more remarkable than that supplied by the sea-hare, *lepus marinus*,

[1] The account given by Tacitus deserves to be read; see lib. xii. c. 66.

[2] The history of this horrid affair may be found both in Tacitus, Annal. xiii. c. 15 and 16, and in Suetonius, vi. cap. 33. Respecting Locusta, see also Juvenal, sat. i. 71.

[3] This account is given by Aulus Gellius from the now lost works of Tuditanus.—Noct. At. lib. vi. cap. 4. Cicero often speaks of the magnanimity of Regulus; as, for example, in his Oration against Piso, and in his Offices, book iii. chap. 27; but he makes no mention of his having been poisoned. Valerius Maximus also, book i. chap. i. 14, says nothing of poison.

with which, as Philostratus says[1], Titus was despatched by Domitian. Without here attempting to define the substances employed by the ancients to compose their poisons, I shall only observe, that the *lepus marinus*, the terrible effects of which are expressly mentioned by Dioscorides, Galen, Nicander, Aëtius, Ælian[2], Pliny[3], and others, is that animal called at present in the Linnæan system *Aplysia depilans*[4], as Rondelet conjectured, and has been since fully proved by Bohadsch[5]. This animal poison however seems to have been seldom used, as it easily betrays itself by some peculiar symptoms. It appears that it was not known to Aristotle, at least he makes no mention of it[6]. With the far stronger, and now common mineral poisons the ancients were not acquainted; for their arsenic was what we call orpiment, and not that pernicious metallic oxide which formed the principal ingredient of those secret poisons which in latter times were in France and Italy brought to a diabolical perfection[7].

No one was ever more infamous by this art than Tophania, or Toffana, a woman who resided first at Palermo, and after-

[1] Apollonii Vit. lib. vi. c. 14.

[2] Histor. Animal. lib. ii. c. 45. [3] Lib. ix. c. 48, and lib. xxxii. c. 1.

[4] In Linnæi Systema Nat., through an error of the press, stands *Laplysia*, which word has since become common. Ἀπλυσία signifies an uncleanness which cannot be washed off; and in Aristotle's History of Animals, b. v. ch. 15, and Pliny, b. ix. ch. 45, it is the name of a zoophyte. In the like manner other errors in the System of Linnæus have been copied into the works of others, such as *Dytiscus* instead of *Dyticus*, &c.

[5] J. B. Bohadsch De quibusdam animalibus marinis. Dresdæ, 1761, 4to, p. 1–53. In this work there is a full description, with a figure of this animal, under the name of *Lernæa*, which was used in the first editions of Linnæus.

[6] The accounts given by the ancients of the sea-hare have been collected in Grevini Lib. de Venenis, Antverpiæ 1571, p. 209. In the Annals of Glycas, iii. (*Script. Byz.*), it is said that Titus was despatched by this poison; and in the first book, b. 27, he says the sea-hare occasions speedy and inevitable destruction to man.

[7] See Stenzelii Diss. de venenis terminatis et temporaneis, quæ Galli *les poudres de succession* vocant; resp. J. G. Arnold. Vitebergæ, 1730. This tract contains several historical relations; but the reader is often referred to authors who either do not say that for which they were quoted, or who must relate the same thing in a different manner in some other place. As for example, Galen in b. ii. c. 7, De Antidotis, speaks of poisons without mentioning secret poison in particular. Avicenna is made to say, in his book De Viribus Cordis, that the Egyptian kings often employed this poison;

wards at Naples. She sold those drops, which from her acquired the name of *aqua Tophania*, *aqua della Toffana*, and which were called also *acquetta di Napoli*, or only *acquetta*; but she distributed her preparation by way of charity to such wives as wished to have other husbands. From four to six drops were sufficient to destroy a man; and it was asserted that the dose could be so proportioned as to operate in a certain time. As she was watched by the government, she fled to an ecclesiastical asylum; and when Keysler was at Naples in 1730, she was then still living, because no one could, or was willing to take away her life, while under that protection. At that time she was visited by many strangers out of curiosity.

In Labat's Travels through Italy[1] we also find some information which may serve still further to illustrate the history of Tophania. She distributed her poison in small glass phials, with this inscription, *Manna of St. Nicholas of Bari*, and ornamented with the image of the saint. A miraculous oil, employed by folly in the cure of many diseases, drops from the tomb of that saint which is shown at Bari in the kingdom of Naples; and on this account it is dispersed in great abundance under the like name. It was therefore the best appellation which Tophania could give to her poison, because the reputed sanctity of it prevented the custom-house officers from examining it too closely. When the viceroy was informed of this, which I think was in 1709, Tophania fled from one convent to another, but was at length seized and thrown into prison. The clergy raised a loud outcry on account of this violation of ecclesiastical freedom, and endeavoured to excite the people to insurrection. But they were soon appeased on a report being spread that Tophania had confessed she had poisoned all the springs in the city. Being put to the rack, she acknowledged her wickedness, and confessed to having caused the death of not less than 600 persons; named those who had protected her, who were immediately dragged from churches and monasteries; and declared that the day before she had absconded, she had sent two boxes of her manna to

but if by that quotation we are to understand Fen. undecima de dispositionibus cordis, I have sought for this information in vain. In lib. iv. fen. 6. tract. 2. c. 14, it is said "Fel canis aquatici interficit post hebdomadam." Rhodiginus also does not relate that for which he is quoted by Stenzel. p. 7.

[1] Vol. iv. p. 33.

Rome, where it was found in the custom-house, but she did not accuse any one of having ordered it. She was afterwards strangled, and to mitigate the archbishop, her body was thrown at night into the area of the convent from which she had been taken. Tophania however was not the only person at Naples who understood the making of this poison; for Keysler says that at the time he was there it was still secretly prepared and much employed.

In the year 1659, under the government of Pope Alexander VII., it was observed at Rome that many young married women were left widows, and that many husbands died when they became disagreeable to their wives. Several of the clergy declared also, that for some time past various persons had acknowledged at confession that they had been guilty of poisoning. As the government employed the utmost vigilance to discover these poisoners, suspicion fell upon a society of young married women, whose president appeared to be an old woman who pretended to foretell future events, and who had often predicted very exactly many deaths to persons who had cause to wish for them. To ascertain the truth, a crafty female, given out to be a person of considerable distinction, was sent to this old woman, pretending that she wished to obtain her confidence, and to procure some of her drops for a cruel and tyrannical husband. The whole society were by this stratagem arrested; and all of them, except the fortune-teller, whose name was Hieronyma Spara, confessed before they were put to the torture.—"Where now," cried she, "are the Roman princes, knights and barons, who on so many occasions promised me their protection! Where are the ladies who assured me of their friendship! Where are my children whom I have placed in so distinguished situations!" In order to deter others from committing the like crime, one Gratiosa, Spara's assistant, three other women, and the obstinate Spara herself, who still entertained hopes of assistance till the last moment, were hanged in the presence of innumerable spectators. Some months after, several more women were executed in the same manner; some were whipt, and others were banished from the country. Notwithstanding these punishments, the effects of this inveterate wickedness have been from time to time remarked. Le Bret, to whom we are indebted

for the above account, says[1] that Spara was a Sicilian, and acquired her knowledge from Tophania at Palermo. If that be true, the latter must have been early initiated in villany, and must have become when very young a teacher of her infamous art. Keysler calls her a little old woman.

The art of poisoning never excited more attention than it did in France about the year 1670[2]. Mary Margaret d'Aubray, daughter of the lieutenant-civil Dreux d'Aubray, was in the year 1651 married to the Marquis de Brinvillier, son of Gobelin president of the Chamber of Accounts, who had a yearly income of thirty thousand livres, and to whom she brought a portion of two hundred thousand. He was mestre-de-camp of the regiment of Normandy, and during the course of his campaigns became acquainted with one Godin de Sainte Croix, a young man of a distinguished family, who served as a captain of cavalry in the regiment of Trassy. This young officer, who was then a needy adventurer, became a constant visitor of the marquis, and in a short time paid his addresses to the marchioness, who lost her husband after she had helped to dissipate his large fortune, and was thus enabled to enjoy her amours in greater freedom. Her indecent conduct, however, gave so much uneasiness to her father, that he procured a lettre de cachet, had Sainte Croix arrested while in a carriage by her side, and thrown into the Bastille[3]. Sainte Croix there got acquainted with an Italian named Exili, who understood the art of preparing poison, and from whom he learnt it. As they were both set at liberty after a year's imprisonment, Sainte Croix kept Exili with him until he became perfectly master of the art, in which he afterwards instructed the marchioness, in order that she might employ it in bettering the circumstances of both. When she had acquired the prin-

[1] J. F. le Bret, Magazin zum Gebrauche der Staaten und-Kirchen-Geschichte, part iv. Francf. and Leips. 1774, 8vo, p. 131–141.

[2] The following account is collected from Causes celèbres, par M. Guyot de Pitaval, tome i.—Lettres de Mad. de Sevigné, tome iv.—Histoire du Règne de Louis XIV., par M. de Reboulet. Avignon, 1746, v. p. 159.—Histoire de Louis XIV., par M. B. de la Martinière, 1740, iv. p. 229.—Le Siècle de Louis XIV., par Voltaire, etc.

[3] Voltaire says that the father did not get Sainte Croix thrown into the Bastille, but sent to his regiment. This however is not the case, for this reprobate was at that time not in the army.

ciples of the art, she assumed the appearance of a nun, distributed food to the poor, nursed the sick in the Hôtel-Dieu, and gave them medicines, but only for the purpose of trying the strength of her poison undetected on these helpless wretches[1]. It was said in Paris, by way of satire, that no young physician, in introducing himself to practice, had ever so speedily filled a churchyard as Brinvillier. By the force of money, she prevailed on Sainte Croix's servant, called La Chaussée, to administer poison to her father, into whose service she got him introduced, and also to her brother, who was a counsellor of the parliament, and resided at his father's house. To the former the poison was given ten times before he died; the son died sooner; but the daughter, Mademoiselle d'Aubray, the marchioness could not poison, because perhaps she was too much on her guard; for a suspicion soon arose that the father and son had been poisoned, and the bodies were opened. She would however have escaped, had not Providence brought to light the villany.

Sainte Croix, when preparing poison, was accustomed to wear a glass mask; but as this once happened to drop off by accident, he was suffocated, and found dead in his laboratory. Government caused the effects of this man, who had no family, to be examined, and a list of them to be made out. On searching them, there was found a small box, to which Sainte Croix had affixed a written request, that after his death it might be delivered to the Marchioness de Brinvillier, or in case she should not be living, that it might be burnt[2]. No-

[1] This circumstance is denied by Voltaire, but only, as appears, to contradict Pitaval, whom he calls *un avocat sans cause*.

[2] This request was as follows:—"I humbly beg that those into whose hands this box may fall, will do me the favour to deliver it into the hands only of the Marchioness de Brinvillier, who resides in the Rue Neuve Saint Paul, as everything it contains concerns her, and belongs to her alone; and as, besides, there is nothing in it that can be of use to any persons except her; and in case she shall be dead before me, to burn it, and everything it contains, without opening or altering anything; and in order that no one may plead ignorance, I swear by the God whom I adore, and by all that is most sacred, that I advance nothing but what is true. And if my intentions, just and reasonable as they are, be thwarted in this point, I charge their consciences with it, both in this world and the next, in order that I may unload mine, protesting that this is my last will. Done at Paris this 25th of May in the afternoon, 1672.

"De Sainte Croix."

thing could be a greater inducement to have it opened than this singular petition; and that being done, there was found in it a great abundance of poisons of every kind, with labels on which their effects, proved by experiments made on animals, were marked. When the marchioness heard of the death of her lover and instructor, she was desirous to have the casket, and endeavoured to get possession of it, by bribing the officers of justice; but as she failed in this, she quitted the kingdom. La Chaussée, however, continued at Paris, laid claim to the property of Sainte Croix, was seized and imprisoned, confessed more acts of villany than were suspected, and was in consequence broke alive on the wheel in 1673.

A very active officer of justice, named Desgrais, was despatched in search of the Marchioness de Brinvillier, who was found in a convent at Liège, to which she had fled from England. To entice her from this privileged place, which folly had consecrated for the protection of vice, Desgrais assumed the dress of an abbé, found means to get acquainted with her, acted the part of a lover, and, having engaged her to go out on an excursion of pleasure, arrested her. Among her effects at the convent, there was found a confession, written by her own hand, which contained a complete catalogue of her crimes. She there acknowledged that she had set fire to houses, and that she had occasioned the death of more persons than any one ever suspected. She remarked also, that she had continued a virgin only till the seventh year of her age. Notwithstanding all the craft which she employed to escape, she was conveyed to Paris, where she at first denied everything; and, when in prison, she played picquet to pass away the time. She was however convicted, brought to a confession of her enormities, became a convert, as her confessor termed it, and went with much firmness to the place of execution, on the 16th of July, 1676; where, when she beheld the multitude of the spectators, she exclaimed in a contemptuous manner, "You have come to see a fine spectacle!" She was beheaded and afterwards burnt; a punishment too mild for such an offender[1]. As she had been amused with some hopes

[1] Martinière says that she was burnt alive, together with all the papers respecting her trial. The latter is improbable, and the former certainly false, notwithstanding the account given in the Encyclopédie.

of a pardon, on account of her relations, when she mounted the scaffold, she cried out, "*C'est donc tout de bon!*[1]"

Among a number of persons suspected of being concerned in this affair, was a German apothecary, named Glaser, who on account of his knowledge in chemistry, was intimate with Exili and Sainte Croix. From him they had both procured the materials which they used, and he was some years confined in the Bastille; but the charge against him being more minutely investigated, he was declared innocent, and set at liberty. He was the author of a Treatise on Chemistry, printed at Paris in 1667, and reprinted afterwards at Brussels in 1676, and at Lyons in 1679.

By the execution of this French Medea, the practice of poisoning was not suppressed; many persons died from time to time under very suspicious circumstances; and the archbishop was informed from different parishes that this crime was still confessed, and that traces of it were remarked both in high and in low families. For watching, searching after, and punishing poisoners, a particular court, called the *Chambre de Poison* or *Chambre ardente*, was at length established in 1679. This court, besides other persons, detected two women named La Vigoreux and La Voisin[2], who carried on a great traffic in poisons. The latter was a midwife. Both of them pretended to foretell future events, to call up ghosts, and to teach the art of finding hidden treasures, and of recovering lost or stolen goods. They also distributed philtres, and sold secret poison to such persons as they knew they could depend upon, and who wished to employ them either to get rid of bad husbands, or recover lost lovers. Female curiosity induced se-

[1] The following description of Brinvillier may perhaps be of use to our physiognomists:—"In order to satisfy the curiosity of those who may be desirous of knowing if such a celebrated criminal partook of the beauties of her sex, I shall observe that nature had not been sparing of them to the marchioness; her features were exceedingly regular, and the form of her face, which was round, was very graceful. This beautiful outside concealed a heart extremely black. Nothing proves more that *metoposcopy*, or the science of physiognomy, is false; for this lady had that serene and tranquil air which announces virtue."—Pitaval, p. 269.

[2] Some information respecting La Voisin may be found in Lettres Historiques et Galantes par Madame de C——. A Cologne, 1709–1711, 4 vols. 12mo, ii. p. 101, and iv. p. 376. The authoress of these letters was Mad. du Noyer.

veral ladies of the first rank, and even some belonging to the court, to visit these women, particularly La Voisin; and who, without thinking of poison, only wished to know how soon a husband, a lover, the king or his mistress, would die. In the possession of La Voisin was found a list of all those who had become dupes to her imposture. They were arrested and carried before the above-mentioned court, which, without following the usual course of justice, detected secret crimes by means of spies, instituted private trials, and began to imitate the proceedings of the holy inquisition. In this list were found the distinguished names of the Countess de Soissons, her sister the Duchess de Bouillon, and Marshal de Luxembourg. The first fled to Flanders to avoid the severity and disgrace of imprisonment; the second saved herself by the help of her friends; and the last, after he had been some months in the Bastille, and had undergone a strict examination, by which he almost lost his reputation, was set at liberty as innocent. Thus did the cruel Louvois the war minister, and the Marchioness de Montespan, ruin those who opposed their measures. La Vigoreux and La Voisin were burnt alive on the 22nd of February 1680, after their hands had been bored through with a red-hot iron and cut off. Several persons of ordinary rank were punished by the common hangman; those of higher rank, after they had been declared by this tribunal not guilty, were set at liberty; and in 1680 an end was put to the *Chambre ardente*, which in reality was a political inquisition.

It is certain that notwithstanding such punishments, like crimes have given occasion to unjust succession both in Italy and in France, and that attempts have been made for the same purpose even in the northern kingdoms. It is known that in Denmark Count Corfitz de Ulfeld was guilty, though it was not proved, of having intended to give the king a poison, which should gradually destroy him like a lethargy[1]. Charles XI. also, king of Sweden, died by the effects of such a poison. Having ruined several noble families by seizing on their property, and having after that made a journey to Torneo, he fell into a consumptive disorder which no medicine could cure. One day he asked his physician in a very earnest manner,

[1] Leben des Grafen von Ulfeld, von H. P. aus dem Dänischen übersetzt. Copenhagen und Leipzig, 1775, 8vo, p. 200.

what was the cause of his illness? The physician replied, "Your majesty has been loaded with too many maledictions." "Yes," returned the king, "I wish to God that the reduction of the nobility's estates had not taken place, and that I had never undertaken a journey to Torneo!" After his death his intestines were found to be full of small ulcers[1].

The oftener poisoning in this manner happens, the more it is to be wished that preventives and antidotes were found out, and that the symptoms were ascertained; but this is hardly possible as long as it is not known of what the poison properly consists. Governments, however, have wisely endeavoured to conceal the recipes, by suppressing the criminal procedures. Pope Alexander VII. caused them to be shut up in the castle of St. Angelo; in France, it is said, they were burnt together with the criminals; in Naples only the same precaution was not taken. I do not know that observations on the bodies of persons destroyed by slow poison have been ever published; for what Pitaval says on that subject is not sufficient[2]. People talk of powders and pills, but the greater part of this kind of poison appears to be a clear insipid water, and that prepared by Tophania never once betrayed itself by any particular effects on the body. The sale of aqua-fortis was a long time forbidden at Rome, because it was considered as the principal ingredient; but this is very improbable. At Paris it was once believed that succession powder consisted of diamond dust pounded exceedingly fine. Without assenting to this idea, one may contradict Voltaire, who conceives that diamond dust is not more prejudicial than powder of coral. It may be rather compared to that fine sand which is rubbed off from our mill-

[1] This anecdote was told to me by the celebrated Linnæus. An account of what appeared on opening the body of this prince may be seen in Baldinger's Neues Magazin für Aerzte, vol. i. p. 91.

[2] "The lieutenant-civil continued still to grow worse. After having languished a long time, being seized with a loathing of every kind of food presented to him, his vomitings still continuing, and nature being at length exhausted, he expired without any fever. The three last days he had wasted very much; he was become extremely shrunk, and he felt a great heat in his stomach. When opened, that part and the duodenum were found to be black, and sloughing off in pieces; the liver was mortified, and as it were burnt. The counsellor was ill three months, had the like symptoms as the lieutenant-civil, and died in the same manner. When opened, his stomach and liver were found in a similar state."—pp. 274, 275.

stones, and which we should consider and guard against as a secret poison, were we not highly negligent and careless of our health in the use of food[1]. In the casket of Sainte Croix were found corrosive sublimate, opium, regulus of antimony, vitriol, and a large quantity of poison ready prepared, the principal ingredients of which the physicians were not able to distinguish. Many have affirmed that sugar of lead was the chief ingredient[2]; but the consequences of the poison did not seem to indicate the use of that metal. For some years past a harmless plant, which is only somewhat bitter and astringent, the ivy-leaved Toadflax (*Linaria Cymbalaria*), that grows on old walls, has been loaded with the opprobrium of producing this slow poison, while at the same time it has been celebrated by others on account of its medicinal properties; but it is perhaps not powerful enough to do either mischief or good; and it is probable that it has been added to poisons either through ignorance, or to conceal other ingredients; for the

[1] In one year a ton of sand, at least, which is baked with the flour, is rubbed off from a pair of mill-stones. If a mill grinds only 4385 bushels annually, and one allows no more than twelve bushels to one man, a person swallows in a year above six pounds, and in a month half a pound of pulverized sandstone, which, in the course of a long life, will amount to upwards of three hundred weight. Is not this sufficient to make governments more attentive to this circumstance?

[Although not very agreeable to the reader to learn that he swallows above six pounds of mill-stone powder in the course of the year, it may perhaps ease his mind to know that the learned author is entirely mistaken in regarding it as a poison. The inhabitants of the northern countries of Europe frequently mix quartz powder with their heavy food to assist in its digestion; and we are informed by Professor Ehrenberg, that in times of scarcity, the inhabitants of Lapland mix the siliceous shells of some species of fossil Infusoria with the ground bark of trees for food. It is probably from this circumstance that the infusorial deposit derives its name of *Bergmehl*, or *Mountain-meal*.]

[2] For the following important information I am indebted to Professor Baldinger:—"There is no doubt that the slow poison of the French and Italians, commonly called succession powder (*poudre de la succession*), owes its origin to sugar of lead. I know a chemist who superintends the laboratory of a certain prince on the confines of Bohemia, and who by the orders (perhaps not very laudable) of his patron, has spent much time and labour in strengthening and moderating poisons. He has often declared, that of sugar of lead, with the addition of some more volatile corrosive, a very slow poison could be prepared; which, if swallowed by a dog or other animal, would insensibly destroy it, without any violent symptoms, in the course of some weeks or months."

emperor Charles VI., who was king of the Two Sicilies at the time when Tophania was arrested, told his physician Garelli, who communicated the same in a letter[1] to the celebrated Hoffmann, in 1718 or 1719, that the poison of that Italian Circe was composed of an arsenical oxide, dissolved in *aqua cymbalariæ*, and which I suppose was rendered stronger and more difficult to be detected by a salt that may be readily guessed. It is dreadful to think that this secret poison is administered as a febrifuge by ignorant or unprincipled physicians, quacks, and old women. It drives off obstinate fevers, it is true; but it is equally certain that it hastens death: it is therefore a cure, which is far worse than the disease, and against which governments and physicians cannot exclaim too severely. It was remarked at Rome, by accident, that lemon juice and the acid of lemons are, in some measure, counter-poisons; and a physician named Paul Branchaletti, respecting whom I can find no information, wrote a book expressly on this antidote to these drops, according to the account of Keysler, who however adds, "Everything hitherto found out, supposes that one has taken the drops only for a short time, or that one has had an opportunity to be upon one's guard when suspicious circumstances occurred, and to discover the threat ened danger."

It seems to be almost certain that the poisons prepared by Tophania and Brinvillier were arsenical mixtures, or, as Dr. Hahneman[2] rightly conjectures, neutral salts of arsenic. Loss of appetite, faintness, gnawing pains in the stomach, loss of strength without any visible cause, a continual indisposition, followed by a wasting of the viscera, a slow fever, &c., are all symptoms which seem to announce that dangerous metallic

[1] Garelli, the emperor's principal physician, lately wrote to me something remarkable in the following words:—"Your elegant dissertation on the errors respecting poisons brought to my recollection a certain slow poison, which that infamous poisoner, still alive in prison at Naples, employed to the destruction of upwards of six hundred persons. It was nothing else than crystallised arsenic, dissolved in a large quantity of water by decoction, with the addition, but for what purpose I know not, of the herb cymbalaria. This was communicated to me by his imperial majesty himself, to whom the judicial procedure, confirmed by the confession of the criminal, was transmitted. This water, in the Neapolitan dialect, is called *aqua del Toffnina*. It is certain death, and many have fallen a sacrifice to it."—Hoffmanni Med. Rationalis System., p. ii. c. 2. § 19.

[2] Ueber die Arsenikvergiftung. Leips. 1786, 8vo, p. 35.

oxide. The opinion, however, that it was composed of opium and cantharides has, in latter times, received so many confirmations, that one is almost induced to believe that there are more kinds than one of this Stygian water. The information given by the abbé Gagliani, seems to carry too much weight with it to be denied[1]. It is confirmed also by M. Archen-

[1] On the 20th of December, 1765, died the dauphin, father of Louis XVI., and in 1767 died the dauphiness. It was a public report that they were both despatched by secret poison : and the gradual decline of their health, the other circumstances which accompanied their illness, and the cabals which then existed at court, make this at least not improbable. Many private anecdotes respecting these events may be found in a book entitled L'Espion Dévalisé. Feliciter audax. London, 1782. In page 61 it is said, that on account of the suspicions then entertained, it was wished that information might be procured respecting secret poison, and the methods of preparing it; and that the abbé Gagliani, well known as a writer, has given the following:—"It is certain that in Europe the preparation of these drugs renders them pernicious and mortal. For example, at Naples the mixture of opium and cantharides, in known doses, is a slow poison; the surest of all, and the more infallible as one cannot mistrust it. At first it is given in small doses, that its effects may be insensible. In Italy we call it *aqua di Tufania*, Tufania water. No one can avoid its attacks, because the liquor obtained from that composition is as limpid as rock water, and without taste. Its effects are slow and almost imperceptible: a few drops of it only are poured into tea, chocolate, or soup, &c. There is not a lady at Naples who has not some of it lying carelessly on her toilette with her smelling-bottles. She alone knows the phial, and can distinguish it. Even the waiting-woman, who is her confidant, is not in the secret, and takes this phial for distilled water, or water obtained by precipitation, which is the purest, and which is used to moderate perfumes when they are too strong.

"The effects of this poison are very simple. A general indisposition is at first felt in the whole frame. The physician examines you, and perceiving no symptoms of disease, either external or internal, no obstructions, no collection of humours, no inflammations, orders detergents, regimen, and evacuation. The dose of poison is then doubled, and the same indisposition continues without being more characterized. The physician, who can see in this nothing extraordinary, ascribes the state of the patient to viscous and peccant humours, which have not been sufficiently carried off by the first evacuation. He orders a second—a third dose—a third evacuation—a fourth dose. The physician then sees that the disease has escaped him; that he has mistaken it, and that the cause of it cannot be discovered but by changing the regimen. He orders the waters, &c. In a word, the noble parts lose their tone, become relaxed and affected, and the lungs particularly, as the most delicate of all, and one of those most employed in the functions of the animal œconomy. The first illness then carries you off; because the critical accumulation settles always on the weak part, and consequently on the lobes of the lungs; the pus there fixes

holz[1]; but what he says of the use made of Spanish flies, by the Chinese, to invigorate the sixth sense, gives reason to suspect that his voucher is *L'Espion Dévalisé*, to whom the abbé Gagliani ascribes the same words. It appears to me, however, if I may be allowed to judge from probabilities, that the poison known in the East Indies under the name of *powst* is also water which has stood a night over the juice of poppies. It is given in the morning fasting to those persons, and particularly princes, whom people wish to despatch privately, and without much violence. It consumes them slowly, so that they at length lose all their strength and understanding, and in the end die torpid and insensible[2].

[Chemical science has made such rapid progress of late years, that there are but few, if any, poisonous substances which cannot be detected with certainty. The improved state of our medical knowledge, and the institution of coroners' inquests in all cases where any suspicion of the cause of death occurs, fortunately renders secret poisoning almost, if not quite impossible, at least in this country.]

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## WOODEN BELLOWS.

After the discovery of fire, the first instrument employed to blow it and strengthen it, has undoubtedly been a hollow reed, until the art was found out of forming a stick into a pipe by boring it. Our common bellows, which consist of two boards joined together by a piece of leather, and which probably are an imitation of the lungs, appear to have been early known to the Greeks. I have, however, met with no passage in any ancient author from which I could learn the oldest

itself, and the disease becomes incurable. By this method they follow one as long as they choose for months, and for years. Robust constitutions resist a long time. In short, it is not the liquor alone that kills, it is rather the different remedies, which alter and then destroy the temperament, exhaust the strength, extenuate and render one incapable of supporting the first indisposition that comes."

[1] England und Italien, ii. p. 354.

[2] Universal History, xxiii. p. 299–323.—The information contained there is taken from Fraser's History of Nadir Shah. Aurengzebe also caused one of his sons to be put to death by this poison.

construction of this machine, which in latter times has received many improvements. Had I found such information, I should have endeavoured to explain it, as it would have contributed to enlarge the knowledge we have of the metallurgy of the ancients.

It may be remarked on the following lines of Virgil,

..... Alii taurinis follibus auras
Accipiunt redduntque[1].....

that bull's leather is unfit for bellows, and that ox or cow leather only can be used for that purpose; but accuracy is not to be expected in a poet; and besides, Virgil is not the only author who employs the expression *folles taurinos*; for Plautus says also, "Quam folles taurini habent, cum liquescunt petræ, ferrum ubi fit."

Strabo[2] tells us, from an old historian, that Anacharsis, the Scythian philosopher, who lived in the time of Solon, invented the bellows, the anchor, and the potter's wheel: but this account is very doubtful, as Pliny, Seneca[3], Diogenes Laërtius[4], and Suidas, who likewise speak of the inventions ascribed to that philosopher, mention only the last two, and not the bellows: besides, Strabo himself remarks that the potter's wheel is noticed in Homer, and this poet is certainly older than Anacharsis. The latter, perhaps, became acquainted with that useful instrument during the course of his travels, and on his return, made his countrymen first acquainted with it. However this may be, it is well known that the person who introduces a foreign invention among a people, is often considered as the author of it.

In the oldest smelting-houses the bellows were worked by men. Refuse, therefore, and other remains of metal, are often found in places where until a recent period no works could be erected, on account of the want of water.

Bellows made with leather, of which I have hitherto spoken, are attended with many inconveniences. They require careful management; are expensive in their repairs; and besides last often not more than six or seven years. If thin leather is employed, it suffers a great deal of the air to escape through it; an evil which must be guarded against by continually besmearing it with train-oil, or other fat substances; and this is

[1] Georg. iv. 171. [2] Lib. vii. [3] Epist. 90. [4] Lib. i. 8.

even necessary when thick leather is used, to prevent it from cracking in the folds. Damage by fire and water must also be avoided; and every time they are repaired, the leather must be again softened with oil, which occasions a considerable loss of time.

In wooden bellows these inconveniences are partly lessened, and partly remedied. As these bellows, except the pipe, consist entirely of wood, many, who are not acquainted with the construction of them, can hardly conceive the possibility of making such a machine. Though they cannot be properly described without a figure, I shall endeavour to give the reader some idea of them by the following short sketch. The whole machine consists of two boxes placed the one upon the other, the uppermost of which can be moved up and down upon the lower one, in the same manner as the lid of a snuff-box, which has a hinge, moves up and down when it is opened or shut; but the sides of the uppermost box are so broad as to contain the lower one between them, when it is raised to its utmost extent. Both boxes are bound together, at the smallest end, where the pipe is, by a strong iron bolt. It may be readily comprehended, that when both boxes fit each other exactly, and the upper one is raised over the under one, which is in a state of rest, the space contained by both will be increased; and consequently more air will rush in through the valve in the bottom of the lower one; and when the upper box is again forced down, this air will be expelled through the pipe. The only difficulty is to prevent the air, which forces its way in, from escaping anywhere else than through the pipe; for it is not to be expected that the boxes will fit each other so closely as to prevent entirely the air from making its way between them. This difficulty, however, is obviated by the following simple and ingenious method. On the inner sides of the uppermost box there are placed moveable slips of wood, which, by means of metal springs, are pressed to the sides of the other box, and fill up the space between them. As these long slips of wood might not be sufficiently pliable to suffer themselves to be pressed close enough, and as, though planed perfectly straight at first, they would in time become warped in various directions, incisions are made in them across through their whole length, at the distance of from fifteen to eighteen inches from each other, so as to leave only a small space in

their thickness, by which means they acquire sufficient pliability to be everywhere pressed close enough to the sides[1].

The advantages of these wooden bellows are very great. When made of clean fir-wood without knots, they will last thirty or forty years, and even longer, though continually kept in action forty-six or forty-eight weeks every year: nay, Polhem assures us, that, when properly made, they will last a century. The effect produced by them is stronger, as well as more uniform, and can be moderated according to circumstances. They are worked also with greater facility. The slips of wood on their sides are apt to become damaged; but they can soon and easily be repaired. Every three or four months, however, the outer sides only of the inner box, and the bolt which keeps the boxes together, must be smeared with oil. If we reckon up the price of such bellows, and the yearly expense, they will, according to Grignon's account, be only a fifth part of those of the old leather bellows.

That the invention of these wooden bellows belongs to the Germans, is certain. Grignon[2] expressly affirms so; and in Becher's[3] time they were to be found in Germany, but not in England. Genssane, who ascribes the invention to the Swiss, is certainly mistaken; and perhaps he was led into this error, because these bellows were first made known in France by a Swiss. I cannot, however, ascertain the name of the real inventor. In the middle of the sixteenth century lived at Nuremberg an artist called Hans Lobsinger, who, in the year 1550, gave to the magistrates of that city a catalogue of his machines. From this catalogue Doppelmayer concludes that he understood the art of making small and large bellows without leather, and entirely of wood, which could be used in

[1] A complete description and a figure of these bellows may be found in Schluter's Unterricht von Hütten-werken. Brunswick, 1738.—Traité de la fonte des mines par le feu du charbon de terre; par M. de Genssane. Paris, 1770, 2 vols. 4to. [Ure's Dictionary, p. 1128, also contains an excellent figure of these wooden bellows.]

[2] "Germany is the country of machines. In general the Germans lessen manual labour considerably by machines adapted to every kind of movement; not that we are destitute of able mechanics; we have the talent of bringing to perfection the machines invented by our neighbours."—P. 200. [This remark of Grignon will sound rather odd to English ears.]

[3] Becher's Narrische Weisheit und weise Narrheit. Frankfort, 1683, 12mo, p. 113.

smelting-houses and for organs, and likewise copper bellows that always emitted a like degree of wind. As Lobsinger made organs, he, perhaps, fell upon this invention; but in what it actually consisted, or whether it might not have died with him, I have not been able to learn. Agricola, who died in the year 1555, makes no mention of wooden bellows.

Samuel Reyher, formerly professor at Kiel, in a dissertation on air[1], printed there in 1669, tells us, that about forty years before that period, two brothers, Martin and Nicholas Schelhorn, millers at the village of Schmalebuche in Coburg, first invented wooden bellows. Both the brothers, he says, kept the invention secret, though he thinks they did not conceal it so closely as to prevent its being guessed at; and he relates also how he himself formed an idea of it[2].

To these bellows Schluter has assigned a much nobler inventor, who, perhaps, was the first person who made them known by a description. He says expressly that they were invented by a bishop of Bamberg[3]: but of this I have been able to find no confirmation; and I am inclined to ascribe that service rather to an organ-builder, or a miller, than to a bishop. According to Schluter's account, these bellows were employed so early as the year 1620, in the Harz forest, to which they were first brought by some people from Bamberg. What Calvor says respecting the introduction of these bellows into the Harz forest is much more probable; that in the year 1621

[1] In this dissertation, the time of the invention is stated to be about forty years before, which would be the year 1629 or 1630; but in an improved edition, printed with additions at Hamburg, in 1725, a different period is given. "About eighty years ago," says the author, "a new kind of bellows, which ought rather to be called the pneumatic chests, was invented in the village of Schmalebuche, in the principality of Coburg, in Franconia. Two brothers, millers in that village, Martin and Nicholas Schelhorn, by means of some box made by them, the lid of which fitted very exactly, found out these chests, as I was told by one of their friends, a man worthy of credit. These chests are not of leather, but entirely of wood joined together with iron nails. In blacksmiths' shops they are preferred to those constructed with leather, because they emit a stronger blast, as leather suffers the more subtile part of the air to escape through its pores."

[2] In many places these bellows were at first put in a wooden case, to prevent their construction from being known.

[3] In J. P. Ludewig, Scriptores Rerum Episcopatus Bambergensis. Francof. 1718, fol. Where any bishop of latter times is praised, I find no mention of this useful and ingenious invention.

Lewis Pfannenschmid, from Thuringia, settled at Ostfeld near Goslar, and began to make wooden bellows. The bellows-makers of that place conspired therefore against him, and swore they would put him to death; but he was protected by the government. He would disclose his art to no one but his son, who, as well as his grandson a few years ago, had the making of all the bellows in the forest.

We are told by French authors, that the art of making these bellows was introduced into France, particularly into Berry, Nivernois, and Franche Comté, by a German.

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## COACHES.

If by this name we are to understand every kind of covered carriage in which one can with convenience travel, there is no doubt that some of them were known to the ancients. The *arcera*, of which mention is made in the twelve tables, was a covered carriage used by sick and infirm persons[1]. It appears to have been employed earlier than the soft *lectica*, and by it to have been brought into disuse. A later invention is the *carpentum*, the form of which may be seen on antique coins, where it is represented as a two-wheeled car with an arched covering, and which was sometimes hung with costly cloth[2]. Still later were introduced the *carrucæ*, first mentioned by Pliny; but so little is known of them, that antiquaries are uncertain whether they had only one wheel, like our wheelbarrows, or, as is more probable, four wheels. This much, however, is known, that they were first-rate vehicles, ornamented with gold and precious stones, and that the Romans considered it as an honour to ride in those that were remarkably high[3]. In the Theodosian code the use of them is not only allowed to civil and military officers of the first rank, but commanded as a mark of their dignity[4].

[1] See Leges XII. tab. illustratæ a J. N. Funccio, p. 72. Gellius, xx. 1.

[2] Scheffer de Re Vehiculari, Spanhem. de Præstant. Numismatum. Amst. 1671, 4to, p. 613. Propertius, iv. 8. 23, mentions *serica carpenta*.

[3] In my opinion the height here alluded to is to be understood as that of the body, rather than that of the wheels, as some think.

[4] Codex Theodos. lib. xiv. tit. 12. and Cod. Justin. lib. xi. tit. 19.

After this, covered carriages seem more and more to have become appendages of Roman pomp and magnificence; but the manner of thinking which prevailed under the feudal system banished the use of them for some time. As it was of the greatest importance to the feudal lords that their vassals should be always able to serve them on horseback, they could not think of indulging them with elegant carriages. They foresaw that by such luxury the nobility would give over riding on horseback, and become much more indolent and less fit for military service. Masters and servants, husbands and wives, clergy and laity, all rode upon horses or mules, and sometimes women and monks upon she-asses, which they found more convenient. The minister rode to court, and the horse, without any conductor, returned alone to his stable, till a servant carried him back to court to fetch his master. In this manner the magistrates of the imperial cities rode to council in the beginning of the sixteenth century; so that in the year 1502 steps to assist in mounting were erected by the Roman gate at Frankfort[1]. The members of the council who, at the diet and on other occasions, were employed as ambassadors, were on this account called *Rittmeister*; and even at present the expression *riding servant* is preserved in some of the imperial cities. The public entry of great lords into any place, or their departure from it, was never in a carriage, but on horseback; and in all the works which speak of the papal ceremonies there is no mention of a state coach or body coachmen, but of state horses or state mules. It was necessary that a horse for his holiness should be of a gray colour; not mettlesome however, but a quiet, tractable nag; that a stool with three steps should be brought to assist him to mount, and the emperor and kings, if present, were obliged to hold his stirrup and to lead the horse[2], &c. Bishops made their public entrance on horses or asses richly decorated[3]. At the coronation of the emperor, the electors and principal officers of the empire were ordered to make their entrance on horses, and to perform their service on horseback[4]. Formerly

[1] Lersner, Chronica der Stadt Frankfurt. i. p. 23.
[2] Sacrarum Cæremoniarum Romanæ Ecclesiæ Libri tres, auctore J. Catalano. Romæ, 1750, 2 vols. fol. i. p. 131.
[3] See Cæremoniæ Episcoporum, lib. i. c. 11.
[4] Ludewig's Erläuter. der Güldenen Bulle. Franc. 1719, vol. i. p. 569.

it was requisite that those who received an investiture should make their appearance on horseback: the vassal was obliged to ride with two attendants to his lord's court, where, having dismounted from his horse, he received his fief.

Covered carriages were known in the beginning of the sixteenth century; but they were used only by women of the first rank, for the men thought it disgraceful to ride in them. At that period, when the electors and princes did not choose to be present at the meetings of the states, they excused themselves by informing the emperor that their health would not permit them to ride on horseback; and it was considered as an established point, that it was unbecoming for them to ride like women[1]. What, according to the then prevailing ideas, was not allowed to princes, was much less permitted to their servants. In the year 1544, when Count Wolf of Barby was summoned by John Frederic, elector of Saxony, to go to Spires to attend the convention of the states assembled there, he requested leave, on account of his ill state of health, to make use of a close carriage with four horses. When the counts and nobility were invited to the marriage solemnity of the elector's half brother, duke John Ernest, the invitation was accompanied with a memorandum, that such dresses of ceremony as they might be desirous of taking with them should be transported in a small waggon[2]. Had they been expected in coaches, such a memorandum would have been superfluous. The use of covered carriages was for a long time forbidden even to women. In the year 1545 the wife of a certain duke obtained from him, with great difficulty, permission to use a covered carriage in a journey to the baths, in which however much pomp was displayed, but with this express stipulation, that her attendants should not have the same indulgence[3]. It is nevertheless certain, that the emperor, kings and princes, about the end of the fifteenth century, began to employ covered carriages on journeys, and afterwards on public solemnities.

In the year 1474 the emperor Frederic III. came to Frankfort in a close carriage; and as he remained in it on account of the wetness of the weather, the inhabitants had no occasion

[1] Ludolf, Electa Juris Publici, v. p. 417.
[2] Ludolf, *l. c.*
[3] Sattler, Historische Beschreibung des Herzogthums Würtemberg.

to support the canopy which was held over him, but while he went to the council-house, and again returned. In the year following the emperor visited the same city in a very magnificent covered carriage. In the description of the splendid tournament held by Joachim, elector of Brandenburg, at Ruppin, in 1509, we read of a carriage gilt all over, which belonged to the electress; of twelve other coaches ornamented with crimson, and of another of the duchess of Mecklenburg, which was hung with red satin. At the coronation of the emperor Maximilian, in the year 1562, the elector of Cologne had twelve carriages. In 1594, when the margrave John Sigismund did homage at Warsaw on account of Prussia, he had in his train thirty-six coaches with six horses each[1]. Count Kevenhiller, speaking of the marriage of the emperor Ferdinand II. with a princess of Bavaria, says, "The bride rode with her sisters in a splendid carriage studded with gold; her maids of honour in carriages hung with black satin, and the rest of the ladies in neat leather carriages." The same author mentions the entrance of Cardinal Dietrichstein into Vienna in 1611, and tells us that forty carriages went to meet him[2]. At the election of the emperor Matthias, the ambassador of Brandenburg had three coaches[3]. When the consort of that emperor made her public entrance, on her marriage in 1611, she rode in a carriage covered with perfumed leather. Mary, infanta of Spain, spouse of the emperor Ferdinand III., rode, in Carinthia, in 1631, in a glass carriage in which no more than two persons could sit. The wedding carriage of the first wife of the emperor Leopold, who was also a Spanish princess, cost together with the harness 38,000 florins[4]. The coaches used by that emperor are thus described by Rink:—"In the imperial coaches no great magnificence was to be seen: they were covered over with red cloth and black nails. The harness was black, and in the whole work there was no gold. The pannels were of glass, and on this

[1] Suite des Mémoires pour servir à l'Hist. de Brandenburg, p. 63, where the royal author adds, "The common use of carriages is not older than the time of John Sigismund."

[2] Annal. Ferdin. V. p. 2199; and vii. p. 375.

[3] In Suite des Mém. pour serv. à l'Hist. de Brandenburg, p. 63, it is remarked that they were coarse coaches, composed of four boards put together in a clumsy manner.

[4] Rink, Leben K. Leopold, p. 607.

account they were called the imperial glass coaches. On festivals the harness was ornamented with red silk fringes. The imperial coaches were distinguished only by their having leather traces; but the ladies in the imperial suite were obliged to be contented with carriages the traces of which were made of ropes." At the magnificent court of duke Ernest Augustus at Hanover, there were, in the year 1681, fifty gilt coaches with six horses each [1]. So early did Hanover begin to surpass other cities in the number of its carriages. The first time that ambassadors appeared in coaches on a public solemnity was at the imperial commission held at Erfurth in 1613, respecting the affair of Juliers [2].

The great lords at first imagined that they could suppress the use of coaches by prohibitions. In the archives of the county of Mark there is still preserved an edict, in which the feudal nobility and vassals are forbid the use of coaches, under pain of incurring the punishment of felony. In the year 1588, duke Julius of Brunswick published an order, couched in very expressive terms, by which his vassals were forbid to ride in carriages. This curious document is in substance as follows:—" As we know from ancient historians, from the annals of heroic, honourable and glorious achievements, and even by our own experience, that the respectable, steady, courageous and spirited Germans were heretofore so much celebrated among all nations on account of their manly virtue, sincerity, boldness, honesty and resolution, that their assistance was courted in war, and that in particular the people of this land, by their discipline and intrepidity, both within and without the kingdom, acquired so much celebrity, that foreign nations readily united with them; we have for some time past found, with great pain and uneasiness, that their useful discipline and skill in riding, in our electorate, county and lordship, have not only visibly declined, but have been almost lost (and no doubt other electors and princes have experienced the same among their nobility); and as the principal cause of this is that our vassals, servants and kinsmen, without distinction, young and old, have dared to give themselves up to indolence and to riding in coaches, and that few of them provide themselves with well-equipped riding horses and with

[1] Lünig's Theatr. Cer. i. p. 289.
[2] Ludolf, v. p. 416. Von Moser's Hofrecht, ii. p. 337.

skilful experienced servants, and boys acquainted with the roads: not being able to suffer any longer this neglect, and being desirous to revive the ancient Brunswick mode of riding, handed down and bequeathed to us by our forefathers, we hereby will and command, that all and each of our before-mentioned vassals, servants and kinsmen, of whatever rank or condition, shall always keep in readiness as many riding-horses as they are obliged to serve us with by their fief or alliance; and shall have in their service able, experienced servants, acquainted with the roads; and that they shall have as many horses as possible with polished steel harness and with saddles proper for carrying the necessary arms and accoutrements, so that they may appear with them when necessity requires. We also will and command our before-mentioned vassals and servants to take notice, that when we order them to assemble, either altogether or in part, in times of turbulence or to receive their fiefs, or when on other occasions they visit our court, they shall not travel or appear in coaches, but on their riding-horses, &c."[1] Philip II., duke of Pomerania-Stettin, reminded his vassals also, in 1608, that they ought not to make so much use of carriages as of horses[2]. All these orders and admonitions however were of no avail, and coaches became common all over Germany.

It would be difficult to give an exact description of these carriages without a figure, and drawings or paintings of them do not seem to be common.

In the month of October 1785, when I visited the senate-house at Bremen, I saw in the tax-chamber a view of the city, painted on the wall in oil colours, by John Landwehr, in 1661. On the left side of the fore-ground I observed a long quadrangular carriage, which did not appear to be suspended by leather straps. It was covered with a canopy supported by four pillars, but had no curtains, so that one could see all the persons who were in it. In the side there was a small door, and before there seemed to be a low seat, or perhaps a box. The coachman sat upon the horses. It was evident, from their dress, that the persons in it were burgomasters.

In the history of France we find many proofs that at Paris,

[1] Lunig. Corp. Jur. Feud. Germ. ii. p. 1447.

[2] An attempt was made also to prevent the use of coaches by a law in Hungary in 1523.

in the fourteenth, fifteenth, and even sixteenth centuries, the French monarchs rode commonly on horses, the servants of the court on mules, and the princesses, together with the principal ladies, sometimes on asses. Persons of the first rank frequently sat behind their equerry, and the horse was often led by servants. When Charles VI. wished to see incognito the entrance of the queen, he placed himself on horseback behind Savoisy, who was his confidant, with whom, however, he was much incommoded in the crowd[1]. When Louis, duke of Orleans, that prince's brother, was assassinated in 1407, the two *ecuyers* who accompanied him rode both upon the same horse[2]. In the year 1534, queen Eleonora and the princesses rode on white horses (*des haquenées blanches*) during a sacred festival. That private persons also, such as physicians, for example, used no carriages in the fifteenth century, is proved by the principal entrance to their public school, which was built in 1472, being so narrow that a carriage could not pass through it, though it was one of the widest at that period. In Paris also, at all the palaces and public buildings, there were steps for mounting on horseback, such as those which the parliament caused to be erected in 1599; and Sauval says on this occasion, that though many of these steps in latter periods had been taken away, there still remained several of them in his time at old buildings.

Carriages, however, appear to have been used very early in France. An ordinance of Philip the Fair, issued in 1294, for suppressing luxury, and in which the citizens' wives are forbid to use carriages (*cars*), is still preserved[3]. Under Francis I., or about 1550, somewhat later, there were at Paris, for the first time, only three coaches, one of which belonged to the queen, another to Diana de Poictiers, the mistress of two kings, Francis I. and Henry II., by the latter of whom she was created duchess of Valentinois, and the third to René de Laval, lord of Bois-dauphin. The last was a corpulent unwieldy nobleman, who was not able to ride on horseback. Others say, that the first three coaches belonged to

[1] Histoire des Antiquités de Paris, par Sauval, i. p. 187.

[2] Sauval; also Mezeray, Abregé Chron. de l'Histoire de France. Amsterdam, 1696, iii. p. 167.

[3] This ordonnance is to be found also in Traité de la Police, par De la Mare, i. p. 418.

Catherine de Medici; Diana, duchess of Angoulême, the natural daughter of Henry II., who died in 1619, in the eightieth year of her age; and Christopher de Thou, first president of the parliament. The last was excused by the gout; but the rest of the ministers of state soon followed his example[1]. Henry IV. was assassinated in a coach; but he usually rode through the streets of Paris on horseback, and to provide against rain, carried a large cloak behind him. For himself and his queen he had only one coach; as appears by a letter still preserved, in which he writes to a friend, "I cannot wait upon you to-day, because my wife is using my coach[2]." We, however, find two coaches at the public solemnity on the arrival of the Spanish ambassador, Don Peter de Toledo, under Henry IV.[3] This contradiction is not worth further research; but it shows that all writers do not speak of the same kind of carriages or coaches, and that every improvement has formed as it were an epoch in the history of them, which perhaps would be best elucidated by figures or engravings.

Roubo, in his costly Treatise on joiners' work[4], has given three figures of such (*chars*) carriages as were used under Henry IV., from drawings preserved in the king's library. By these it is seen that those coaches were not suspended by straps, that they had a canopy supported by ornamented pillars, and that the whole body was surrounded by curtains of stuff or leather, which could be drawn up. The coach in which Louis XIV. made his public entrance, about the middle of the seventeenth century, appears, from a drawing in the king's library, to have been a suspended carriage.

The oldest carriages used by the ladies in England were known under the now-forgotten name of *whirlicotes*. When Richard II., towards the end of the fourteenth century, was obliged to fly before his rebellious subjects, he and all his followers were on horseback; his mother only, who was indisposed, rode in a carriage. This, however, became afterwards somewhat unfashionable, when that monarch's queen, Ann, the

[1] Valesiana. Paris, 1695, 12mo, p. 35.

[2] Variétés Historiques, p. 96.

[3] Sauval says, "I shall here remark, that this was the first time coaches were used for that ceremony (the entrance of ambassadors), and that it was only at this period they were invented, and began to be used."

[4] L'Art du Menuisier-carossier, p. 457, planche 171.

daughter of the emperor Charles IV., showed the English ladies how gracefully and conveniently she could ride on a side-saddle. Whirlicotes therefore were disused, except at coronations and other public solemnities[1]. Coaches were first known in England about the year 1580, and, as Stow says, were introduced from Germany by Fitz-allen, earl of Arundel[2]. In the year 1598, when the English ambassador came to Scotland, he had a coach with him[3]. Anderson places the period when coaches began to be in common use, about the year 1605. The celebrated duke of Buckingham, the unworthy favourite of two kings, was the first person who rode with a coach and six horses, in 1619. To ridicule this new pomp, the earl of Northumberland put eight horses to his carriage.

Towards the end of the thirteenth century, when Charles of Anjou made his entrance into Naples, the queen rode in a carriage, called by historians *caretta*, the outside and inside of which were covered with sky-blue velvet, interspersed with golden lilies, a magnificence never before seen by the Neapolitans. At the entrance of Frederic II. into Padua, in the year 1239, it appears that there were no carriages, for the most elegantly dressed ladies who came to meet him were on palfreys ornamented with trappings (*sedentes in phaleratis et ambulantibus palafredis*). It is well known that the luxury of carriages spread from Naples all over Italy.

Coaches were seen for the first time in Spain in the year 1546. Such at least is the account of Twiss, who, according to his usual custom, says so without giving his authority[4].

Towards the end of the sixteenth century, John of Finland, on his return from England, among other articles of luxury, brought with him to Sweden the first coach[5]. Before that period, the greatest lords in Sweden, when they travelled by land, carried their wives with them on horseback. The princesses even travelled in that manner, and, when it rained, took with them a mantle of wax-cloth.

It appears that there were elegant coaches in the capital

[1] Stow's Survey of London, 1633, fol. p. 70.
[2] Anderson's Hist. of Commerce, iv. p. 180.
[3] Arnot's Hist. of Edinburgh, p. 596.
[4] Twiss's Travels through Spain and Portugal.
[5] Dalin, Geschichte des Reichs Schweden, iii. 1, p. 390 and 402.

of Russia so early as the beginning of the seventeenth century[1].

But to what nation ought we to ascribe the invention of coaches? If under this name we comprehend covered carriages, these are so old as not to admit of any dispute respecting the question. To the following, however, one might expect an answer, Who first fell on the idea of suspending the body of the carriage from elastic springs, by which the whole machine has undoubtedly been much improved? To this question, however, I can find no answer, except the information before mentioned, that suspended carriages were known in the time of Louis XIV.

As the name coach is now adopted, with a little variation, in all the European languages, some have thought to determine the country of this invention from the etymology of the word[2]. But even allowing that one could fix the origin of the word, it would by no means be ascertained what kind of a carriage we ought properly to understand by it. M. Cornides[3] has lately endeavoured to prove that the word *coach* is of Hungarian extraction, and that it had its rise from a village in the province of Wieselburg, which at present is called *Kitsee*, but was known formerly by the name of *Kotsee*, and that this travelling machine was even there first invented. However this may be, the grounds on which he supports his assertion deserve to be here quoted, as they seem at least to prove that in the sixteenth century, or even earlier, a kind of covered carriages was known, under the name of Hungarian carriages[4]. As the word *Gutschi*, and not *Gutsche*, was used

[1] Bacmeister, Essai sur la Bibliothèque de l'Académie de S. Pétersburg, 1776, 8vo, p. 38.

[2] Joh. Ihre, Glossarium Sueogothic. i. col. 1178. *Kusk*, a coachman. It seems properly to denote the carriage itself. Gall. *cocher*. Hisp. id. Ital. *cocchio*. Ang. *coach*. Hung. *cotczy*. Belg. *goetse*. Germ. *kutsche*. The person who drives such carriages is by the English called *coachman*, which in other languages is made shorter, as the French say *cocher*, and the Germans *kusk*. It is difficult, however, to determine whence it is derived, as we do not know by whom these close carriages were invented. Menage makes it Latin, and by a far-fetched derivation from *vehiculum*; Junius derives it somewhat shorter from ὀχέω to carry. Wachter thinks it comes from the German word *kutten*, to cover; and Lye from the Belgic *koetsen*, to lie along, as it properly signifies a couch or chair.

[3] Ungrisches Magaz. Pressburg, 1781, vol. i. p. 15.

[4] Stephanus Broderithus says, speaking of the year 1526, "When the

at first in Germany, the last syllable gives us reason to conjecture that it is rather of Hungarian than German extraction. As Hortleder[1] tells us that Charles V., because he had the gout, laid himself to sleep in an Hungarian *Gutsche*, one might almost conclude that the peculiarity of these carriages consisted in their being so constructed as to admit people to sleep in them. This conjecture is supported by the meaning of the word *Gutsche*, which formerly signified a couch or sofa[2]. As the writers quoted by Cornides call the Hungarian coaches sometimes (*leves*) light, sometimes (*veloces*) swift, they ought rather to be considered as a particular kind of carriages for travelling with expedition. It is, however, still more worthy of remark, that, so early as the year 1457, the ambassador of Ladislaus V., king of Hungary and Bohemia, brought with him to the queen of France, besides other presents, a carriage which excited great wonder at Paris, and which, as an old historian says, was *branlant et moult riche*[3]. Does not the first word of this expression seem to indicate that the carriage was suspended?

A peculiar kind of coach has been introduced in latter times under the name of Berlin. The name indicates the place

archbishop received certain intelligence that the Turks had entered Hungary, not contented with informing the king by letter of this event, he speedily got into one of those light carriages, which, from the name of the place, we call *Kotcze*, and hastened to his majesty." Siegmund baron Herberstein, ambassador from Louis II. to the king of Hungary, says, in Commentario de Rebus Moscoviticis, Basil 1571, fol. p. 145, where he occasionally mentions some stages in Hungary, "The fourth stage for stopping to give the horses breath is six miles below Jaurinum, in the village of *Cotzi*, from which both drivers and carriages take their name, and are still generally called *cotzi*." That the word *coach* is of Hungarian extraction is confirmed also by John Cuspinianus (Spiesshammer), physician to the emperor Maximilian I., in Bell's Appar. ad Histor. Hungariæ, dec. 1, monum. 6, p. 292. "Many of the Hungarians rode in those light carriages called in their native tongue *Kottschi*." In Czvittinger's Specimen Hungariæ Litteratæ, Franc. et Lips. 1711, 4to, we find an account of the service rendered to the arts and sciences by the Hungarians; but the author nowhere makes mention of coaches.

[1] In his Account of the German War, p. 612.

[2] Examples may be seen in Frisch's German Dictionary, where it appears that the beds which are used for raising tobacco plants are at present called *Tabacks kutschen*, tobacco beds. This expression is old, for I find it in Pet. Laurembergii Horticultura, Franc. 1631, p. 43.

[3] Roubo, p. 457. The historian, however, gives it no name.

which gave birth to the invention, as the French themselves acknowledge; though some, with very little probability, wish to derive it from the Italian[1]. Philip de Chiese, a native of Piedmont, and descended from the Italian family of Chiesa, was a colonel and quarter-master-general in the service of Frederic William, elector of Brandenburg, by whom he was much esteemed on account of his knowledge in architecture. Being once sent to France on his master's business, he caused to be built, on purpose for this journey, a carriage capable of containing two persons; which, in France and everywhere else, was much approved, and called a berline. This Philip de Chiese died at Berlin in 1673[2].

Coaches have given rise to a profession which in large cities affords maintenance to a great number of people, and which is attended with much convenience; I mean that of letting out coaches for hire, known under the name of *fiacres*, hackney-coaches[3]. This originated in France; for about the year 1650 one Nicholas Sauvage first thought of keeping horses and carriages ready to be let out to those who might have occasion for them. The Parisians approved of and patronised this plan; and as Sauvage lived in the street St. Martin, in a house called the *hôtel St. Fiacre*, the coaches, coachmen and proprietor, were called *fiacres*. In a little time this undertaking was improved by others, who obtained a license for their new institutions on paying a certain sum of money[4]. Some kept coaches ready in certain places of the streets, and let them out as long as was required, to go from one part of the city to another. These alone, at length, retained the name of *fiacre*, which at first was common to every kind of hired carriage without distinction. Others kept carriages at their houses, which they let out for a half or a whole

[1] "*Berlin*. A kind of carriage which takes its name from the city of Berlin, in Germany; though some persons ascribe the invention of it to the Italians, and pretend to find the etymology of it in *berlina*, a name which the latter give to a kind of stage on which criminals are exposed to public ignominy."—Encyclopédie, ii. p. 209.

[2] Nicolai Beschreibung von Berlin, Anhang, p. 67.

[3] At Rome, however, at a very early period, there appears to have been carriages to be let out for hire: Suetonius calls them (i. chap. 57) *rheda meritoria*, and (iv. c. 39) *meritoria vehicula*.

[4] Charles Villerme paid in 1650, into the king's treasury, for the exclusive privilege of keeping coaches for hire within the city of Paris, 15,000 livres.

day, a week, or a month: these coaches were known by the name of *carosses de remise*. Others kept carriages which at a certain stated time went from one quarter of the city to another, like a kind of stages, and took up such passengers as presented themselves; and in the year 1662 some persons set up carriages with four horses, for the purpose of conveying people to the different palaces at which the court might be; these were called *voitures pour la suite de la cour*. The proprietors often quarreled respecting the boundaries prescribed to them by their licenses; and on this account they were sometimes united into one company, and sometimes separated. The police established useful regulations, by which the safety and cleanliness of these carriages were promoted; marks were affixed to them, by which they might be known; and young persons and women of the town were forbidden to use them [1], &c.

A particular kind of hackney carriage, peculiar to the Parisians, in the opinion of some does no great honour to their urbanity. I mean the *brouettes*, called sometimes *roulettes*, and by way of derision *vinaigrettes*. The body of these is almost like that of our sedans, but rolls upon two low wheels, and is dragged forwards by men. An attempt was made to introduce such machines under Louis XIII.; but the proprietors of the sedans prevented it, as they apprehended the ruin of their business. In the year 1669 they were however permitted, and came into common use in 1671, but were employed only by the common people. Dupin, the inventor of these *brouettes*, found means to contrive them so that they did not jolt so much as might have been expected; and he was able to conceal this art so well, that for a long time he was the only person who could make them [2]. The number of all the coaches at Paris is by some said to be fifteen thousand; the author of Tableau de Paris reckons the number of the hackney coaches to amount to eighteen hundred, and asserts that more than a hundred foot passengers lose their lives by them every year.

[1] A full history of the Parisian *fiacres*, and the orders issued respecting them, may be seen in Continuation du Traité de la Police. Paris, 1738, fol. p. 435. See also Histoire de la Ville de Paris, par Sauval, i. p. 192.

[2] An account of the manner in which these *brouettes* were suspended may be seen in Roubo, p. 588. He places the invention of post-chaises in the year 1664.

Coaches to be let for hire were first established at London in 1625. At that time there were only twenty, which did not stand in the streets, but at the principal inns. Ten years after, however, they were become so numerous, that king Charles I. found it necessary to issue an order for limiting their number. In the year 1637 there were in London and Westminster fifty hackney coaches, for each of which no more than twelve horses were to be kept. In the year 1652 their number had increased to two hundred; in 1654 there were three hundred, for which six hundred horses were employed; in 1694 they were limited to seven hundred, and in 1715 to eight hundred[1].

Hackney coaches were first established in Edinburgh in 1673. Their number was twenty; but as the situation of the city was unfavourable for carriages, it fell in 1752 to fourteen, and in 1778 to nine, and the number of sedans increased.

*Fiacres* were introduced at Warsaw, for the first time, in 1778. In Copenhagen there are a hundred hackney coaches[2].

In Madrid there are from four to five thousand gentlemen's carriages[3]; in Vienna three thousand, and two hundred hackney coaches.

At Amsterdam coaches with wheels were in the year 1663 forbidden, in order to save the expensive pavement of the streets; for coaches there, even in summer, are placed upon sledges, as those at Petersburgh are in winter. The tax upon carriages in Holland has from time to time been raised, yet the number has increased; and some years ago the coach horses in the Seven United Provinces amounted to twenty-five thousand.

When Prince Repnin made his entrance into Constantinople in 1775, he had with him eighty coaches, and two hundred livery servants.

[Since the former edition of this work, published in 1814, public conveyances have undergone considerable changes. Stage-coaches, which in this country had arrived at such a degree of perfection, and which, till within a few years, passed through and connected almost every small town in the United Kingdom, have now nearly disappeared in consequence of the introduction of railroads. It is also rare in

[1] Anderson's Hist. of Commerce.
[2] Haubers Beschr. von Copenhagen, p. 173.
[3] Twiss's Travels through Spain and Portugal.

London to meet with a solitary hackney coach, this class of vehicles being almost entirely superseded by the lighter one-horsed cabriolets which were first introduced as public conveyances in the year 1823. The number of hackney coaches and cabriolets now plying for hire in the streets of London amounts to 2650, of which probably not more than 250 are two-horsed coaches.

That very useful form of public conveyance, the omnibus, which is at present met with in nearly every large town in Europe, originated in Paris in 1827. In the latter part of 1831 and the beginning of 1832, omnibuses began to ply in the streets of London. Those running from Paddington to the Bank were the earliest. Carriages, however, of a similar form were used in England as Long Stages more than forty years ago, but were discontinued as they were not found profitable. They were in most request at holiday time, by schoolmasters in the neighbourhood of London; and some even of the present generation will remember their joyous pranks on journeying home in these capacious machines.

There are now about 900 omnibuses running in London and its immediate vicinity. The line from Paddington to the Bank is served by two companies, the London Conveyance Company, and the Paddington Association, which have mutually agreed to run forty omnibuses each. An idea of the utility of these conveyances may be formed from the fact that the receipts of each of the eighty carriages on the above line averages 1000*l.* per annum, in sixpences.

Omnibuses began to run in Amsterdam in 1839.]

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## WATER-CLOCKS, CLEPSYDRAS.

We are well assured that the ancients had machines by which, through the help of water, they were able to measure time[1].

[1] [Sextus Empiricus (Adv. Math. cap. 21) says that the Chaldæans divided the zodiac into 12 equal parts, as they supposed, by allowing water to run out of a small orifice during the whole revolution of a star, and dividing the fluid into 12 equal parts, the time answering to each part being taken for that of the passage of a sign over the horizon.]

The invention of them is by Vitruvius[1] ascribed to Ctesibius of Alexandria, who lived under Ptolemy Euergetes, or about the year 245 before the Christian æra[2]. They were introduced at Rome by P. Cornelius Scipio Nasica, in the year 594 after the building of the city, or about 157 years before the birth of Christ. How these water-clocks were constructed, or whether they were different from the clepsydras, I shall not inquire. If under the latter name we understand those measurers of time which were used in courts of justice, the clepsydra is a Grecian invention, first adopted at Rome under the third consulship of Pompey[3]. The most common kinds of these water-clocks all, however, corresponded in this, that the water issued drop by drop through a hole of the vessel, and fell into another, in which a light body that floated marked the height of the water as it rose, and, by these means, the time that had elapsed. They all had this failing in common, that the water at first flowed out rapidly, and afterwards more slowly, so that they required much care and regulation[4].

That ingenious machine, which we have at present under the name of a water-clock, was invented in the seventeenth century. The precise time seems to be uncertain; but had it been before the year 1643[5], Kircher, who mentions all the machines of this kind then known, would in all probability have taken notice of it. It consists of a cylinder divided into several small cells, and suspended by a thread fixed to its axis in a frame on which the hour distances, found by trial, are marked out. As the water flows from the one cell into the other, it changes very slowly the centre of gravity of the

[1] Lib. ix. c. 9.

[2] [Some mode of measuring time by the reflux of water, however rude it might be, was used at Athens before the time of Ctesibius, as we see by various passages in Demosthenes.]

[3] Aúctor Dialog. de Caus. Cor. Eloq. 38.—The orators were confined to a certain time; and hence Cicero says, *latrare ad clepsydram.*

[4] Some account of the writers who have spoken of the water-clocks of the ancients may be found in Fabricii Bibliograph. Antiquaria, p. 1011. They were formerly used for astronomical observations. The authors who treat of them in this respect are mentioned in Riccioli Almagest. Novo, i. p. 117.

[5] In that year Kircher's Ars Umbræ et Lucis was published for the first time. In the edition of 1671, several kinds of water-clocks are described. p. 698.

cylinder, and puts it in motion[1]; much like the quicksilver puppets invented by the Chinese[2].

These machines must have been very scarce in France in 1691; for Graverol at that time gave a figure and description of the external parts of one, but promised to give the internal construction as soon as he should become acquainted with it[3]. This was the only one then in Nismes. He says, also, that they were invented a little before by an Italian Jesuit, who resided at Bologna, but were brought to perfection by Taliaisson, professor of law at Toulouse, and a young clergyman named De l'Isle.

Alexander says more than once that this machine was invented at Sens in Burgundy, in 1690, by Dom Charles Vailly, a Benedictine of the brotherhood of St. Maur, and that he brought it to perfection by the assistance of a pewterer there, named Regnard. This account is in some measure confirmed by Ozanam; for he says expressly, that the first water-clocks were brought from Burgundy to Paris in 1693, and he describes one which was made of tin at Sens. Dom Charles Vailly was born at Paris in 1646, and died in 1726; he was celebrated on account of his mathematical knowledge, though he is known by no works, as he burned all his manuscripts[4].

Alexander, however, who was of the same order, seems to have ascribed to his brother Benedictine an honour to which he was not entitled; for Dominic Martinelli, an Italian of Spoletto, published at Venice, in 1663, a treatise written expressly on these water-clocks, which Ozanam got translated

[1] A particular account of these water-clocks is to be found in Ozanam, Recréations Math. et Physiques [republished in Hutton's Mathematical Recreations, ii. 40]. Bion on Mathematical Instruments.

[2] Muschenbroek, Philos. Natur. i. p. 143.

[3] Journal des Sçavans, 1691.

[4] This monk may be considered as the restorer of the clepsydra, or clock which measures time by the fall of a certain quantity of water confined in a cylindric vessel. These clocks were in use among ancient nations. They are said to have been invented at the time when the Ptolemies reigned in Egypt. Dom Vailly, who applied himself particularly to practical mathematics, having remarked the faults of these clocks, bestowed much labour in order to bring them to perfection; and by a number of experiments, combinations, and calculations, he was at length able to carry them to that which they have attained at present. At the time of their arrival they were very much in vogue in France.—Hist. Littéraire de la de Congr. St. Maur, ordre de S. Bénoit. Bruxelles, 1770, 4to, p. 478.

into French by one of his friends, and caused to be printed with his additions[1]. This translator says that water-clocks were known in France twenty years earlier than Ozanam had imagined. It appears therefore that they were invented in Italy about the middle of the seventeenth century, and that Vailly, perhaps, may have first made them known in France[2].

It may perhaps afford some pleasure to those who are fond of the history of the arts, to know that Salmon, an ingenious pewterer at Chartres in France, has given very full and ample directions how to construct and use this machine[3]. He is of opinion that the invention is scarcely a century old; and that these water-clocks, which are now common, were first made for sale and brought into use among the people in the country, by a pewterer at Sens in Burgundy. What this artist affirms, that they can be constructed of no metal so easily, so accurately, and to last so long as of tin, is perfectly true. I have however in my possession one of brass, which is well constructed; but it suffers a little from acids. Among the newest improvements to this machine may be reckoned an alarum, which consists of a bell and small wheels, like those of a clock that strikes the hours, screwed to the top of the frame in which the cylinder is suspended. The axis of the cylinder, at the hour when one is desirous of being wakened, pushes down a small crank, which, by letting fall a weight, puts the alarum in motion. A dial-plate with a handle is also placed sometimes over the frame.

[A very ingenious application of the principle of the clepsydra, for the purpose of measuring accurately very small intervals of time, is due to the late Captain H. Kater. Mercury is allowed to flow from a small orifice in the bottom of a vessel, kept constantly filled to a certain height. At the moment of noting any event, the stream is interrupted and turned aside into a receiver, into which it continues to run till the moment of noting any other event, when the intercepting cause is suddenly removed. The stream then flows in its

[1] Ozanam, ii. p. 475.

[2] Alexander will not admit this to be the case. "It is possible," says he, "that two persons of penetrating genius may have discovered the same thing."

[3] Art du potier d'étain, par Salmon. Paris, 1788, fol. p. 131.

original course. The weight of mercury in the receiver, compared with the weight of that which passes through the orifice in a given time, observed by the clock, gives the interval between the events.]

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## TOURMALINE.

The ancients, though ignorant of electricity, were acquainted with the nature of amber, and knew that when rubbed it had the power of attracting light bodies. In like manner they might have been acquainted with the tourmaline, and might have known that it also, when heated, attracted light bodies, and again repelled them; for had they only bethought themselves, in order to search out the hidden properties of this stone (which on account of its colour and hardness is very remarkable), to put it into the fire, they would have then seen it sport with the ashes. Some learned men have thought they found traces of the properties of this stone, in what the ancients tell us respecting the *lyncurium*, *theamedes*, and *carbunculus*. The fruit of my researches respecting this subject I shall here lay before the reader. All that we find in the ancients to enable us to characterize the lyncurium is, that it was a very hard stone, which could with difficulty be cut; that seals were formed of it; that it was transparent, and of a fiery colour, almost like that of yellow amber; that it attracted light bodies, such as chaff, shavings of wood, leaves, feathers, and bits of thin iron and copper leaf, in the same manner as amber; that the ancients procured it from Æthiopia, but that in the time of Pliny no stone was known under that name[1].

This information proves, in my opinion, that the lyncurium cannot be the belemnites, as some old commentators and Woodward have affirmed; for the latter has not the celebrated hardness and transparency of the former, neither has it the property of attracting light bodies, nor is it fit for being cut

[1] Theophrast. De Lapidibus, edit. Heinsii, fol. p. 395, and Plin. lib. xxxvii. c. 3, and lib. viii. c. 38.

into seals. That opinion probably has arisen in the following manner:—the ancients supposed that the lyncurium was the crystallized urine of the animal which we call the lynx. As some belemnites contain bituminous particles which give them an affinity to the swine-stone, naturalists, when they have rubbed or heated yellow and somewhat transparent pieces of this fossil, have imagined that they smelt the fabulous origin of the lyncurium.

Less ridiculous is the opinion of some old and modern writers, that the lyncurium was a species of amber. Theophrastus, however, the ablest and most accurate mineralogist of the ancients, would certainly have remarked this and not have separated the lyncurium from amber. Besides, the latter has not the hardness of the former, nor can it be said that it is difficult to be cut; for at present it is often made into various toys with much ingenuity. The opinion of Pliny is here of little weight; for it is founded, as ours must be, on the information of Theophrastus.

Epiphanius, who considered the Bible as a system of mineralogy, but could not find the lyncurium in it, supposes that it may have been the hyacinth[1]. However ridiculous the cause of this conjecture may be, it must be allowed that it is not entirely destitute of probability; and I say with John de Laet, "The description of the lyncurium does not ill agree with the hyacinth of the moderns[2]." If we consider its attracting of small bodies in the same light as that power which our hyacinth has in common with all stones of the glassy species, I cannot see anything to controvert this opinion, and to induce us to believe the lyncurium and the tourmaline to be the same. The grounds which Watson produces for this supposition, are more in favour of the hyacinth than the tourmaline[3]. Had Theophrastus been acquainted with the latter, he would certainly have remarked that it did not acquire its attractive power till it was heated. At present, at least, no tourmaline is known to attract until it is heated; though it would not appear very wonderful if a stone like the magnet should retain its virtue for a long time.

The duke of Noya Caraffa believes the theamedes of the

[1] Epiphanius De XII Gemmis.
[2] J. de Laet De Gemmis. 1647, 8vo, p. 155.
[3] Phil. Trans. vol. li. 1. p. 394.

ancients to have been the tourmaline[1]. Of that stone we are told, by Pliny, only that it possessed a power contrary to the power of the magnet; that is, that it did not attract but repel iron. But this only proves, that it had then been remarked that the magnet repelled the negative pole of a piece of magnetic iron. This account has been thus explained by Boot[2]. To induce us to consider the theamedes as the tourmaline, Pliny ought to have said that it attracted iron and then repelled it.

With much greater probability may we consider as the tourmaline a precious stone, classed by Pliny among the numerous varieties of the carbuncle[3]; for however perplexed and unintelligible his account of the carbuncles may be, and however much the readings in the different copies may vary, we still know that he describes a stone which was very hard; which was of a purple, that is a dark violet colour, and used for seals; and which, when heated by the beams of the sun, or by friction, attracted chaff and other light bodies. Had Pliny told us that it at first attracted and then repelled them, no doubt would remain; but he does not say so, nor do his transcribers Solinus and Isidorus[4].

A much later account of a stone that, when rubbed, is, like the magnet, endued with an attractive power is to be found in a passage of John Serapion, the Arabian, pointed out to me by Professor Bütner[5]. This stone indeed cannot with

[1] Recueil de Mem. sur la Tourmaline, par Æpinus. Petersb. 1762, 8vo, p. 122.

[2] Gemm. et Lapidum Historia. 1647, 8vo, p. 441, 450.

[3] Plin. lib. xxxvii. c. 7.

[4] India produces also the lychnites, the splendour of which is heightened when seen by the light of lamps; and on this account it has been so called by the Greeks. It is of two colours; either a bright purple, or a clear red, and if pure is thoroughly transparent. When heated by the rays of the sun, or by friction, it attracts chaff and shavings of paper. It obstinately resists the art of the engraver.—Solinus, c. lii. p. 59. Traj. 1689, fol.

[5] "Hager albuzedi is a red stone, but less so than the hyacinth, the redness of which is more agreeable to the eye, as there is no obscurity in it The mines where this stone is found are in the East. When taken from the mine it is opake; but when divested of its outer coat by a lapidary, its goodness is discovered, and it becomes transparent. When this stone has been strongly rubbed against the hair of the head it attracts chaff, as the magnet does iron."—Serapionis Lib. de simplicibus medicinis. Argent. 1531, fol. p. 263.

much probability be taken for the tourmaline, as all precious stones, when heated, have the same property; but it is worthy of remark, that, like the lyncurium of the ancients, it belongs to the hyacinths, the colour of which many of the real tourmalines have; and among those of the island of Ceylon there are, perhaps, some which ought to be classed among the hyacinths, rather than among the schorls.

The real tourmaline was first brought from Ceylon, and made known by the Dutch, about the end of the seventeenth or beginning of the eighteenth century. It is commonly believed that the first account of it ever published is that to be found in the Memoirs of the Academy of Sciences at Paris for the year 1717; but it appears that fuller and more accurate descriptions of the properties of that stone were given in German works ten years before. The earliest information that I know respecting it is in a book now almost and justly forgotten, entitled Curious Speculations during Sleepless Nights[1]. In a passage, where the author, speaking of hard and glassy bodies which attract light substances, affirms that this property is not magnetic, he says, "The ingenious Dr. Daumius, chief physician to the Polish and Saxon troops on the Rhine, told me, that in the year 1703 the Dutch first brought from Ceylon in the East Indies a precious stone called tourmaline, or turmale, and named also *trip*, which had the property, that it not only attracted the ashes from the warm or burning coals, as the magnet does iron, but also repelled them again, which was very amusing; for as soon as a small quantity of ashes leaped upon it, and appeared as if endeavouring to writhe themselves by force into the stone, they in a little sprang from it again, as if about to make a new effort; and on this account it was by the Dutch called the *ashes-drawer*. The colour of it was an orange-red heightened by a fire colour. When the turf coals were cold, it did not produce these effects, and it required no care like the magnet. I have considered whether it would not attract and repel the ashes of other burning coals as well as those of turf; and I have no doubt, that, if heated, it would attract other things besides ashes."

[1] Curiöse Speculationes bey Schlaf-losen Nächten, 8vo, Chemnitz, 1707. The author's name appears to be expressed by the initials I. G. S. This work consists of forty-eight dialogues, each twelve of which have a distinct title.

This whole passage has been inserted word for word, without variation or addition, and without telling the source from which taken, in a book perhaps equally forgotten, called Observationes curioso-physicæ, or Remarks and Observations on the great Wonders of the World, by Felix Maurer, physician[1]. This thick volume is entirely compiled from a number of works, the names of which are not mentioned.

In the Catalogue of the collection of natural curiosities belonging to Paul Hermann, which were sold at Leyden in June 1711, I find, among the precious stones, *Chrysolithus Turmale Zeylon.* Though no description is added, it cannot be doubted that our tourmaline is meant. From this however we learn that the name together with the stone came to us from Ceylon, as Watson has remarked. We learn further, that the stone was at first considered as a chrysolite, and perhaps it may be mentioned under this name in the old accounts of Ceylon. Hermann, whose service to botany is well known, was in that island from 1670 to 1677; and it might be presumed, from his spirit of inquiry, that, had he known this stone, he would somewhere or other in his works have taken notice of its properties: but I find no mention of it either in his Cynosura Materiæ Medicæ, or in Musæum Zeylonicum.

In the year 1719 the Academy of Sciences at Paris announced in their memoirs for 1717, that in the latter year M. Lemery had laid before them a stone found in a river in the island of Ceylon, which attracted and repelled light bodies[2]. It is there called a small magnet, though some difference between the two stones was admitted; but the German natu-

[1] Frankf. 1713, 8vo.

[2] I shall here lay before the reader the whole passage, taken from Histoire de l'Académie for 1717, p. 7:—"Here we have a small magnet. It is a stone found in a river of the island of Ceylon. It is of the size of a denier, flat, orbicular, about the tenth part of an inch in thickness, of a brown colour, smooth and shining, without smell and without taste, which attracts and afterwards repels small light bodies, such as ashes, filings of iron, and bits of paper. It was shown by M. Lemery. It is not common, and that which he had cost twenty-five livres (about twenty shillings sterling). When a needle has been touched with a loadstone, the south pole of the loadstone attracts the north pole of the needle, and repels its south pole: thus it attracts or repels different parts of the same body, according as they are presented to it, and it always attracts or repels the same. But the stone of Ceylon attracts, and then repels in the like manner, the same small body presented to it: in this it is very different from the loadstone. It would seem that it has a vortex. . . ."

ralist before-mentioned, denies that the tourmaline is endowed with magnetic virtue. It is however very remarkable, that though it is said, in the Memoirs of the Academy, that it has the power of attracting and repelling, no mention is made that it acquires that property, only after it has been heated, which is expressly remarked by the German. Those therefore who wish to ascribe to the ancients a knowledge of the tourmaline may say, If the editor of the Memoirs of the French Academy could forget this circumstance, is it not highly probable that Theophrastus might have forgot it in describing the lyncurium; Pliny, in describing the carbuncle; and Serapion, in describing his hyacinth?

After this period the tourmaline must have been very scarce in Europe; for when Muschenbroek made his well-known experiments with the loadstone, and spared no labour to carry them to the utmost extent, he was not acquainted with the nature of the tourmaline, which, according to the account given of it by the Academy at Paris, he considered as a magnet, as he himself says in the preface to his first dissertation, published in 1724.

About the year 1740 however some German naturalists made experiments with this stone, in order to discover the real cause of its attractive property. These may be seen, under the article *Trip*, in the well-known Dictionary of Natural History which is often printed with Hübner's preface; but I do not know to whom the honour belongs of having first investigated the properties of this stone. As the above dictionary is common, I shall give here only a very short extract from it:—"This stone was brought to Holland by some persons who had travelled in India, from the island of Ceylon, where it is found pretty frequently among the fine sand near Columbo, and sold to the German Jews. These caused it to be cut thinner, and the price of it soon rose to eight and ten Dutch florins. It has been since much dearer; but at present it is cheaper. It attracts not only ashes, but also metallic calces: it however attracts more easily and with greater force those which have been formed by means of sal-ammoniac, or the spirit of that salt. It acquires its attractive power only after it has been moderately heated; for when cold or heated to a greater degree it produces no effect, which the author

ascribes to its being united with martial sulphur. The chrysolites and other precious stones of the island do not possess the same property." As the author quotes the Laboratorium Zeylonicum, I consulted it, but found no information in it respecting the tourmaline. The first person who thought of explaining the property of the tourmaline by electricity was the great Linnæus, who in the preface to his Flora Zeylanica[1], where he enumerates the productions of the island, calls it the electrical stone; but at that time, as he himself afterwards told me, he had not seen it.

What Linnæus only conjectured, Æpinus proved at Berlin in 1757 by accurate observation and experiments, when endeavouring with Wilke to investigate the secret of negative and positive electricity. The history of their discoveries I shall here omit, as a better account of them than I could give has been published in the Transactions of the Swedish Academy by Wilke.

[The discovery by Huygens, in 1678, of the polarization of light by double refraction, laid the foundation of a much more important application of the tourmaline; for MM. Biot and Seebeck, in their subsequent experiments, discovered that certain yellowish tourmalines, that is, those which are yellowish by refracted light, possessed the remarkable property of absorbing or checking one of the rays of a beam of polarized light, and transmitting the others. This discovery led to the use of tourmalines in most experiments which were subsequently made with polarized light. For this purpose, the tourmaline, which generally crystallizes in the form of a long prism, is cut lengthwise, that is, parallel to the axis of the prism, into plates about the 30th of an inch thick.

The invention of Mr. Nichol of a method of destroying one of the rays of a polarized beam in a crystal of calcareous spar, has however in later times entirely replaced the use of the

[1] "I must not omit to mention that the rivers contain the electric stone, which is of the size of a halfpenny, flat, orbicular, shining, smooth, of a brown colour, one-tenth of an inch in thickness, without smell and without taste, and which attracts light bodies, such as ashes, filings of iron, shavings of paper, &c., and afterwards repels them. A wonderful and singular property, discovered and observed in this stone alone, when neither heated by motion nor by friction."

tourmaline in optical science, the colour of the tourmaline being a disadvantage which is entirely removed in the use of Nichol's prism[1].]

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## SPEAKING-TRUMPET

INSTRUMENTS by which the voice could be so strengthened as to be heard at a much greater distance than would otherwise have been possible, were known in the earliest ages; for of all musical instruments, wind instruments were first invented, and their use in war to give the signal of battle, we find

[1 Light is called polarized, which, having been once reflected or refracted, is incapable of being again reflected or refracted in certain positions of the second medium. Ordinarily, light which has been reflected from a pane of glass or any other substance, may be a second time reflected from another surface, and will also freely pass through transparent bodies. But if a ray of light be reflected from a pane of glass at an angle of 57°, it is rendered totally incapable of reflexion from the surface of another pane in some positions, whilst it will be completely reflected by it in others. If a plate of tourmaline, cut in the manner described above, or a Nichol's prism be held between the eye and a candle, and turned slowly round in its own plane, no change will take place in the image of the candle; but if the plate or prism be fixed in a vertical position, on interposing another of the same kind between the former and the eye, parallel to the first, and turning it round slowly in its own plane, the image of the candle will be found to vanish and re-appear alternately at each quarter turn of the plate, varying through all degrees of brightness down to total or almost total evanescence, and then increasing again by the same degrees as it had before decreased. These changes depend upon the relative positions of the plates; when the longitudinal sections of the two plates are parallel, the brightness of the image is at its maximum; and when the axes of the sections cross at right angles, the image of the candle vanishes. Thus the light, in passing through the first plate of tourmaline, has acquired a property totally different from the ordinary light of the candle; the latter would penetrate the second plate equally well in all directions, whereas the altered light will only pass through it in particular positions, and is altogether incapable of penetrating it in others. The light is polarized by passing through the first plate or prism. Thus, one of the properties of polarized light is proved to be the incapability of passing through a plate of tourmaline perpendicular to it in certain positions and its ready transmission in other positions at right angles to the former.]

mentioned in Job[1]. It had been remarked, even in Pliny's time, that the least touch of a beam of wood could be heard when the ear was applied to the other end[2]. It was known likewise that the larger trumpets emitted a louder and stronger sound. The Grecians had a wind instrument with the bellowing noise of which the people who were placed to guard the vineyards frightened away the wild animals[3]. All these wind instruments however were little in comparison with the monstrous trumpets of the ancient Chinese, a kind of speaking-trumpets, or instruments by which words could not only be heard at the greatest distance possible, but could be also understood[4]. This invention belongs to the 17th century, though some think that traces of it are to be found among the ancient Grecians.

Kircher, as far as I have been able to learn, was the first person who made known, from a very ancient manuscript of Aristotle, De Secretis ad Alexandrum Magnum, preserved in the Vatican, that Alexander had a prodigious large horn with which he could assemble his army at the distance of a hundred stadia, or eight Italian miles. It was, according to the manuscript, five cubits in diameter; and Kircher, who gives a figure of it, which he says he found in the manuscript, thinks that, on account of its size, it must have been suspended from a beam by a ring. This horn has by many been considered as the oldest speaking-trumpet[5], but in my opinion without reason. Aristotelis Secretum Secretorum ad Alexandrum Magnum I have never had an opportunity to see. It appears to have been printed only once, and is, like all the other works ascribed to that philosopher, extremely scarce; for they have all had the fate of being little regarded after it became the unanimous opinion of the learned that they were forged. These works, however, are old; some of them indeed very old: and, if some one would take the trouble to fix their antiquity, they might be used with advantage on many occasions. Mor-

[1] Goguet. i. p. 326. [2] Plin. lib. xvi. c. 38, p. 32.

[3] Septalii Comm. in Aristotelis Problem. Lugd. 1632, fol. p. 206. There is also a passage to the same purpose in Seneca, Epist. 108.

[4] See Anciennes Relations des Indes et de la Chine, de deux voyageurs Mahometans, qui y allèrent dans le neuvième siècle. Par Renaudot. Paris, 1718, 8vo, p. 25.

[5] Ars magna lucis et umbræ. Amst. 1671, fol. p. 102. Kircher repeats this account with some new circumstances in his Phonurgia, p. 132.

hof had in his possession the edition of that book published by Alexander Achillinus, a physician at Bologna, in 1516, which is a Latin translation from the Arabic[1]. If we compare what is said there and by Kircher, we may make the following conclusion :—

In the first place, it is certain that the book itself, as well as the whole account, is not the production of Aristotle, for in all the writers who relate the actions of Alexander we do not find the least mention of such a horn. Secondly, it is not expressly said in that work that Alexander spoke through this horn, but only that he assembled his soldiers by it, which in past times was done by the sound of a trumpet, and at present is done both by trumpets and drums. It appears also that the author of the book, perhaps an Arabian, intended to give the reader an idea of a horn that had an uncommonly strong and loud sound. Thirdly, Kircher's account and figure of the horn do not agree with that which Morhof found in the edition of Achillinus[2]. Lastly, none of these descriptions are such that an instrument to serve as a speaking-trumpet could be constructed from them.

Wolf and other mathematicians are of opinion that the most advantageous form of a speaking-trumpet would be found with more certainty by experience than by theory. It may then be asked, whether any one ever caused such an instrument to be made from these descriptions. Kircher, who attempted things much more improbable, says he never tried it. Duhamel however relates that a Frenchman tried it, and discovered the real instrument[3]; but this information is of little weight,

[1] Morhofii Diss. de vitro per vocis sonum rupto, in Dissertationibus Academicis. Hamburgi 1669, 4to, p. 381.

[2] Morhof quotes the following passage :—"With this brazen horn, constructed with wonderful art, Alexander the Great called together his army at the distance of sixty miles. On account of its inestimable workmanship and monstrous size, it was under the management of sixty men. Many kinds of sonorous metals were combined in the composition of it."

[3] "Among many things which the celebrated D'Alance caused to be made for this purpose, the trumpet ascribed to Alexander, and with which he called together his army, ought not to be omitted. As the figure of it was represented in an old manuscript in the Vatican library, and had been described by Bettini, that learned man was desirous of trying whether it could be proved by experience, and the attempt succeeded; for that kind of trumpet, if it does not excel, seems undoubtedly to equal the other instruments constructed for that end."

as it is much to be doubted that this Frenchman caused it to be made sufficiently exact according to the ancient description. I am as little acquainted with Bettini as Morhof; but I suspect that Duhamel meant Mar. Bettini, who, without making the smallest mention of Alexander's horn, proposes only a tube, the one end of which should be applied to the mouth of a person who speaks, and the other to the ear of one who is dull of hearing[1]. This was rather an ear-trumpet than a speaking-trumpet, and it is certain that the former was invented before the latter.

What we read in Porta, and what many think alludes to a speaking-trumpet, alludes evidently to an ear-trumpet only. That author infers, very justly, from the form of the ear, and particularly from that of the ears of those animals which are quick of hearing, that to hear at a distance one must apply to the ear a kind of wide funnel, as people to strengthen the sight use spectacles[2]. He asserts also, with equal truth, that one, through a long tube, can convey a whisper to the ear of another person at a very great distance[3]; an experiment which he himself made at the distance of two hundred paces. Schwenter, who wrote before the speaking-trumpet was known, proposes, from the hint of Porta, an ear-trumpet, one end of which should be applied to the ear[4].

Sir Samuel Morland, an Englishman, and the jesuit Kircher, have in later times contended respecting the invention of the speaking-trumpet. The former, in 1671, published a particular description of one, after he had made many experiments upon it the year preceding. This instrument, shaped like a wide-mouthed trumpet, he caused first to be constructed

[1] Bettini Apiaria univ. Philosophiæ Mathemat. Bonon. 1642, fol. p. 38.

[2] Magia Natural. lib. xx. c. 5.

[3] "To communicate anything to one's friends by means of a tube. This can be done with a tube made of earthenware, though one of lead is better, or of any other substance, but very close, that the voice may not be weakened; for whatever you speak at the one end, the words issue perfect and entire as from the mouth of the speaker, and are conveyed to the ears of the other, which, in my opinion, may be done for some miles. The voice, neither broken nor dispersed, is carried entire to the greatest distance. We tried it at the distance of two hundred paces, not having convenience for a greater, and the words were heard as clearly and distinctly as if they had come from the mouth of the speaker."—Lib. xvi. c. 12.

[4] Mathematische Erquickstunden, i. p. 243.

of glass, and afterwards of copper, with various alterations, and performed several experiments with it in presence of the king (Charles II.), prince Rupert, and other persons, who were astonished at its effects[1].

As an account of this discovery was soon spread all over Europe, Kircher asserted that he had constructed speaking-trumpets before Sir Samuel Morland, and supported his assertion by referring to his former writings, and by the testimony of other authors. I shall first take notice of the former. His Ars Magna Lucis et Umbræ was first printed in 1643. I at least conclude so, because, in the preface to his Phonurgia, printed in 1673, he says that work had been published thirty years before. The second edition is of 1671, in which I find only the already-quoted passage respecting Alexander's horn, and the figure of a tube, which, like that proposed by Bettini, should be applied to the ear of a person who hears, and to the mouth of the speaker. The Musurgia, printed in 1650, contains better grounds for supporting the assertion of Kircher. In the second part he describes how a funnel can be placed in a building in such a manner, that a person in an apartment where the narrow end is introduced can hear what is spoken without the building, or in another apartment, where the wide end may be. To this description a figure is added, and the author acknowledges he was led to that idea by the construction of a well-known building of Dionysius[2]. He does

[1] An Account of the Speaking-trumpet, as it hath been contrived and published by Sir Samuel Morland, knight and baronet, together with its use both at sea and land. London, 1671. An extract from it may be seen in the Phil. Trans., No. 78, p. 3056.

[2] Among the antiquities of Syracuse in Sicily, one beholds with wonder chambers and galleries which are hewn out in the solid rock, and particularly a grotto, from which arises a winding passage, that becomes upwards still narrower. Ancient tradition says that this was a prison, which the celebrated tyrant Dionysius caused to be built for state prisoners, that in an apartment of his palace, which stood over the narrow end of the passage, he might hear everything the prisoners said, or what plots they formed against him. This grotto therefore is called *Orechio di Dionysio*, or *la grotta della favella*; *auris Dionysii*, the ear of Dionysius. Many travellers and others formerly imagined that this passage was an ingenious imitation of that part of the human ear called the helix, which was first remarked by Alcmaon the Pythagorean. This is the account given by Kircher, who was there in the year 1638. See his Phonurgia (published 1673), p. 82, where there is a figure of it. In later times, however, this grotto has been examined with more skill and acuteness by people less

not however say expressly that he had ever tried the experiment; but in the last page of the preface to the Phonurgia, he pretends that so early as the year 1649 he had caused such a machine to be fixed up in the Jesuits' college. But, supposing this to be true, it can only be said that he then approached very near to the invention of the speaking-trumpet,

subject to prejudice, and since that period the supposed wonder has been lessened. The rock consists of limestone, at least I conclude so from what is said by Brydone, who found it everywhere full of cracks and fissures. The stones of which Syracuse was built were hewn from the rock; and hence have been formed these chambers or openings, like those found in the neighbourhood of other ancient and modern cities, such as Rome, Naples, and Maestricht. Many of these, in the course of time, have been employed as prisons, or used as burying-vaults. The above-mentioned passage, which has excited so much wonder, is not properly spiral, and is of such a figure that it may have been produced either by accident or through the whim of the workmen employed to hew out the stones. The double echo which Kircher assures us he heard in the grotto was not remarked by Schott, who was there in 1646, as he expressly says, in opposition to his brother jesuit, in his Magia Naturalis. In the accounts still remaining of Dionysius we find mention of an astonishing prison, which is well described by Cicero in his fifth oration against Verres: "You have all heard of," says he, "and most of you know the prison (lautumias) of Syracuse. It is an immense and magnificent work, executed by kings and tyrants; the whole is sunk to a wonderful depth in the rock, and has been entirely cut out by the labour of many hands. No place so secured against an escape; no place so enclosed on all sides; no place so safe for confining prisoners can be either planned out or constructed." But it cannot be proved, and according to D'Orville's opinion it is improbable, that this grotto was the work of that tyrant, who, as Plutarch tells us in his Life of Dion, employed very different means to learn the intention of dangerous persons. "The common people attacked the tyrant's friends, and seized those whom they called his emissaries (προσαγώγιδας), worthless men, detested by the gods. These went about the city, mixed with the citizens, and, prying into everything, gave an account to the tyrant of what they thought and what expressions they made use of." It was merely for its strength, and the labour employed in building it, and not on account of its ingenious construction, that the ancients admired the prison of the tyrant. At present the upper end of the winding passage is closed up; and it is so narrow, that some years ago the captain of an English vessel found great difficulty to clamber up it. It cannot, however, be denied that this grotto may have been used for the service ascribed to it; and I can readily believe that it may have led Kircher to the invention of the ear-trumpet. See the Travels of P. de la Valle, Ray, and Brydone; Delle antiche Siracuse, da G. Bonanni, &c., 2 vols. fol. Palermo 1717. Dan. Bartolo del suono e de' tremori harmonici, Bonon. 1680, who examined this grotto as a naturalist. D'Orville, Sicula. Amst. 1764, pp. 182, 194.

by an instrument, which, in reality, however, was calculated to strengthen the hearing, and not the voice; and therefore only the half is true of what he advanced in his preface in 1673, that twenty years before he had described in his Musurgia the trumpet invented in England.

In the Phonurgia, however, written after Morland's publication was everywhere known, Kircher certainly treats of the speaking-trumpet, and says that, from the similarity of the progress of sound to that of the rays of light, he was led to the idea of conveying the former, in the same manner as the latter, to a great distance, by means of an instrument. For this purpose, about twenty-four years before, he had caused to be constructed, in the Jesuits' college at Rome, an ear-trumpet, through which the porter could communicate anything he had to say to him when he was in his apartment in the upper story. This apparatus attracted the notice of many strangers, who were astonished at its effect. He here represents it as a proper speaking-trumpet, and adds, that it excited much surprise, on account of the uncommon strength which it gave to the voice. For this reason he was very desirous of trying to what distance words could be distinctly conveyed by such a tube; and an opportunity occurred of doing this the same year that he wrote his Phonurgia. From a convent, situated on the top of a mountain, he assembled twelve hundred persons to divine service, at the distance of from two to five Italian miles, and read the Litany through it. Soon after, the emperor caused a tube to be made according to Kircher's description, by which, without elevating the voice, he could be understood from Ebersdorf to Neugebeu. But though Kircher came so near to the invention of the speaking-trumpet, it does not appear certain by his works that he attempted or constructed it before Sir Samuel Morland. I shall now examine the evidences he adduces in his favour.

The most important of these is Schott, because he published his Magia Naturalis [1] in 1657, before the invention of

[1] This machine was invented by Kircher, in imitation of the ear of Dionysius; nor is it a vain and empty speculation, for the machine produces an infallible effect. Kircher caused to be made at Rome, of tin plate, a very large and straight tube, like a funnel, and placed it in an apartment next to his chamber, in such a manner that the large end projected into the garden of the college, and the less entered his chamber.

Sir Samuel Morland. All that is to be found in this work, however, relates alone to the ear-trumpet, a figure of which is added from the Musurgia; but we learn, with certainty, that Kircher then had the before-mentioned funnel or tube in his apartment. It is also not improbable that he had tried to answer the porter from his apartment, and that he had thereby remarked that the voice was strengthened; for it is not proved by Schott that he at that time was acquainted with and had in his possession a portable speaking-trumpet.

Another author by whom Kircher endeavours to support his claim is Harsdorfer; who, however, speaks only of tubes to be closely applied to the mouth and to the ear, and who refers to the Musurgia, without mentioning the real speaking-trumpet, though the second part of his Mathematical Recreations was first printed in 1677, and the third in 1692. Besides these testimonies, Kircher quotes also Eschinard concerning sound[1]. With that work I am not acquainted; but as the information it contains is taken from the Musurgia, it is of as little importance as that of Derham[2], who refuses the invention to his countryman, and gives it to Kircher. When I unite all the evidence in favour of Kircher, it appears to be certain that he made known and employed the ear-trumpet earlier than the portable speaking-trumpet; that he, however, approached very near to the invention of the latter, but did not cause one to be constructed before Sir Samuel Morland, to whom the honour belongs of having first brought it to that state as to be of real use. Such, at least, is the manner in which this dispute is decided by the Jesuit De Lanis[3].

When Morland's invention was made known in France, it

When the porter of the college had occasion to call him to the gate, that he might not be obliged always to go up stairs, or to bawl out, he went to the broad end of the funnel, and communicated what he wished to Kircher. —Schotti Magia Universalis, ii. p. 156.

[1] Eschinardi Discursus de Sono Pneumatico, p. 10.

[2] Physico-theology.

[3] Our Kircher, in his Phonurgia, justly claims that invention, as it was several years ago exhibited by him in the Jesuits' college at Rome, and an account of it printed. That this is true I myself was an eye-witness; though I must acknowledge that no one before the above-mentioned Englishman ever applied this speaking instrument, at least in so perfect a manner, to that use for which it was afterwards employed.—Magisterium Naturæ et Artis. Brixiæ, 1684–92 ,fol. ii. p. 436.

was pretended that Salar, an Augustine monk, had seven or eight years before caused such tubes or trumpets to be made, in order to strengthen the voice of a weak bass-singer; but he himself acknowledges that he never had an idea of speaking with them at a distance [1].

This instrument was soon made for sale at Nuremberg in Germany, particularly by that well-known artist Grundler, mentioned by Becher, who imagined that two persons, by means of a speaking-trumpet and an ear-trumpet, could converse together at a great distance, without any one in the neighbourhood, or in the intermediate space, hearing what they said.

Of those who employed their ingenuity in improving this instrument I shall mention the following. Cassegrain, known on account of his optical instruments, published some hints for that purpose in 1672 [2]; as did Sturm [3], Conyers [4], Hase and others afterwards. The last who investigated the theory of the speaking-trumpet was Lambert [5]; according to whose ideas the figure of a shortened cone, if not the best, is at least as good as any other that might be employed.

[It would appear, however, from the experiments of Hassenfratz (Journ. de Phys., t. xxvi.) that neither the shape of the instrument nor the material of which it is composed is of much consequence. He ascertained the power of the trumpet by fixing a small watch in the mouth-piece, and observing the distance at which the beats ceased to be audible, and thus found that the effects were precisely the same with a trumpet of tinned iron, whether used in its naked form, or tightly bound round with linen to prevent vibration, or when lined with woollen cloth whereby reflexion was entirely prevented; he also found that the range of a cylindrical trumpet was as great as that of a conical one.

Leslie supposes the effect of the trumpet to be owing to the more condensed and vigorous impulsion given to the air from its lateral flow being checked. He observes, "that the tube, by its length and narrowness, detains the efflux of air, and

[1] Journal des Scavans, tome iii. [2] Ibid. p. 131.
[3] J. A. Sturm, Collegium Experimentale, ii. p. 146.
[4] Philosophical Transactions.
[5] Mémoires de l'Acad. des Sciences à Berlin, 1763, p. 97.

has the same effect as if it diminished the volubility of that fluid, or increased its density. The organs of articulation strike with concentrated force, and the pulses, so vigorously thus excited, are, from the reflected form of the aperture, finally enabled to escape and to spread themselves along the atmosphere[1]."]

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## ANANAS.—PINE-APPLE.

To discover the excellence of the ananas required no great skill; it recommended itself so much by its taste, smell, and colour, as to attract the notice of the first Europeans who visited Brazil; and we find it praised in the earliest writers on America, who give an account of it, as well as of tobacco, maize, and other productions of the new world.

Gonçalo Hernandez de Oviedo is, as far as I know, the first person who described and delineated the ananas. This author was born at Madrid in 1478, went to America in 1513, and in 1535 was governor of St. Domingo. In the last-mentioned year his General History of America was printed at Seville. At that time three kinds were known, which in America were called *yayama*, *boniama*, and *yayagua*, but by the Spaniards *pinas*. Attempts had then been made to send the fruit to Spain by pulling it before it was ripe; but it had always become spoilt in the course of the voyage. Oviedo had tried also to send slips or young shoots to Europe, but these also died by the way. He however entertained hopes that means would be found to rear the ananas in Spain, in which maize or Turkish corn had been brought to maturity, provided it could be transported with sufficient expedition[2].

[1] Experimental Inquiry into the Nature, &c. of Heat, p. 225.

[2] La Historia General de las Indias. Sevilla, 1535, fol. lib. xvii. c. 13. [An earlier notice of the pine-apple had been given by Andræa Navagero in his letter to Rannusio, dated from Seville, May 12, 1526. He says, "I have also seen a most beautiful fruit, the name of which I do not recollect: I have eaten of it, for it was imported fresh. It has the taste of the quince, together with that of the peach, with some resemblance also of the melon: it is fragrant, and is truly of most delicious flavour."—Lettere di xiii Huomini Illustri.]

Geronimo Benzono, a Milanese, who resided in Mexico from 1541 to 1555, caused, on his return, his History of the New World to be printed, for the first time, at Venice in 1568. In this work he highly extols the pinas, and says he believes that no fruit on the earth can be more pleasant; sick persons, who loathed all other food, might relish it.

After him, Andrew Thevet, a French monk, who was in Brazil from 1555 to 1556, described and delineated this plant under the name of *nanas*. The art of preserving the fruit with sugar was at that time known [1].

John de Lery, who went to Brazil in 1557 as chaplain to a Huguenot colony, in the account of his voyage first used the word *ananas*, which probably took its rise from the *nanas* of Thevet [2].

In the middle of the sixteenth century Franc. Hernandes, a naturalist, undertook an expensive, and almost useless voyage to Mexico. It cost Philip II. king of Spain 60,000 ducats, and the observations he collected, for which, at the time Acosta was in America, 1200 figures were ready, were never completely printed; and in what are printed one can scarcely distinguish those of the original author from the additions of strangers. He has, however, given a somewhat better figure of the ananas, which he calls *matzatli* or *pinea Indica* [3].

Christopher Acosto, in his Treatise of the drugs and medicines of the East Indies, printed in 1578, calls this plant the ananas. He says it was brought from Santa Cruz to the West Indies, and that it was afterwards transplanted to the East Indies and China, where it was at that time common. The latter part of this account is confirmed by J. Hugo de Linschotten, who was in the East Indies from 1594 to 1595 [4].

Attempts were very early made, as Oviedo assures us, to

[1] Les Singularitez de la France Antarctique, autrement nommée Amerique. Par André Thevet. Anvers, 1558.

[2] Voyage faict en la terre du Brésil, autrement dite Amerique. Par J. de Lery. Genève, 1580, 8vo, p. 188.

[3] Rerum Med. novæ Hispaniæ Thesaurus. Rome, 1651. fol.

[4] The accounts given by Acosta and Linschotten may be seen in Bauhini Histor. Plantarum, iii. p. 95. Kircher in his China Illustrata says, "That fruit which the Americans and people of the East Indies, among whom it is common, call the ananas, and which grows also in great abundance in the provinces of Quantung, Chiamsi, and Fokien, is supposed to have been brought from Peru to China."

transplant the ananas into Europe; and as in the beginning of the seventeenth century it was reckoned among the marks of royal magnificence to have orange-trees in expensive hot-houses, it was hoped that this fruit could be brought to maturity also in the artificial climate of these buildings. These attempts, however, were everywhere unsuccessful; no fruit was produced, or it did not ripen, because, perhaps, this favourite exotic was treated with too much care. It is not certainly known who in Europe first had the pleasure of seeing ananas ripen in his garden; but it appears that several enjoyed that satisfaction at the same time in the beginning of the last century.

The German gardens in which the ananas was first brought to maturity appear to have been the following. First, that of Baron de Munchausen, at Schwobber, not far from Hameln, which on account of the botanical knowledge of its proprietor, and the abundance of plants it contains, is well-known to all those who are fond of botany. In the beginning of the last century it belonged to Otto de Munchausen, who, perhaps, was the first person who erected large buildings for the express purpose of raising that fruit, and who had the noble satisfaction of making known their advantageous construction. With this view he sent a description and plan of his ananas-houses to J. Christopher Volkamer, a merchant of Nuremberg, who inserted them in his continuation of the Nuremberg Hesperides, printed there in 1714, and by these means rendered the attainment of this fruit common. This Baron de Munchausen is the same who has been celebrated by Leibnitz: "All the travellers in the world," says that great man, "could not have given us, by their relations, what we are indebted for to a gentleman of this country, who cultivates with success the ananas, three leagues from Hanover, almost on the banks of the Weser, and who has found out the method of multiplying them, so that we may, perhaps, have them one day as plentiful, of our own growth, as the Portuguese oranges, though there will, in all appearance, be some deficiency in the taste[1]." As the Baron Munchausen's garden at Schwobber was in the absence of the proprietor, as Volkamer says, under the care

[1] See Leibnitz, Nouveaux Essais sur l'Entendement Humain (Œuv. Phil.), p. 256, Amst. 1765, 4to.

of J. F. Berner, canon of the cathedral of St. Boniface, he probably may have had some share in rendering this service to horticulture.

This fruit was produced also in the garden of Dr. Volkamer at Nuremberg, and in that of Dr. F. Kaltschmid at Breslau, almost about the same time. The latter was so fortunate as to bring it to maturity so early as 1702, and he sent some of it then for the first time to the imperial court. At Frankfort on the Maine it was first produced in 1702[1]; and at Cassel in 1715, by the skill of Wurstorfs, the head gardener.

Holland procured the first ripe ananas from the garden of De la Court, whom Miller calls Le Cour, in the neighbourhood of Leyden. As a great many plants were sold out of this garden to foreigners, and as the English had theirs first from it, many are of opinion that Europe is indebted for the first possession of this fruit to De la Court, and his gardener William de Vinck[2].

I shall here take occasion to mention a circumstance which belongs also to the history of gardening. Before the cultivation of the ananas was introduced, the Dutch had begun to employ tanner's bark for making forcing-beds. From them the English learned this improvement, and the first forcing-beds in England were made at Blackheath in Kent, in 1688, and employed for rearing orange-trees; but about the year 1719, much later than in Holland, ananas became more common, and forcing-beds were in much greater use[3].

This plant, the history of which I have given, received from Plumier[4], who first distinguished its characters, the name of *Bromelia*[5], after the Swedish naturalist, whose remembrance deserves to be here revived. Olof Bromelius was born in 1639, at Oerebro, where his father carried on trade. He studied

[1] Lersner, Chronik, ii. p. 824.

[2] Miller's Gardener's Dictionary, i. p. 132. Lueder, Wartung der Küchengewächse. Lubeck, 1780, 8vo, p. 248.

[3] Miller, ii. p. 824. Lueder, p. 39. That putrid bark forms an excellent manure, had been before remarked by Lauremberg, in Horticultura, p. 52.

[4] Nova Plantarum Americanarum Genera. Parisiis 1708, 4to, p. 46.

[5] [The plants producing the pine-apple have been separated by Prof. Lindley under the name *Ananassa* from the allied genus *Bromelia*, after which the Natural Order BROMELIACEÆ takes its name.]

physic at Upsal, disputed there in 1667 de Pleuritide, and in 1668 taught botany at Stockholm. In 1672 he was physician to the embassy to England, and afterwards to that to Holland, where, in 1673, he received the degree of doctor at Leyden, and wrote a dissertation De Lumbricis. On his return to his native country, in 1674, he became a member of the college of physicians at Stockholm; but in 1691 he was city physician to Gottenburg, and provincial physician in Elsburg and Bahuslan, in which situation he died in the year 1705. His botanical writings are Lupologia, and Chloris Gothica[1]. His son, Magnus von Bromel, is the author of Lithographia Suecana.

[Within the few last years, large numbers of pine-apples have been imported into this country from the Bahamas, where they are grown as turnips are grown in our fields. They are sold comparatively speaking at an extremely moderate price, and those that have become somewhat spoilt by the long carriage are hawked about the streets of London at a halfpenny or penny per slice. They are however vastly inferior in flavour to the pines cultivated in our hot-houses, but it is to be expected, from the considerable demand, that greater care will be bestowed on their cultivation, and the markets of London be regularly supplied with a much improved kind.]

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## SYMPATHETIC INK.

If we give this name to any fluid, which when written with, will remain invisible till after a certain operation, such liquids were known in very early periods. Among the methods, with which Ovid teaches young women to deceive their guardians, when they write to their lovers[2], he mentions that of writing with new milk, and of making the writing legible by coal-dust or soot. Ausonius proposes the same means to Paulinus[3]; but his

[1] Halleri Bibl. Botan. i. p. 640. [2] De Arte Amandi, lib. iii. v. 629.
[3] Ausonii Epist. xxiii. v. 21. The poet afterwards teaches other methods of secret writing, and Gellius, lib. xvii. cap. 9, mentions the like.

commentators seem not to have fully understood his meaning; for *favilla* is not to be explained by *favilla non modice calida*, as Vinetus has explained it, but by *fuligo*. That word is often employed by the poets in the same sense. As a proof of it, Columella, speaking of the method, not altogether ineffectual, and even still used, of preserving plants from insects by soot, calls it *nigra favilla*; and afterwards, when mentioning the same method, free from poetical fetters, he says *fuliginem quæ supra focos tectis inhæret*[1]. It may be easily perceived, that instead of milk any other colourless and glutinous juice might be employed, as it would equally hold fast the black powder strewed over it. Pliny, therefore, recommends the milky sap of certain plants for the like purpose[2].

There are several metallic solutions perfectly colourless, or, at least, without any strong tint, which being used for writing, the letters will not appear until the paper be washed over with another colourless solution, or exposed to the vapour of it; but among all these there is none which excites more astonishment, than that which consists of a solution of lead in acetic acid, and which by sulphuretted hydrogen gas becomes black, even at a considerable distance. This ink, which may be employed by conjurers, proves the subtlety of this gas, and the porosity of bodies; as the change or colouring takes place, even when the writing is placed on the other side of a thin wall.

This effect presented itself perhaps accidentally to some chemist; but the discovery is not of great antiquity. Wecker, who compiled his book De Secretis from Porta, Cardan, and several old writers, and printed it for the first time in 1582, and gave a third edition in 1592, must have been unacquainted with it; else he certainly would not have omitted it in the fourteenth book, where he mentions all the methods of secret writing. Neither would it have been unnoticed by Caneparius, whose book De Atramentis was printed at Venice, for the first time, in 1619.

The first person who, as far as I have been able to learn, gave a receipt for preparing this ink, was Peter Borel, in Historiarum et Observationum Medico-physic. Centuriæ quatuor. In this work, which was printed for the first time in 1653, and a second time in 1657, at Paris, and of which there were

[1] Colum. De Re Rust. x. 354. and xi. 3, 60.
[2] Plin. lib. xxvi. cap. 8. p. 460.

several editions afterwards, the author calls it a magnetic water, which acts at a distance[1]. After the occult qualities of the schoolmen were exploded, it was customary to ascribe phænomena, the causes of which were unknown, and particularly those the causes of which seemed to operate without any visible agency, to magnetic effluvia; as the tourmaline was at first considered to be a kind of magnet. Others concealed their ignorance under what they called sympathy, and in latter times attraction and electricity have been employed for the like purpose. Borel, who made it his business to collect new observations that were kept secret, learned the method of preparing this magnetic water from an ingenious apothecary of Montpelier, and in return taught him some other secrets. Otto Tachen, a German chemist[2], afterwards thought of the same experiment, which he explains much better, without the assistance of magnetism or sympathy. The receipt for making these liquids, under the name of sympathetic ink, I find first given by Le Mort[3], and that name has been still retained[4].

[1] The sixth observation of the second century is as follows: *Magnetic waters which act at a distance.* An astonishing effect, indeed, is produced by the contest of the following waters, which are thus made. Let quicklime be quenched in common water, and while quenching, let some orpiment be added to it (this however ought to be done by placing warm ashes under it for a whole day), and let the liquor be filtered, and preserved in a glass bottle well corked. Then boil litharge of gold well pounded, for half an hour with vinegar in a brass vessel, and filter the whole through paper, and preserve it also in a bottle closely corked. If you write any thing with this last water with a clean pen, the writing will be invisible when dry; but if it be washed over with the first water it will become instantly black. In this, however, there is nothing astonishing; but this is wonderful, that though sheets of paper without number, and even a board be placed between the invisible writing and the second liquid, it will have the same effect, and turn the writing black, penetrating the wood and paper without leaving any traces of its action, which is certainly surprising; but a fetid smell, occasioned by the mutual action of the liquids, deters many from making the experiment. I am, however, of opinion, that I could improve this secret by a more refined chemical preparation, so that it should perform its effect through a wall. This secret I received, in exchange for others, from J. Brosson, a learned and ingenious apothecary of Montpelier.

[2] Tachenii Hippocraticæ Medicinæ Clavis, p. 236. 1669.

[3] Collectanea Chymica Leydensia, edidit Morley. Lugd. Bat. 1684, 4to, p. 97.

[4] For an account of various kinds of secret writing see Halle, Magie oder Zauberkräfte der Natur. Berlin, 1783, 8vo, v. i. p. 138.

Another remarkable kind of sympathetic ink is that prepared from cobalt, the writing of which disappears in the cold, but appears again of a beautiful green colour, as often as one chooses, after being exposed to a moderate degree of heat.

The invention of this ink is generally ascribed to a Frenchman named Hellot. He was, indeed, the first person who, after trying experiments with it, made it publicly known, but he was not the inventor; and he himself acknowledges that a German artist of Stolberg first showed him a reddish salt, which, when exposed to heat, became blue, and which he assured him was made out of Schneeberg cobalt, with aqua regia[1]. This account induced Hellot to prepare salts and ink from various minerals impregnated with cobalt; but A. Gesner proved, long after, that this ink is produced by cobalt only, and not by marcasite[2].

When Hellot's experiments were made known in Germany, it was affirmed that Professor H. F. Teichmeyer, at Jena, had prepared the same ink six years before, and shown it to his scholars, in the course of his lectures, under the name of sympathetic ink[3]. It appears, however, that it was invented, even before Teichmeyer, in the beginning of the last century by a German lady. This is confirmed by Pot, who says that the authoress of a book printed in 1705, which he quotes under the unintelligible title of D. J. W. in clave, had given a proper receipt for preparing the above-mentioned red salt, and the ink produced by it[4]. If it be true that Theophrastus Paracelsus, by means of this invention, could represent a garden in winter, it must be undoubtedly older[5].

[1] Hist. et Mém. de l'Acad. des Sciences à Paris, 1737, pp. 101 and 228.

[2] Historia Cadmiæ fossilis, sive Cobalti. Berl. 1744.

[3] This account, together with Teichmeyer's receipt for preparing it, may be found in Commercium Litterarium Norimbergense, 1737, p. 91.

[4] "Copiosius minera bismuthi tam ab aqua forti quam ab aqua regia dissolvitur, restante pulvere albo corroso; solutio in aqua forti roseum colorem sistit, quæ si sali in aqua soluto, secundum præscriptum D. J. W. in clave, affundatur, abstrahatur, ex residuo extrahitur sal roseum, quod pulverisari et cum spiritu vini extrahi potest: adeoque hæc autrix jam anno 1705 publice totum processum et fundamentum sic dicti atramenti sympathetici, quod a calore viridescit, evulgavit."—Pot, Observ. Chym. collectio prima. Berolini, 1739, p. 163.

[5] So thinks Gesner in Selecta Physico-œconomica, or Sammlung von allerhand zur Naturgeschichte gehörigen Begebenheiten. Stutgard, vii. p. 22.

[In consequence of the progress of modern chemistry and the discovery of a vast number of new chemical compounds, sympathetic inks may be made in an almost endless number and variety. The principal may be classed in the following manner:—1, *such as when dried upon paper being invisible, on moistening with another liquid become again evident*: of this kind there are a vast number; among which we may mention a solution of a soluble salt of lead, or bismuth, for writing, and a solution of sulphuretted hydrogen for washing over; the writing then appears black; or green vitriol for writing and prussiate of potash for washing over, when the writing becomes blue[1]; 2, *such as are rendered evident by being sifted over with some powder*, as the milk with soot described above; 3, *those which become visible by heat*, such as characters in dilute sulphuric acid, lemon-juice, solutions of the nitrate and chloride of cobalt, and of chloride of copper; the two former become black or brown, the latter are rendered green, the colouring disappearing subsequently when allowed to cool in a moist place. Amusing pictures are sometimes made with these sympathetic inks, particularly those composed of cobalt; for if a landscape be drawn to represent winter, the vegetation being covered with a solution of cobalt, on holding the paper to the fire, all these portions covered with the solution appear of a bright green, and thus completely change the character of the scene.]

[1] [

| *Inks formed of solutions of the following salts,* | *and washed with solutions of* | *become* |
|---|---|---|
| Muriate of antimony, | tincture of galls, | yellow. |
| Green vitriol, | tincture of galls, | black. |
| Nitrate of cobalt, | oxalic acid, | blue. |
| Subacetate of lead, | hydriodic acid, | yellow. |
| Arseniate of potash, | nitrate of copper, | green. |
| Nitrate of copper, | prussiate of potash, | brown. |
| Solution of gold, | muriate of tin, | purple. |
| Perchloride of mercury, | hydrochlorate of tin, | black.] |

## DIVING-BELL.

The first divers learned their art by early and adventurous experience, in trying to continue under water as long as possible without breathing; and, indeed, it must be allowed that some of them carried it to very great perfection. This art, however, excites little surprise; for, like running, throwing, and other bodily dexterities, it requires only practice; but it is certain that those nations called by us uncultivated and savage excel in it the Europeans[1], who, through refinement and luxury, have become more delicate, and less fit for such laborious exercises.

In remote ages, divers were kept in ships to assist in raising anchors[2], and goods thrown overboard in times of danger[3]; and, by the laws of the Rhodians, they were allowed a share of the wreck, proportioned to the depth to which they had gone in search of it[4]. In war, they were often employed to destroy the works and ships of the enemy. When Alexander was besieging Tyre, divers swam off from the city, under water, to a great distance, and with long hooks tore to pieces the mole with which the besiegers were endeavouring to block up the harbour[5]. The pearls of the Greek and Roman ladies were fished up by divers at the great hazard of their lives;

[1] Instances of the dexterity of the savages in diving and swimming may be seen in J. Kraft, Sitten der Wilden, Kopenhagen, 1766, 8vo, p. 39. To which may be added the account given by Maffæus of the Brasilians: "They are," says he, "wonderfully skilled in the art of diving, and can remain sometimes for hours under water, with their eyes open, in order to search for any thing at the bottom."—Hist. Indic. lib. ii.

[2] Lucanus, iii. 697.

[3] Livius, xliv. c. 10. Manilii Astronom. v. 449.

[4] A Latin translation of these laws may be found in Marquard de Jure Mercatorum, p. 338. "If gold or silver, or any other article be brought up from the depth of eight cubits, the person who saves it shall receive one-third. If from fifteen cubits, the person who saves it shall, on account of the danger of the depth, receive one-half. If goods are cast up by the waves towards the shore, and found sunk at the depth of one cubit, the person who carries them out safe shall receive a tenth part." See also Scheffer De Militia Navali, Upsaliæ, 1654, 4to, p. 110.

[5] Q. Curtius, iv. c. 3. The same account is given by Arrian, De Expedit. Alexandri, lib. ii. p. 138. We are told by Thucydides, in his seventh book, that the Syracusans did the same thing.

and by the like means are procured at present those which are purchased as ornaments by our fair.

I do not know whether observations have ever been collected respecting the time that divers can continue under water. Anatomists once believed that persons in whom the oval opening of the heart (*foramen ovale*) was not closed up, could live longer than others without breathing, and could therefore be expert divers. Haller[1], however, and others, have controverted this opinion; as people who had that opening have been soon suffocated, and as animals which have it not can live a long time under water: besides, when that opening is perceptible in grown persons, it is so small as not to be sufficient for that purpose, especially as the *ductus arteriosus* is scarcely ever found open.

The divers of Astracan, employed in the fishery there, can remain only seven minutes under water[2]. The divers in Holland seem to have been more expert. An observer, during the time they were under water, was obliged to breathe at least ten times[3]. Those who collect pearl-shells in the East Indies can remain under water a quarter of an hour, though some are of opinion that it is possible to continue longer; and Mersenne mentions a diver, named John Barrinus, who could dive under water for six hours[4]. How far this may be true I shall leave others to judge.

[The various statements regarding the length of time during which divers can remain under water, unaided by apparatus for renewing the supply of atmospheric air, are not borne out by the experience of those who have carefully observed and noted these phænomena. The average time which human

[1] Boerhaave, Prælectiones Academicæ, edit. Halleri, Göttingæ, 1774. 8vo, v. ii. p. 472–474. Halleri Elementa Physiologiæ, iii. p. 252, and viii. 2, p. 14.

[2] "The divers of Astracan stepped from the warm bath into the water, in which they could not continue above seven minutes, and were brought back from the water, cold and benumbed, to the warm bath, from which they were obliged to return to the water again. This change from heat to cold they repeat five times a day, until at length the blood flows from their nose and ears, and they are carried back quite senseless."—Gmelin's Reise durch Russland, ii. p. 199.

[3] Acta Philosophica Societatis in Anglia, auctore Oldenburgio. Lipsiæ, 1675, 4to, p. 724.

[4] Scheeps-bouw beschreven door Nic. Witsen. Amsterdam, 1671, fol. p. 288.

beings can remain in the water under these conditions, is one and a half or two minutes[1]; extraordinary cases are attested where five and even six minutes have elapsed, but these are exceedingly rare instances and far beyond the average; no instance of a longer time than this is recorded on credible authority. Some interesting remarks on this point were made not long since by a member of the Asiatic Society to Dr. Faraday. The lungs in their natural state are charged with a large quantity of impure air; this being a portion of the carbonic acid gas which is formed during respiration, but which, after each expiration, remains lodged in the involved passages of the pulmonary tubes. By breathing hard for a short time, as a person does after violent exercise, this impure air is expelled, and its place is supplied by pure atmospheric air, by which a person will be enabled to hold his breath much longer than without such precaution. Dr. Faraday states, that although he could only hold his breath, after breathing in the ordinary way, for about three-fourths of a minute, and that with great difficulty, he felt no inconvenience, after making eight or ten forced respirations to clear the lungs, until the mouth and nostrils had been closed more than a minute and a half; and that he continued to hold breath to the end of the second minute. A knowledge of this fact may enable a diver to remain under water at least twice as long as he otherwise could do. It is suggested that possibly the exertion of swimming may have the effect of occasioning the lungs to be cleared, so that persons accustomed to diving may unconsciously avail themselves of this preparatory measure.]

It is certain, however, that men began very early to contrive means for supplying divers with air under the water, and of thereby enabling them to remain under it much longer. For this purpose the diving-bell, *campana urinatoria*, was invented. Those who had no idea of this machine, might have easily been led to it by the following experiment. If a drinking-glass inverted be immersed in water, in such a manner that the surface of the water may rise equally around the edge of the glass, it will be found that the glass does not become filled with water, even when pressed down to the greatest depth; for where there is air no other body can enter, and

[1] [See the account of the Ceylon pearl fishery in Percival's Ceylon.]

by the above precaution the air cannot be expelled by the water. In like manner, if a bell of metal be constructed under which the diver can stand on a stool suspended from it so that the edge of the bell may reach to about his knee, the upper part of his body will be secured from water, and he can, even at the bottom of the sea, breathe the air enclosed in the bell.

The invention of this bell is generally assigned to the sixteenth century, and I am of opinion that it was little known before that period. We read, however, that even in the time of Aristotle divers used a kind of kettle to enable them to continue longer under water; but the manner in which it was employed is not clearly described.

The oldest information we have respecting the use of the diving-bell in Europe is that of John Taisnier, quoted by Schott[1]. The former, who was born at Hainault in 1509, had a place at court under Charles V., whom he attended on his voyage to Africa. He relates in what manner he saw at Toledo, in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water, in a large inverted kettle, with a burning light, and rise up again without being wet. It appears that this art was then new to the emperor and the Spaniards, and that the Greeks were

[1] "Were the ignorant vulgar told that one could descend to the bottom of the Rhine, in the midst of the water, without wetting one's clothes, or any part of one's body, and even carry a lighted candle to the bottom of the water, they would consider it as altogether ridiculous and impossible. This, however, I saw done at Toledo, in Spain, in the year 1538, before the emperor Charles V. and almost ten thousand spectators. The experiment was made by two Greeks, who taking a very large kettle, suspended from ropes with the mouth downwards, fixed beams and planks in the middle of its concavity, upon which they placed themselves, together with a candle. The kettle was equipoised by means of lead fixed round its mouth, so that when let down towards the water no part of its circumference should touch the water sooner than another, else the water might easily have overcome the air included in it, and have converted it into moist vapour. If a vessel thus prepared be let down gently, and with due care, to the water, the included air with great force makes way for itself through the resisting fluid. Thus the men enclosed in it remain dry, in the midst of the water, for a little while, until, in the course of time, the included air becomes weakened by repeated aspiration, and is at length resolved into gross vapours, being consumed by the greater moisture of the water: but if the vessel be gently drawn up, the men continue dry, and the candle is found burning."—Taisneri Opuscula de celerrimo motu, quoted by Schott in his Technica Curiosa, lib. vi. c. 9, p. 393.

induced to make the experiment in order to prove the possibility of it. After this period the use of the diving-bell seems to have become still better known. It is described more than once in the works of Lord Bacon, who explains its effects, and remarks that it was invented to facilitate labour under the water[1].

In the latter part of the seventeenth century the diving-bell was sometimes employed in great undertakings. When the English, in the year 1588, dispersed the Spanish fleet called the Invincible Armada, part of the ships went to the bottom near the Isle of Mull, on the western coast of Scotland; and some of these, according to the account of the Spanish prisoners, contained great riches. This information excited, from time to time, the avarice of speculators, and gave rise to several attempts to procure part of the lost treasure. In the year 1665, a person was so fortunate as to bring up some cannon, which, however, were not sufficient to defray the expenses. Of these attempts, and the kind of diving-bell used, an account has been given by a Scotsman named Sinclair[2]; but Paschius[3], Leupold[4] and others falsely ascribe the invention of this machine to that learned man. He himself does not lay claim to this honour; but says only, that he conversed with the artist and measured the machine.

Some years after attempts of the like kind were renewed. William Phipps, the son of a blacksmith, born in America in 1650, and who had been brought up as a ship-carpenter at Boston, formed a project for searching and unloading a rich Spanish ship sunk on the coast of Hispaniola, and represented

[1] "Excellent use may be made of this vessel, which is employed sometimes in labouring under water on sunk ships, to enable the divers to continue longer under water, and to breathe, in turns, for a little while. It was constructed in this manner. A hollow vessel was made of metal, which was let down equally to the surface of the water, and thus carried with it to the bottom of the sea the whole air it contained. It stood upon three feet, like a tripod, which were in length somewhat less than the height of a man; so that the diver, when he was no longer able to contain his breath, could put his head into the vessel, and, having breathed, return again to his work."—Novum Organum, lib. ii. § 50. Bacon relates the same thing in his Phænomena Universi.

[2] G. Sinclari Ars nova et magna gravitatis et levitatis. Rot. 1669, 4to, p. 220.

[3] Paschii Inventa nov-antiqua. Lipsiæ, 1700, 4to, p. 650.

[4] Theatri Statici universalis pars tertia. Lipsiæ, 1726, fol. p. 242.

his plan in such a plausible manner, that king Charles II. gave him a ship, and furnished him with every thing necessary for the undertaking. He set sail in the year 1683; but, being unsuccessful, returned again in great poverty, though with a firm conviction of the possibility of his scheme. He endeavoured, therefore, to procure another vessel from James II., who was then on the throne; but as he failed in this, he tried to find the means of executing his design by the support of private persons, and, according to the prevailing practice, opened for that purpose a subscription. At first he was laughed at; but at length the duke of Albemarle, son of the celebrated General Monk, took part in it, and advanced a considerable sum to enable him to make the necessary preparations for a new voyage. Phipps soon collected the remainder; and in 1687 set sail in a ship of two hundred tons burthen to try his fortune once more, having previously engaged to divide the profit according to the twenty shares of which the subscription consisted. At first, all his labour proved fruitless; but at last, when his patience was almost entirely exhausted, he was so lucky as to bring up, from the depth of six or seven fathoms, so much treasure, that he returned to England with the value of two hundred thousand pounds sterling. Of this sum he himself got about sixteen, others say twenty thousand, and the duke ninety thousand pounds. After he came back, some persons endeavoured to persuade the king to seize both the ship and the cargo, under a pretence that Phipps, when he solicited for his Majesty's permission, had not given accurate information respecting the business. But the king answered, with much greatness of mind, that he knew Phipps to be an honest man, and that he and his friends should share the whole among them, had he returned with double the value. His Majesty even conferred upon him the honour of knighthood, to show how much he was satisfied with his conduct. This Phipps was afterwards high sheriff of New England, and died at London, greatly respected, in 1693. This affair was attended with such good consequences to the duke of Albemarle, that he obtained from the king the governorship of Jamaica, in order to try his fortune with other ships sunk in that neighbourhood. But whether it was that the gold had been already taken from the one before mentioned, or that, when the vessel

went to pieces, the sea had dispersed the cargo, it is certain that nothing further was found worth the labour of searching for[1].

In England, however, several companies were formed, and obtained exclusive privileges of fishing up goods on certain coasts, by means of divers. The most considerable of these was that which, in 1688, tried its success at the Isle of Mull, and at the head of which was the earl of Argyle. The divers went down to the depth of sixty feet under water, remained there sometimes a whole hour, and brought up gold chains, money, and other articles, which, however, when collected, were of very little importance[2]. Without giving more examples of the use of the diving-bell, I shall now mention some of those who, in later times, have endeavoured to improve it. That this machine was very little known in the first half of the sixteenth century, I conclude from the following circumstance. To the oldest edition of Vegetius on the art of war, there are added, by the editor, some figures, of which no explanation is given in the book. Among these is represented a method of catching fish with the hands, at the bottom of the sea. The apparatus for this purpose consists of a cap, which is fitted so closely to the head of the diver that no water can make its way between; and from the cap there ascends a long leather pipe, the opening of which floats on the surface of the water. Had the person who drew these figures been acquainted with the diving-bell, he would certainly have delineated it rather than this useless apparatus[3]. Of the old figures of a diving machine, that which approaches nearest to the diving-bell is in a book on fortification, by Lorini; who describes a square box bound round with iron, which is furnished with windows, and has a stool affixed to it

[1] This account is taken from the History of the British Empire in America, by J. Wynne. London, 1770, 2 vols. 8vo, i. p. 131, and from Campbell's Lives of the Admirals.

[2] Martin's Description of the Western Islands. The second edition. London, 1716, 8vo, p. 253.—Campbell's Political Survey of Britain. London, 1774, 2 vols. 4to, p. 604.

[3] These figures are to be found in the following editions of Vegetius:—Lutetiæ apud C. Wechelum, 1532, fol. p. 180. Fegetius, vier Bücher von der Rytterschafft. Erfurt, Hans. Knappen, 1511, fol. These figures are inserted also in Leupold's Theatrum Pontificale, p. 11, tab. ii. fig. 6.

for the diver. This more ingenious contrivance appears, however, to be older than that Italian; at least he does not pretend to be the inventor of it[1].

In the year 1617, Francis Kessler gave a description of his water-armour[2], intended also for diving, but which cannot really be used for that purpose[3]. In the year 1671, Witsen taught, in a better manner than any of his predecessors, the construction and use of the diving-bell[4]; but he is much mistaken when he says that it was invented at Amsterdam. In 1679 appeared, for the first time, Borelli's well-known work De Motu Animalium[5], in which he not only described the diving-bell, but also proposed another, the impracticability of which was shown by James Bernoulli[6]. When Sturm published his Collegium Curiosum, in 1678, he proposed some hints for the improvement of this machine, on which remarks were made in the Journal des Sçavans (Jan. 1678). None, however, have carried their researches further for this purpose than Dr. Halley, and Triewald a Swede.

The bell which Edmund Halley, secretary to the Royal Society, caused to be made, was three feet broad at the top, five feet at the bottom, and eight feet in height; forming a cavity of sixty-three cubic feet. It was covered with lead; and was so heavy that it sunk to the bottom, even when entirely empty. Around the lower edge, weights were disposed in such a manner that it should always sink in a perpendicular direction, and never remain in an oblique position. In the top was fixed a piece of strong glass to admit the light from above, and likewise a valve to give a passage to the air corrupted by the breath. Around the whole circumference of the bottom was placed a seat, on which the divers sat; and a stool, fixed to ropes, hung below, on which they could stand in order to work. The whole machine was suspended from a cross beam fastened to the mast of a ship, so that it could be easily lowered down into the water and again drawn up. That the bell might be supplied with fresh air under the water,

[1] Le Fortificationi di Bounaiuto Lorini. Venet. 1609, fol. p. 232.
[2] Fran. Kessleri Secreta. Oppenheim, 1617, 8vo.
[3] Bartholini Acta Hafn. 1676, p. i. obs. 17. [4] Scheeps-bouw, ut supra.
[5] See vol. i. p. 222, edit. Hag. Com. 1743.
[6] Acta Eruditorum, 1683, Decemb. p. 553. Jac. Bernoulli Opera.

large vessels filled with air, and which had an opening below through which the water compressed the included air, were let down by ropes. In the top of these vessels were leather pipes, besmeared with oil, through which the diver introduced air from the vessels into the bell; and as soon as a vessel was emptied, it was drawn up, on a signal made by the diver, and another let down. The foul air in the bell, being the warmest and lightest, rose to the top of the machine, where it was suffered to escape through the valve before mentioned. By these means the bell could be continually supplied with fresh air in such abundance, that Halley, and four other persons, remained under water, at the depth of ten fathoms, an hour and a half, without suffering the least injury, and could, with equal security, have continued longer, or even as long as they might have wished. This precaution, however, is necessary, that the bell be let down at first very slowly, that the divers may be gradually accustomed to inspire the compressed air; and at every twelve fathoms the bell must be held fast, in order to expel the water which has rushed in, by letting fresh air into it. By such apparatus, Halley was enabled to make the bottom of the sea, within the circumference of the bell, so dry that the sand or mud did not rise above his shoe. Through the window, in the top, so much light was admitted, that when the sea was still and the waves did not roll, he could see perfectly well to read and write under the water. When the empty air-vessels were drawn up, he sent up with them his orders, written with an iron spike on a plate of lead, and could thus let those above know when he wished to be removed with the bell to another place. In bad weather, and when the sea was rough, it was as dark under the bell as at night; he then kindled a light; but a burning candle consumed as much air as a man. The only inconvenience of which Halley complained was, that, in going down, he felt a pain in his ears, as if a sharp quill had been thrust into them. This pain returned every time the bell was let down to a greater depth, but soon went off again. A diver thought to prevent this pain by putting chewed paper into both his ears; but the bits of paper were forced in so far by the air, that a surgeon found great difficulty to extract them.

Another improvement of the diving-bell was effected by the well-known Triewald, a Swede, in 1732. His bell, which was

much smaller and more commodious, was made of copper, tinned in the inside. On the top there were panes of glass, which, for the greater security, were fixed in a frame of the same metal. The stool below was placed in such a manner, that the head only of the diver, when he stood upon it, rose above the surface of the water in the bell. This situation is much better than when the whole body is raised above the water in the bell, because near the surface of the water the air is much cooler and fitter to breathe in than at the top of the machine. That the diver also might remain conveniently in the upper part of the bell, Triewald arranged his apparatus so that when the diver had breathed as long as possible in the upper air, he found at the side of the bell a spiral pipe, through which he could draw in the lower cool air which was over the surface of the water. To the upper end of this copper pipe was affixed a pliable leather one, with an ivory mouth-piece, which the diver put into his mouth, and could thus inspire fresh air, in whatever position his body might be[1].

[In 1776, Mr. Spalding of Edinburgh made some improvements in Dr. Halley's diving-bell, for which he was rewarded by the Society of Arts. His diving-bell was made of wood, and was so light, that, with the divers and the weights attached to its rim, it would not sink; the weight necessary to counteract its buoyancy being added in the form of a large balance-weight, suspended from its centre by a rope, which was so mounted on pulleys that the divers could either draw the balance-weight up to the mouth of the bell or allow it to fall a considerable depth below it. Thus by letting the weight down to the bottom, the divers could, as it were, anchor the bell at any required level, or prevent its further descent if they perceived a rock or part of a wreck beneath it, which might otherwise overturn it. Also, by hauling in the rope while the weight was at the bottom, the persons in the bell might lower themselves at pleasure. Another improvement consisted in the addition of a horizontal partition near the top of the bell, which divided off a chamber, that might, by suitable openings and valves, be filled either with water or with air from the lower part of the bell, so as to alter the specific

[1] Phil. Trans. 1736.—Martin Triewald's Konst at lefwa under watnet. Stockholm, 1741, 4to.

gravity of the whole machine, and thereby cause it to ascend or descend at pleasure. The bell was supplied with air by an apparatus resembling that of Dr. Halley, and ropes stretched across the bell were used instead of seats and platforms for standing on. Thus the persons in the diving-bell were enabled, in case of accident, to raise themselves to the surface without any assistance from above, and it was rendered so perfectly manageable, that it might be removed to a considerable distance from the point at which it descended; its outward motion and its return to the vessel for the purpose of being hauled up, being assisted by a long boat, which carried the signal lines and the tackle for working the air-barrels.

Mr. John Farey, junior, made an improvement in Spalding's apparatus[1]. The upper chamber of the diving-bell is very strong and air-tight, without any openings for the admission of water. Two pumps are fixed in the partition, by which air may be forced into the upper chamber, whenever, during a pause in the descent, the lower chamber or the cavity of the bell is replenished with air. By this means, the upper chamber is made a reservoir of condensed air, from which the bell may be replenished with air, when it is desired to increase its buoyancy, by forcing out the water from the lower part. Hence also, the buoyancy of the bell may be at any time diminished, by pumping some of the air from it into the upper chamber, whereby the water will be allowed to enter to a greater height; and as this is effected without wasting the air, there is no danger of diminishing the buoyancy of the machine to a degree which would prevent it from rising, in case the suspending rope or chain should break.

Smeaton first employed the diving-bell in civil engineering operations in repairing the foundations of Hexham bridge in 1779. The bell was made of wood, and was supplied with air by means of a forcing-pump, which was fixed to the top, and threw in a gallon of air at a time; the river being shallow, the top of the bell was not covered with water[2]. In 1788 he used a cast-iron one in repairing Ramsgate harbour; a forcing-pump in a boat supplied air through a flexible tube. Since that time it has been frequently used by Rennie and others in

[1] Brewster's Edinburgh Encyclopædia, Art. Diving-bell.
[2] Reports of the late John Smeaton, F.R.S., vol. iii. p. 279.

submarine operations, recovering property from wrecks, blasting, &c. Mr. Rennie has moreover constructed apparatus for moving the bell in any direction.

In addition to the various forms of diving-bell, different water- and air-tight dresses have been invented to enable divers to remain in the water and perform various operations. Thus, Dr. Halley invented a leaden cap which covered the diver's head; it had glass before it, and contained as much air as was sufficient for two minutes, and had affixed to it a thick pliable pipe, with the other end fastened to the bell, and which, at the cap, was furnished with a valve to convey fresh air to the diver from the bell. This pipe, which the diver was obliged to wind round his arm, served him also as a guide to find his way back to the bell[1].

Mr. Martin states that a gentleman at Newton-Bushel, in Devonshire, invented an apparatus consisting of a large case of strong leather, holding about half a hogshead of air, made perfectly water-tight, and adapted to the legs and arms, with a glass in the anterior part, so that when the case was put on, he could walk about very easily at the bottom of the sea, and go into the cabin and other parts of a ship in a wreck, and deliver out the goods; and that he practised this method for forty years, and thereby acquired a large fortune and equal fame[2].

M. Klingert also invented a similar kind of apparatus, and described it in a pamphlet published at Breslau in 1798. The armour was made of tin-plate, in the form of a cylinder, with a round end to enclose the head and body; also, a leather jacket with short sleeves, and a pair of water-tight drawers of the same, buttoned on the metal part, where they joined, and were made tight by brass hoops. Two distinct flexible pipes terminated in the helmet, and rose to the surface of the water; one was for inhaling, and terminated in an ivory mouth-piece, the other was for the escape of foul air. The body was kept down by weights.

Another method of supplying air to the apparatus was used by Mr. Tonkin in 1804. This consisted in the application of a bellows or pump, until the elastic force of the air was equal

[1] Phil. Trans. 1717 and 1721. The art of living under water, by Halley.
[2] Martin's Philosophia Britannica, vol. iii. p. 180.

to the pressure of the water, the foul air being allowed to escape into the water through a valve, or conducted to the surface by a pipe[1].]

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## COLOURED GLASS.—ARTIFICIAL GEMS.

It is probable that there was no great interval between the discovery of the art of making glass, and that of giving it different colours. When the substance of which it is formed contains, by accident, any metallic particles, the glass assumes some tint; and this happens oftener than is wished; nay, a considerable degree of foresight is necessary to produce glass perfectly colourless; and I am of opinion that this skill has not been attained till a late period in the progress of the art. Even in Pliny's time the highest value was set upon glass entirely free from colour, and transparent, or, as it was called, crystal[2]. From the different colours which glass acquired of itself, it was easy to conceive the idea of giving it the tinge of some precious stone: and this art, in ancient times, was carried to a very great extent. Proofs of this may be found in Pliny, who, besides others, mentions artificial hyacinths, sapphires, and that black glass which approached very near to the obsidian stone, and which in more than one place he calls *gemmæ vitreæ*[3]. Trebellius Pollio relates in how whimsical a manner Gallienus punished a cheat who had sold to his wife

[1] For further information on this important subject the reader is referred to the article Diving-bell in the Encyclopædia Britannica and its Supplement, also the Encyclopædia Metropolitana, Brewster's Edinburgh and the Penny Cyclopædia, Halley's papers in the Phil. Trans. for 1716 and 1721, Treiwald's in the same for 1736, Healy in the Philosophical Magazine, vol. xv., and Leopold's Theatrum Machinarum Hydraulicarum.

[2] Lib. xxxvi. c. 26.

[3] Lib. xxxv. c. 26. and lib. xxxvii. c. 9. The *lapis obsidianus*, which Obsidius first found in Ethiopia, and made known, is undoubtedly the same as that vulcanic glass which is sometimes called Icelandic agate, *pumex vitreus*, and by the Spaniards, who brought it from America and California, named *galinace*.

a piece of glass for a jewel[1]: and Tertullian ridicules the folly of paying as dear for coloured glass as for real pearls. The glass-houses at Alexandria were celebrated among the ancients for the skill and ingenuity of the workmen employed in them. From these, the Romans, who did not acquire a knowledge of that art till a late period, procured for a long time all their glass ware. The learned author of Recherches sur les Égyptiens et les Chinois, in the end of his first volume, relates more of these glass-houses than I know where to find in the works of the ancients; but it is certain that coloured glass was made even in those early ages. The emperor Adrian received as a present from an Egyptian priest, several glass cups which sparkled with colours of every kind, and which, as costly wares, he ordered to be used only on grand festivals[2]. Strabo tells us, that a glass-maker in Alexandria informed him that an earth was found in Egypt, without which the valuable coloured glass could not be made[3].

Seneca, in his ninetieth epistle, in which he judges too philosophically, that is, with too little knowledge of the world, in regard to the value of labour, mentions one Democritus who had discovered the art of making artificial emeralds[4]; but in my opinion this discovery consisted in giving a green colour by cementation to the natural rock crystal: and this art I imagine was treated of in that book, the name of which Pliny, through an over-anxious care lest the deception should become common, does not mention[5]. For colouring crystal and glass, so as to resemble stones, Porta[6], Neri[7], and others have, in modern times, given directions which are, however, not much used, because the crystal is thereby liable to acquire

[1] Historiæ Augustæ Scriptores, in vita Gallieni, cap. 12.

[2] Ib. in Vopisc. vita Saturnini, c. 8.

[3] Strabo, Amst. 1707, fol. lib. xvi. p. 1099.—Some consider the glass earth here mentioned as a mineral alkali that was really found in Egypt, and which served to make glass; but, as the author speaks expressly of coloured glass, I do not think that the above salt, without which no glass was then made, is what is meant; but rather a metallic oxide, such perhaps as ochre or manganese.

[4] Sen. Op. Lipsii, p. 579.

[5] Hist. Nat. lib. xxxvii. c. 12. A passage in Diodorus Siculus, lib. ii. c. 52, alludes, in my opinion, to this method of colouring by cementation.

[6] Magia Naturalis. Franc. 1591, 8vo, p. 275.

[7] Kunkel's Ars Vitraria. Nur. 1743, 4to, pp. 98, 101.

so many flaws that it cannot be easily cut afterwards, though, as Neri assures us, these by attention may sometimes be avoided.

It is worthy of remark, that in some collections of antiquities at Rome, there are pieces of coloured glass which were once used as jewels. In the Museum Victorium, for example, there are shown a chrysolite and an emerald, both of which are so well executed, that they are not only perfectly transparent and coloured throughout, but neither externally nor internally have the smallest blemish, which certainly could not be guarded against without great care and skill.

What materials the ancients used for colouring glass, has not been told to us by any of their writers. It is, however, certain that metallic oxides only can be employed for that purpose, because these pigments withstand the heat of the glass furnaces; and it is highly probable that ferruginous earth, if not the sole, was at least the principal substance, by which not only all shades of red, violet, and yellow, but even a blue colour, could be communicated, as Professor Gmelin has shown[1]. Respecting the red, of which only I mean here to speak, there is the less doubt, as, at present, sometimes an artificial, and sometimes a natural, iron ochre is often employed for that purpose. For common works this is sufficient; but when pure clear glass, coloured strongly throughout with a beautiful lively red, free from flaws, and in somewhat large pieces, is required, iron is not fit, because its colour, by the continued heat necessary for making glass, either disappears or becomes dirty and almost blackish[2].

In the last century, some artists in Germany first fell upon the method of employing gold instead of iron, and of thereby making artificial rubies, which when they were well set could deceive the eye of a connoisseur, unless he tried them with a diamond or a file. The usual method was to dissolve the gold in aqua regia, and to precipitate it by a solution of tin, when it assumed the form of a purple-coloured powder. This substance, which must be mixed with the best frit, is called the precipitate of Cassius, gold-purple, or mineral-purple[3].

[1] Comment. Soc. Scient. Gotting. ii. p. 41.

[2] Montamy von den Farben zum Porzellan- und Email-malen. Leipsic, 1767, 8vo, p. 82. Fontanieu, p. 16.

[3] [The extensive use of this substance in colouring glass and porcelain

This Cassius, from whom it takes its name, was called Andrew, and because both the father and the son had the same christian name, they have been often confounded with each other. The father was secretary to the duke of Schleswig, and is not known as a man of letters; but the son is celebrated as the inventor or preparer of the gold-purple, and of a bezoar-essence. He took the degree of doctor at Leyden, in 1632, practised physic at Hamburg, and was appointed physician in ordinary to the bishop of Lubec. As far as I know, he never published anything respecting his art; but this service was rendered to the public by his son, who was born at Hamburg, and resided as a physician at Lubec. He was the author of a well-known treatise, now exceedingly scarce, entitled Thoughts concerning that last and most perfect work of nature, and chief of metals, gold, its wonderful properties,

has rendered its best and most œconomical preparation a subject of interest both to the chemist and the manufacturer. Although the determination of its true chemical composition has presented obstacles almost insuperable, still many important points with regard to its manufacture have been elucidated. It has been found that the tin salt used in precipitating it must contain both the binoxide and protoxide of tin in certain proportions, and it has been also discovered that the degree of dilution both of the gold and tin solutions exerts a very perceptible influence on the beauty of the preparation. Capaun has examined this latter point with great attention, by testing all the different products as to their power of colouring glass.

The first point to be attained is the preparation of a solution of sesquioxide of tin; and for this purpose Bolley proposes to employ the double compound of bichloride of tin with sal-ammoniac (pink salt). This salt is not altered by exposure to the atmosphere, and contains a fixed and known quantity of bichloride of tin, and when boiled with metallic tin it takes up so much as will form the protochloride; as the exact quantity of the bichloride is known, it is very easy to use exactly such a quantity of tin as will serve to form the sesquichloride. 100 parts of the pink salt require for this purpose 10·7 parts of metallic tin.

Capaun recommends dissolving 1·34 gr. of gold in aqua regia, an excess being carefully avoided, and diluting the solution with 480 grs. of water. 10 grs. of pink salt are mixed with 1·07 gr. of tin filings and 40 grs. of water, and the whole boiled till the tin is dissolved. 140 grs. of water are then added to this, and the solution gradually mixed with the gold liquor, slightly warmed, until no more precipitation ensues. The precipitate washed and dried weighs 4·92 grs. and is of a dark brown colour.

M. Figuier states, as the results of his investigations, that the purple of Cassius is a perfectly definite combination of protoxide of gold and of stannic acid, or peroxide of tin, the proof of which is, that it is instantly produced when protoxide of gold and peroxide of tin are placed in contact.]

generation, affections, effects, and fitness for the operations of art; illustrated by experiments[1].

From this work it will be easily understood why the author does not give himself out as the inventor of the gold-purple[2], which he is commonly supposed to be, at which Lewis is much astonished. It is seen also by it that Leibnitz calls him improperly a physician at Hamburg, having probably confounded the father and son together[3]. Upon the whole, it is not proved that any of the Cassius's was the inventor of the above precipitate, else it would certainly not have been omitted[4] in this treatise; and mention of gold-purple is to be found in the works of several old chemists[5].

Something of this kind has, doubtless, been meant by the old chemists, when they talk of red lions, the purple soul of gold, and the golden mantle; but what they wished to conceal under these metaphors, I am not able to conjecture. In the year 1606, when Libavius published his Alchemy, the art of making ruby-glass must have been unknown. He indeed quotes an old receipt for making rubies; and conjectures, that because the real stones of the same name are found in the neighbourhood of gold mines, they may have acquired their colour from that metal; and that by means of art, glass might be coloured by a solution of gold[6]. The later chemists, however, and particularly Achard, found no traces of gold, but of iron, in that precious stone[7].

Neri, who lived almost at the same time as Libavius[8], was better acquainted with the gold-purple, though his receipt is

[1] The original title runs thus:—De extremo illo et perfectissimo naturæ opificio ac principe terrenorum sidere, auro, et admiranda ejus natura, generatione, affectionibus, effectis, atque ad operationes artis habitudine, cogitata; experimentis illustrata. Hamburgi, 1685, 8vo.

[2] Joh. Molleri Cimbria Literata. Havniæ, 1774, fol. i. p. 88.

[3] Miscellanea Berolinensia, i. p. 94.

[4] The author shows only, in a brief manner, in how many ways this precipitate can be used; but he makes no mention of employing it in colouring glass.

[5] I cannot, however, affirm that the *vasa murrhina* of the ancients were a kind of porcelain coloured with this salt of gold. This is only a mere conjecture.

[6] Alchymia Andr. Libavii. Franc. 1606, fol. ii. tract. i. c. 34.

[7] See Gotting. Gel. Anzeigen, 1778, p. 177.

[8] It is well known that Neri's works are translated into Kunkel's Ars Vitraria, the edition of which, published at Nuremberg in 1743, I have in

very defective. According to his directions, the gold solution must be evaporated, and the residue suffered to remain over the fire until it becomes of a purple colour. One may readily believe that this colour will be produced; but glass will scarcely be coloured equally through by this powder, and perhaps some of the gold particles will show themselves in it. Kunkel affirms, and not without reason, that something more is necessary to make rubies by means of gold; but he has not thought proper to tell us what it is[1].

Glauber, who wrote his Philosophical Furnace[2] about the middle of the seventeenth century, appears to have made several experiments with the gold-purple. He dissolved the metal in aqua regia; precipitated it by liquor of flint, and melted into glass the precipitate, which contained in it abundance of vitreous earth[3].

None, however, in the seventeenth century, understood better the use and preparation of gold-purple than John Kunkel, who, after being ennobled by Charles XI., king of Sweden, assumed the name of Löwenstiern. He himself tells us, that he made artificial rubies in great abundance, and sold them by weight, at a high price. He says, he made for the elector of Cologne a cup of ruby glass, weighing not less than twenty-four pounds, which was a full inch in thickness, and of an equally beautiful colour throughout. He employed himself most on this art after he engaged in the service of Frederic William, elector of Brandenburg, in the year 1679. At that time he was inspector of the glass-houses at Potsdam; and, in order that the art of making ruby-glass might be brought to perfection, the elector expended 1600 ducats. A cup with a cover, of this manufacture, is still preserved at Berlin. Kunkel, however, has nowhere given a full account of this art. He has only

my possession. The time Neri lived is not mentioned in the Dictionary of Learned Men; but it appears, from the above edition of Kunkel, that he was at Florence in 1601, and at Antwerp in 1609. The oldest Italian edition of his works I have ever seen is L'arte vetraria—del R. R. Antonio Neri, Fiorentino. In Venetia, 1663. The first edition, however, must be older. [It is Florence, Giunti, 1612.—Ed.]

[1] Neri, b. vii. c. 129, pp. 157 and 174.

[2] Amst. 1651, vol. iv. p. 78. Lewis says that Furnus Philosophicus was printed as early as 1648.

[3] Glauber first made known liquor of flint, and recommended it for several uses. See Ettmulleri Opera, Gen. 1736, 4 vol. fol. ii. p. 170.

left in his works a few scattered remarks, which Lewis has collected[1].

In the year 1684, earlier than Cassius, John Christian Orschal wrote his well-known work, Sol sine veste[2], in which he treats, more intelligibly than any one before him, of the manner of making ruby-glass. He, however, confesses that Cassius first taught him to precipitate gold by means of tin; that Cassius traded in glass coloured with this precipitate, and that a good deal of coloured glass was then made at Freysingen, but that the art was kept very secret. As Orschal deserves that his fate should be better known, I shall here mention the following few particulars respecting him. About the year 1682 he was at Dresden, in the service of John Henry Rudolf, from whom he learnt many chemical processes, and particularly amalgamation, by which he gained money afterwards in Bohemia. After this he was employed at the mines in Hesse; but he brought great trouble upon himself by polygamy and other irregularities, and died in a monastery in Poland.

Christopher Grummet, who was Kunkel's assistant, wrote, in opposition to Orschal, his known treatise, Sol non sine veste, which was printed at Rothenburg, in 1685[3]. In like manner, an anonymous author printed against Orschal, at Cologne, in 1684, another work, in duodecimo, entitled Apelles post tabulam observans maculas in Sole sine veste. The dispute, however, was not so much concerning the use of gold-purple, as the cause of the red colour, and the vitrification of gold.

It is worthy of remark, that Kunkel affirms he could give to glass a perfect ruby-red colour without gold; which Orschal and most chemists have however doubted. It is nevertheless said, that Krüger, who was inspector of the glass-houses at Potsdam, under Frederic William king of Prussia, discovered earlier the art of making ruby-glass without gold, and that a

[1] Lewis, Zusammenhang der Künste. Zür. 1764, 2 vols. 8vo, i. p. 279.

[2] The first edition was printed at Augsburg, in duodecimo, and the same year at Amsterdam. It has been often printed since, as in 1739, in 3 vols. 4to, without name or place.

[3] A French translation of Orschal and Grummet is added to l'Art de la Verrérie de Neri, Merret et Kunkel. Paris, 1752, 4to. The editor is the Baron de Holbach.

cup and cover of cut glass made in this manner is still preserved at Berlin.

*Painting* on glass and in enamel, and the preparation of coloured materials for mosaic work, may, in certain respects, be considered as branches of the art of colouring glass; and in all these a beautiful red is the most difficult, the dearest, and the scarcest. When the old master-pieces of painting on glass are examined, it is found either that the panes have on one side a transparent red varnish burnt into them, or that the pieces which are stained through and through, are thinner than those coloured in the other manner[1]. It is therefore extremely probable that the old artists, as they did not know how to give to thick pieces a beautiful transparent red colour, employed only iron, or manganese, which pigment, as already observed, easily becomes in a strong heat blackish and muddy[2]. Enamel-painters, however, were for a long time obliged to be contented with it. A red colour in mosaic work is attended with less difficulty, because no transparency, nay rather opacity, is required. At Rome those pieces are valued most which have the beautiful shining red colour of the finest sealing-wax. We are told by Ferber that such pieces were at one time made only by a man named Mathioli, and out of a kind of copper dross; at present (1792), there are several artists in that city who prepare these materials, but they are not able to give them a perfect high colour[3].

[Of late years the interesting art of painting on glass has attracted considerable attention; lovers of the fine arts, antiquaries, and chemists, have contributed to its perfection, and have sought to ascertain by what methods their predecessors were able to give those beautiful and brilliant tints to their productions, many of which have been so wantonly destroyed

[1] See Peter le Vieil's Kunst auf Glas zu malen, Nuremberg 1779, 4to, ii. p. 25. This singular performance must, in regard to history, particularly that of the ancients, be read with precaution. Seldom has the author perused the works which he quotes; sometimes one cannot find in them what he assures us he found, and very often he misrepresents their words.

[2] In what the art of Abraham Helmback, a Nuremberg artist, consisted, I do not know. Doppelmayer, in his Account of the Mathematicians and Artists of Nuremberg, printed in 1730, says that he fortunately revived, in 1717, according to experiments made in a glass-house, the old red glass; the proper method of preparing which had been long lost.

[3] Ferber's Briefe aus Welschland. Prague, 1773, 8vo, p. 114.

by the barbarity of the last century[1]. One of the most ingenious essays that has been written on the subject, is that published by an anonymous correspondent in the Philosophical Magazine for December 1836, which we subjoin in elucidation of our present knowledge on the subject.

*On the Art of Glass-Painting. By* a Correspondent.

It is a singular fact, that the art of glass-painting, practised with such success during the former ages from one end of Europe to the other, should gradually have fallen into such disuse, that in the beginning of the last century it came to be generally considered as a lost art. In the course of the eighteenth century, however, the art again began to attract attention, and many attempts were made to revive it. It was soon found by modern artists, that by employing the processes always in use among enamel-painters, the works of the old painters on glass might in most respects be successfully imitated; but they were totally unable to produce any imitation whatever of that glowing red which sheds such incomparable brilliancy over the ancient windows that still adorn so many of our churches[2]. For this splendid colour they possessed no substitute, until a property, peculiar to silver alone among all the metals, was discovered, which will presently be described.

[1] The devastations to which the productions of this beautiful art have been subjected are deeply to be regretted. It appears from the interesting Account of Durham Cathedral, published by the Rev. James Raine, that there was much fine stained glass in the fifteen windows of the Nine Altars which

"shed their many-colour'd light
Through the rich robes of eremites and saints;"

until the year 1795, when "their richly painted glass and mullions were swept away, and the present plain windows inserted in their place. The glass lay for a long time afterwards in baskets on the floor; and when the greater part of it had been purloined the remainder was locked up in the Galilee." And in 1802 a beautiful ancient structure, the Great Vestry, "was, for no apparent reason, demolished, and the richly painted glass which decorated its windows was either destroyed by the workmen or afterwards purloined." The exquisite Galilee itself had been condemned, but was saved by a happy chance.

[2] In 1774 the French Academy published Le Vieil's treatise on Glass-painting. He possessed no colour approaching to red, except the brick-red or rather rust-coloured enamel subsequently mentioned in the text, derived from iron.

The art of enamelling on glass differs little from the well-known art of enamelling on other substances. The colouring materials (which are exclusively metallic) are prepared by being ground up with a *flux*, that is, a very fusible glass, composed of silex, flint-glass, lead, and borax: the colour with its flux is then mixed with volatile oil, and laid on with the brush. The pane of glass thus enamelled is then exposed to a dull red heat, just sufficient to soften and unite together the particles of the flux, by which means the colour is perfectly fixed on the glass. Treated in this way, gold yields a purple, gold and silver mixed a rose colour, iron a brick-red, cobalt a blue[1]; mixtures of iron, copper and manganese, brown and black. Copper, which yields the green in common enamel-painting[2], is not found to produce a fine colour when applied in the same way to glass, and viewed by transmitted light; for a green therefore recourse is often had to glass coloured blue on one side and yellow on the other. To obtain a yellow, silver is employed, which, either in the metallic or in any other form, possesses the singular property of imparting a transparent stain, when exposed to a low red heat in contact with glass. This stain is either yellow, orange, or red, according to circumstances. For this purpose no flux is used: the prepared silver is merely ground up with ochre or clay, and applied in a thick layer upon the glass. When removed from the furnace the silver is found not at all adhering to the glass; it is easily scraped off, leaving a transparent stain, which penetrates to a certain depth. If a large proportion of ochre has been employed, the stain is yellow; if a small proportion, it is orange-coloured; and by repeated exposure to the fire, without any additional colouring matter, the orange may be converted into red. This conversion of orange into red is, I believe, a matter of much nicety, in which experience only can ensure success. Till within a few years this was the only bright red in use among modern glass-painters; and though the best specimens certainly produce a fine effect, yet it will seldom bear comparison with the red employed in such profusion by the old artists.

[1] It appears by a boast of Suger, abbot of St. Denis, which has been preserved, that the ancient glass-painters pretended to employ sapphires among their materials; hence, perhaps, the origin of the term *Zaffres*, under which the oxide of cobalt is still known in commerce.

[2] Oxide of chromium is now substituted for the copper.

Besides the enamels and stains above described, artists, whenever the subject will allow of it, make use of panes coloured throughout their substance in the glass-house melting-pot, because the perfect transparency of such glass gives a brilliancy of effect, which enamel-colouring, always more or less opake, cannot equal. It was to a glass of this kind that the old glass-painters owed their splendid red. This in fact is the only point in which the modern and ancient processes differ, and this is the only part of the art which was ever really lost. Instead of blowing plates of solid red, the old glass-makers used to *flash* a thin layer of red over a substratum of plain glass. Their process must have been to melt side by side in the glass-house a pot of plain and a pot of red glass: then the workman, by dipping his rod first into the plain and then into the red glass pot, obtained a lump of plain glass covered with a coating of red, which, by dexterous management in blowing and whirling, he extended into a plate, exhibiting on its surface a very thin stratum of the desired colour[1]. In this state the glass came into the hands of the glass-painter, and answered most of his purposes, except when the subject required the representation of white or other colours on a red ground: in this case it became necessary to employ a machine like the lapidary's wheel, partially to grind away the coloured surface till the white substratum appeared.

The material employed by the old glass-makers to tinge their glass red was the protoxide of copper, but on the discontinuance of the art of glass-painting the dependent manufacture of red glass of course ceased, and all knowledge of the art became so entirely extinct, that the notion generally prevailed that the colour in question was derived from gold[2]. It is not

[1] That such was the method in use, an attentive examination of old specimens affords sufficient evidence. One piece that I possess exhibits large bubbles in the midst of the red stratum; another consists of a stratum of red inclosed between two colourless strata: both circumstances plainly point out the only means by which such an arrangement could be produced.

[2] In 1793, the French government actually collected a quantity of old red glass, with the view of extracting the gold by which it was supposed to be coloured! Le Vieil was himself a glass-painter employed in the repair of ancient windows, and the descendant of glass-painters, yet so little was he aware of the true nature of the glass, that he even fancied he could detect the marks of the brush with which he imagined the red stratum had been laid on!

a little remarkable that the knowledge of the copper-red should have been so entirely lost, though printed receipts have always existed detailing the whole process. Baptista Porta (born about 1540) gives a receipt in his Magia Naturalis, noticing at the same time the difficulty of success. Several receipts are found in the compilations of Neri, Merret and Kunckel, from whence they have been copied into our Encyclopædias[1]. None of these receipts however state to what purposes the red glass was applied, nor do they make any mention of the *flashing*. The difficulty of the art consists in the proneness of the copper to pass from the state of protoxide into that of peroxide, in which latter state it tinges glass green. In order to preserve it in the state of protoxide, these receipts prescribe various deoxygenating substances to be stirred into the melted glass, such as smiths' clinkers, tartar, soot, rotten wood, and cinnabar.

One curious circumstance deserves to be noticed, which is, that glass containing copper when removed from the melting-pot sometimes only exhibits a faint greenish tinge, yet in this state nothing more than simple exposure to a gentle heat is requisite to throw out a brilliant red. This change of colour is very remarkable, as it is obvious that no change of oxygenation can possibly take place during the *recuisson*.

The art of tinging glass by protoxide of copper and flashing it on crown-glass, has of late years been revived by the Tyne Company in England, at Choisy in France[2], and in Suabia in Germany, and in 1827 the Academy of Arts at Berlin gave a premium for an imperfect receipt. To what extent modern glass-painters make use of these new glasses I am ignorant; the specimens that I have seen were so strongly coloured as to be in parts almost opake, but this is a defect which might no doubt be easily remedied[3].

[1] [M. Langlois names the following writers: "Neri en 1612, Handicquer de Blancourt en 1667, Kunkel en 1679, Le Vieil en 1774, et plusieurs autres écrivains à diverses époques, decrivaient ces procédés." (p. 192.) He fixes the restoration of the art in France at about the year 1800, when Brongniart, who had the direction of the Sèvres porcelain manufacture, worked with Méraud at the preparation of vitrifiable colours, p. 194. Among modern artists he particularly mentions Dihl, Schilt, Mortelègue, Robert, Leclair, Collins, and Willement.]

[2] Bulletin de la Société d'Encouragement pour l'Industrie Nationale, 1826.

[3] Though it is difficult to produce the copper-glass uniformly coloured,

I shall now conclude these observations by a few notices respecting glass tinged by fusion with gold, which, though never brought into general use among glass-painters, has I know been employed in one or two instances, flashed both on crown- and on flint-glass. Not long after the time when the art of making the copper-red glass was lost, Kunkel appears to have discovered that gold melted with flint-glass was capable of imparting to it a beautiful ruby colour. As he derived much profit from the invention, he kept his method secret, and his successors have done the same to the present day. The art, however, has been practised ever since for the purpose of imitating precious stones, &c., and the glass used to be sold at Birmingham for a high price under the name of *Jew's glass*. The rose-coloured scent-bottles, &c., now commonly made, are composed of plain glass flashed or coated with a very thin layer of the glass in question. I have myself made numerous experiments on this subject, and have been completely, and at last uniformly, successful, in producing glass of a fine crimson colour. One cause why so many persons have failed in the same attempt[1], I suspect is that they have used too large a proportion of gold; for it is a fact, that an additional quantity of gold, beyond a certain point, far from deepening the colour, actually destroys it altogether. Another cause probably is, that they have not employed a sufficient degree of heat in the fusion. I have found that a degree of heat, which I judged sufficient to melt cast-iron, is not strong enough to injure the colour. It would appear, that in order to receive the colour, it is necessary that the glass should contain a proportion either of lead, or of some other metallic glass. I have found bismuth, zinc, and antimony to answer the purpose, but have in vain attempted to impart any tinge of this colour to crown-glass alone.

Glass containing gold exhibits the same singular change of

it is easy to obtain streaks and patches of a fine transparent red. For this purpose it is sufficient to fuse together 100 parts of crown-glass with one of oxide of copper, putting a lump of tin into the bottom of the crucible. Metallic iron employed in the same way as the tin throws out a bright scarlet, but perfectly opake.

[1] "Dr. Lewis states that he once produced a potfull of glass of beautiful colour, yet was never able to succeed a second time, though he took infinite pains, and tried a multitude of experiments with that view." Commerce of Arts, p. 177.

colour on being exposed to a gentle heat, as has been already noticed with respect to glass containing copper[1]. The former when taken from the crucible is generally of a pale rose-colour, but sometimes colourless as water, and does not assume its ruby colour till it has been exposed to a low red-heat, either under a muffle or in the lamp. Great care must be taken in this operation, for a slight excess of fire destroys the colour, leaving the glass of a dingy brown, but with a blue transparency like that of gold-leaf. These changes of colour have been vaguely attributed to change of oxygenation in the gold; but it is obviously impossible that mere exposure to a gentle heat can effect any chemical change in the interior of a solid mass of glass, which has already undergone a heat far more intense. In fact I have found that metallic gold gives the red colour as well as the oxide, and it appears scarcely to admit of a doubt, that in a metal so easily reduced, the whole of the oxygen must be expelled long before the glass has reached its melting-point. It has long been known that silver yields its colour to glass while in the metallic state, and everything leads one to suppose that the case is the same as to gold.

There is still one other substance by means of which I find it is possible to give a red colour to glass, and that is a compound of tin, chromic acid, and lime; but my trials do not lead me to suppose that glass thus coloured will ever be brought into use.

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With respect to the production of artificial gems, they are now made abundantly of almost every shade of colour, closely approximating to those which occur in nature, excepting in hardness and refractive power. They are formed by fusing what is called a base with various metallic oxides. The base varies in composition: thus, M. Fontanieu makes his by fusing silica with carbonate of potash, carbonate of lead and borax. M. Donault Wieland's consists of silica, potash, borax, oxide of

[1] [At the recent meeting of the British Association for the Advancement of Science, held at Cambridge (June 1845), M. Splittgerber exhibited specimens of glass into the composition of which gold entered as a chloride. These specimens were white, but upon gently heating them in the flame of a spirit-lamp, they became a deep-red. If again the same reddened glass is exposed to the heat of an oxygen blowpipe, it loses nearly all its colours, a slight pinkiness only remaining.]

lead, and sometimes arsenious acid. Hence the base differs but little in composition from glass. By fusing the base with metallic oxides, the former acquires various tints. Thus with oxide of antimony the oriental topaz is prepared; with oxide of manganese and a little purple of cassius, the amethyst; with antimony and a very small quantity of cobalt, the beryl; with horn silver (chloride of silver), the diamond and opal: the oriental ruby is prepared from the base, the purple of cassius, peroxide of iron, golden sulphuret of antimony, manganese calcined with nitre and rock crystal.]

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## SEALING-WAX.

WRITERS on diplomatics mention, besides metals, five other substances on which impressions were made, or with which letters and public acts were sealed, viz. *terra sigillaris*, cement, paste, common wax, and sealing-wax[1]. The *terra sigillaris* was used by the Egyptians, and appears to have been the first substance employed for sealing[2]. The Egyptian priests bound to the horns of the cattle fit for sacrifice a piece of paper; stuck upon it some sealing-earth, on which they made an impression with their seal; and such cattle only could be offered up as victims[3]

Lucian speaks of a fortune-teller who ordered those who came to consult him to write down on a bit of paper the questions they wished to ask, to fold it up, and to seal it with clay, or any other substance of the like kind[4]. Such earth seems to have been employed in sealing by the Byzantine emperors: for we are told that at the second council of Nice, a certain person defended the worship of images by saying, no one believed that those who received written orders from the emperor

[1] Gattereri Elem. Artis Diplom. 1765, 4to, p. 285.

[2] It is singular that Pliny denies that the Egyptians used seals, lib. xxiii. c. 1. Herodotus however, and others, prove the contrary; and Moses speaks of the seal-rings of the Egyptians. See Goguet.

[3] Herodot. lib. ii. c. 38.

[4] Lucian. in Pseudomant.

and venerated the seal, worshiped on that account the sealing-earth, the paper, or the lead [1].

Cicero relates that Verres having seen in the hands of one of his servants a letter written to him from Agrigentum, and having observed on it an impression in sealing-earth (*cretula*), he was so pleased with it that he caused the seal-ring with which it was made to be taken from the possessor [2]. The same orator, in his defence of Flaccus, produced an attestation sent from Asia, and proved its authenticity by its being sealed with Asiatic sealing-earth; with which, said he to the auditors, as you daily see, all public and private letters in Asia are sealed: and he showed on the other hand that the testimony brought by the accuser was false, because it was sealed with wax, and for that reason could not have come from Asia [3]. The scholiast Servius relates, that a sibyl received a promise from Apollo, that she should live as long as she did not see the earth of the island Erythræa where she resided; that she therefore quitted the place, and retired to Cumæ, where she became old and decrepid; but that having received a letter sealed with Erythræan earth (*creta*), when she saw the seal she instantly expired [4].

No one however will suppose that this earth was the same as that to which we at present give the name of *creta*, chalk; for if it was a natural earth it must have been of that kind called potters' clay, as that clay is capable of receiving an impression and of retaining it after it is hardened by drying. That the Romans, under the indefinite name of *creta*, often

[1] Act. iv. ap. Bin. tom. iii. Concil. part. i. p. 356. Whether the γῆ σημαντρὶς, however, of Herodotus and the πηλὸς of Lucian and of the Byzantine be the same kind of earth, can be determined with as little certainty as whether the *creta*, called by some Roman authors a sealing-earth, be different from both.

[2] Orat. in Verrem, iv. c. 9. In the passage referred to, some instead of *cretula* read *cerula*. I shall here take occasion to remark also, that in the Acts of the Council of Nice before-mentioned, instead of πηλὸν some read κηρόν: but I do not see a sufficient reason for this alteration, as in the before-quoted passage of Lucian it is expressly said, that people sealed κηρῷ ἢ πηλῷ. Reiske himself, who proposes that amendment, says that πηλὸν may be retained. Stephanus, however, does not give that meaning to this word in his Lexicon. Pollux and Hesychius tell us, that the Athenians called sealing-earth also ῥύπον.

[3] Orat. pro Flacco, c. 16. [4] Serv. ad lib. vi. Æneid. p. 1037.

understood a kind of potters' earth, can be proved by many passages of their writers. Columella speaks of a kind of chalk of which wine-jars and dishes were made[1]. Virgil calls it tough[2]; and the ancient writers on agriculture give the same name to marl which was employed to manure land[3]. Notwithstanding all these authorities, I do not clearly comprehend how letters could be sealed with potters' clay, as it does not adhere with sufficient force either to linen, of which in ancient times the covers of letters were made, or to parchment; as it must be laid on very thick to have a distinct impression; as it is long in drying, and is again easily softened by moisture; and, at any rate, if conveyed by post at present, it would be crumbled into dust in going only from Hamburg to Altona. I can readily believe that the Roman messengers employed more skill and attention to preserve the letters committed to their care than are employed by our postmen; but the distance from Asia to Rome is much greater than that from Hamburg to Altona.

But may there not be as little foundation for the ancient expression *creta Asiatica*, Asiatic earth, as for the modern expression, *cera Hispanica*, Spanish wax? May not the former have signified a kind of coarse artificial cement? These questions might be answered by those who have had an opportunity of examining or only seeing the *sigilla cretacea* in collections of antiquities. We are assured that such are still preserved; at least we find in Ficoroni[4] the representation of six impressions which, as he tells us, consisted of that earth. In that author however I find nothing to clear up my doubts; he says only that some of these seals were white; others of a gray colour, like ashes; others red, and others brown. They seem all to have been enclosed in leaden cases. Could it be proved that each letter was wrapped round with a thread, and that the thread, as in the seals affixed to diplomas, was drawn through the covering of the seal, the difficulty which I think occurs in the use of these earths, as mentioned by the ancients,

[1] Lib. xii. c. 43. [2] Georg. i. v. 179.

[3] Creta fossica, qua stercorantur agri.—Varro, i. 7. 8. It appears also that the πηλὸς of the Greeks signified a kind of potters' earth. Those who do not choose to rely upon our dictionaries, need only to read the ancient Greek writers on husbandry, who speak of ἀρόσαγεῖ πηλῷ ἀργιλλώδει. See Geopon. x. c. 75. 12, and ix. c. 10. 4.

[4] I piombi antichi. Roma 1740, 4to, p. 16.

would entirely disappear [1]. It seems to me remarkable that neither Theophrastus nor Pliny says anything of the Asiatic *creta*, or speaks at all of sealing-earth; though they have carefully enumerated all those kinds of earth which were worth notice on account of any use.

In Europe, as far as I know, wax has been everywhere used for sealing since the earliest ages. Writers on diplomatics, however, are not agreed whether yellow or white wax was first employed; but it appears that the former, on account of its low price, must have been first and principally used, at least by private persons. It is probable also, that the seals of diplomas were more durable when they consisted of yellow wax; for it is certain that white wax is rendered more brittle and much less durable by the process of bleaching. Many seals also may at present be considered white which were at first yellow; for not only does wax highly bleached resume in time a dirty yellow colour, but yellow wax also in the course of years loses so much of its colour as to become almost like white wax. This perhaps may account for the oldest seals appearing to be of white, and the more modern of yellow wax. These however are conjectures which I submit with deference to the determination of those versed in diplomatics.

In the course of time wax was coloured red; and a good deal later, at least in Germany, but not before the fourteenth century, it was coloured green, and sometimes black. I find it remarked that blue wax never appears on diplomas; and I may indeed say it is impossible it should appear, for the art of giving a blue colour to wax has never yet been discovered; and in old books, such as that of Wecker, we find no receipt for that purpose. Later authors have pretended to give directions how to communicate that colour to wax, but they are altogether false; for vegetable dyes when united with wax become greenish, so that the wax almost resembles the hipstone; and earthy colours do not combine with it, but in melting fall again to the bottom. A seal of blue wax, not coloured blue merely on the outer surface, would be as great a rarity in the arts as in diplomatics, and would afford matter

[1] Heineccius and others think that the *amphoræ vitreæ diligenter gypsatæ*, in Petronius, were sealed; but it is much more probable that they were only daubed over or closed with gypsum, for the same reason that we pitch our casks.

of speculation for our chemists; but I can give them no hopes that such a thing can ever be produced[1]. The emperor Charles V. in the year 1524 granted to Dr. Stockamar of Nuremberg, the privilege of using blue wax in seals;—a favour like that conferred in 1704 on the manufactories in the principality of Halberstadt and the county of Reinstein, to make indigo from minerals. It was certainly as difficult for the doctor to find blue wax for seals as for the proprietors of these manufactories to discover indigo in the earth[2].

Much later are impressions made on paste or dough, which perhaps could not be employed on the ancient parchment or the linen covers of letters, though in Pliny's time the paper then in use was joined together with flour paste[3]. Proper diplomas were never sealed with wafers; and in the matchless diplomatic collection of H. Gatterer there are no wafer-seals much above two hundred years old. From that collection I have now in my possession one of these seals, around the impression of which is the following inscription, *Secretum civium in Ulma*, 1474; but it is only a new copy of a very old impression. Kings, however, before the invention of sealing-wax, were accustomed to seal their letters with this paste[4].

Heineccius and others relate that *maltha* also was employed for seals. This word signifies a kind of cement, formed chiefly of inflammable substances, and used to make reservoirs, pipes, &c. water-tight. Directions how to prepare it may be found in the writers on agriculture, Pliny, Festus and others. The latter tells how to make it of a composition of pitch and wax[5]: but neither in that author nor in any other have I found proofs that letters were sealed with it, or that seals of it were affixed to diplomas: for the words of Pollux, "cera qua tabella judicum obliniebatur[6]," will admit of a different explanation. If maltha has been in reality used for seals, that mixture may be considered as the first or oldest sealing-wax, as what of it is still preserved has been composed of resinous substances.

[1] [Blue wax may now be seen in every wax-chandler's shop; it is coloured blue by means of indigo.]

[2] Heineccii Syntagma de Vet. Sigillis, 1719, p. 55.

[3] Plin. lib. xxii. c. 25.

[4] Trotz, Not. in Prim. Scribendi Origine, p. 73, 74.

[5] P. Festi de Verb. Sig. lib. xx. Hesychius calls this cement *μεμαλάγμενον κηρόν*.—Plin. lib. xxxvi. c. 24.

[6] Lib. viii. c. 4.

Some writers assert[1], upon the authority of Lebeuf[2], that sealing-wax was invented about the year 1640 by a Frenchman named Rousseau; but that author refers his readers to Papillon[3], who refers again to Pomet[4], so that the last appears to be the first person who broached that opinion. According to his account, Francis Rousseau, born not far from Auxerre, and who travelled a long time in Persia, Pegu and other parts of the East Indies, and in 1692 resided in St. Domingo, was the inventor of sealing-wax. Having, while he lived at Paris as a merchant, during the latter years of the reign of Louis XIII., who died in 1643, lost all his property by a fire, he bethought himself of preparing sealing-wax from shell-lac, as he had seen it prepared in India, in order to maintain his wife and five children. A lady of the name of Longueville made this wax known at court, and caused Louis XIII. to use it, after which it was purchased and used throughout all Paris. By this article, Rousseau, before the expiration of a year, gained 50,000 livres. It acquired the name of *cire d'Espagne*, Spanish wax, because at that time a kind of lac, which was only once melted and coloured a little red, was called Portugal wax, *cire de Portugal*[5].

That sealing-wax was either very little or not at all known in Germany in the beginning of the sixteenth century, may be concluded from its not being mentioned either by Porta or Wecker; though in the works of both these authors there are various receipts respecting common wax, and little-known methods of writing and sealing[6]. The former says, that to open letters in such a manner as not to be perceived, the wax

[1] Nouveau Traité de Diplomatique. Paris, 1759, 4to, iv. p. 33.
[2] Mémoires conc. l'Histoire d'Auxerre. Par. 1743, ii. p. 517.
[3] Bibliothèque des Auteurs de Bourgogne, 2 vols. fol. ii. p. 217.
[4] Histoire Générale des Drogues. Paris, 1735.
[5] This Rousseau appears also in the History of Cochineal, as he sent to Pomet a paper on that subject, which was contradicted by the well-known Plumier in the Journal des Scavans for 1694. He is mentioned also by Labat, who says he saw him at Rochelle; but at that time he must have been nearly a hundred years of age.
[6] Von Murr, in his learned Beschreibung der Merkwürdigkeiten in Nürnberg, Nurnb. 1778, 8vo, p. 702, says that Spanish wax was not invented, or at least not known, before the year 1559. This appears also from a manuscript of the same year, which contains various receipts in the arts and medicine. There are some in it for making the common white sealing-wax green or red.

seal must be heated a little, and must be then carefully separated from the letter by a horse's hair; and when the letter has been read and folded up, the seal must be again dexterously fastened to it. This manœuvre, as the writers on diplomatics remark, has been often made use of to forge public acts; and they have therefore given directions how to discover such frauds[1]. The above method of opening letters, however, can be applied only to common wax, and not to sealing-wax: had the latter been used in Wecker's time he would have mentioned this limitation[2].

Whether sealing-wax was used earlier in the East Indies than in Europe, as the French think, I cannot with certainty determine. Tavernier[3], however, seems to say that the lac produced in the kingdom of Assam is employed there not only for lackering, but also for making Spanish sealing-wax. I must confess also that I do not know whether the Turks and other eastern nations use it in general. In the collection of natural curiosities belonging to our university there are two sticks of sealing-wax which Professor Butner procured from Constantinople, under the name of Turkish wax. They are angular, bent like a bow, are neither stamped nor glazed, and are of a dark but pure red colour. Two other sticks which came from the East Indies are straight, glazed, made somewhat thin at both ends, have no stamp, and are of a darker and dirtier red colour. All these four sticks seem to be lighter than ours, and I perceive that by rubbing they do not acquire so soon nor so strong an electrical quality as our German wax of moderate fineness. But whether the first were made in Turkey and the latter in the East Indies, or whether the whole four were made in Europe, is not known. That sealing-wax however was made and used in Germany a hundred years before Rousseau's time, and that the merit of that Frenchman consisted probably only in this, that he first made it in

[1] See Chronicon Godvicense, p. 102.

[2] Wecker gives directions also to make an impression with calcined gypsum, and a solution of gum or isinglass. Porta knew that this could be done to greater perfection with amalgam of quicksilver; an art employed even at present.

[3] Tavernier, in his Travels, says that in Surat lac is melted and formed into sticks like sealing-wax. Compare with this Dapper's Asia, Nuremberg, 1681, fol. p. 237.

France, or made the first good wax, will appear in the course of what follows.

The oldest known seal of our common sealing-wax is that found by M. Roos, on a letter written from London, Aug. 3rd, 1554, to the rheingrave Philip Francis von Daun, by his agent in England, Gerrard Hermann[1]. The colour of the wax is a dark-red; it is very shining, and the impression bears the initials of the writer's name G.H. The next seal, in the order of time, is one of the year 1561, on a letter written to the council of Gorlitz at Breslau. This letter was found among the ancient records of Gorlitz by Dr. Anton, and is three times sealed with beautiful red wax[2]. Among the archives of the before-mentioned family M. Roos found two other letters of the year 1566, both addressed to the rheingrave Frederick von Daun, from Orchamp in Picardy, by his steward Charles de Pousol; the one dated September the 2nd, and the other September the 7th. Another letter, written by the same person to the same rheingrave, but dated Paris January 22nd, 1567, is likewise sealed with red wax, which is of a higher colour, and appears to be of a coarser quality. As the oldest seals of this kind came from France and England, M. Roos conjectures that the invention, as the name seems to indicate, belongs to the Spaniards. This conjecture appears to me however improbable, especially as sealing-wax was used at Breslau so early as 1561; but this matter can be best determined perhaps by the Spanish literati. It is much to be lamented that John Fenn, in his Original letters of the last half of the fifteenth century[3], when he gives an account of the size and shape of the seals, does not inform us of what substances they are composed. Respecting a letter of the year 1455, he says only, "The seal is of red wax;" by which is to be understood, undoubtedly, common wax.

Among the records of the landgraviate of Cassel, M. Ledderhose found two letters of Count Louis of Nassau to the land-

[1] Bruchstücke betreffend die Pflichten eines Staatsdieners; aus den Handlungen des Raths Dreitz, nebst Bemerkungen vom ältesten Gebrauche des Spanischen Siegelwachses, Frankf. 1785, 4to, p. 86; where the use of these antiquarian researches is illustrated by examples worthy of notice.

[2] Historische Untersuchungen gesammelt von J. G. Meusel, i. 3, p. 240.

[3] Original Letters of the Paston Family, temp. Henry VI. i.p. 21, and p. 87 and 92.

grave William IV., one of which, dated March the 3rd, 1563, is sealed with red wax, and the other, dated November 7th, the same year, is sealed with black wax[1]. M. Neuberger, private keeper of the archives at Weimar, found among the records of that duchy a letter sealed with red wax, and written at Paris, May the 15th, 1571, by a French nobleman named Vulcob, who the year before had been ambassador from the king of France to the court of Weimar. It is worthy of remark, that the same person had sealed nine letters of a prior date with common wax, and that the tenth is sealed with Spanish wax. P. L. Spiess, principal keeper of the records at Plessenburg, who gave rise to this research by his queries, saw a letter of the year 1574 sealed with red sealing-wax, and another of the year 1620 sealed with black sealing-wax. He found also in an old expense-book of 1616, that Spanish wax, expressly, and other materials for writing were ordered from a manufacturer of sealing-wax at Nuremberg, for the personal use of Christian margrave of Brandenburg[2].

The oldest mention of sealing-wax which I have hitherto observed in printed books is in the work of Garcia ab Orto[3], where the author remarks, speaking of lac, that those sticks used for sealing letters were made of it. This book was first printed in 1563, about which time it appears that the use of sealing-wax was very common among the Portuguese.

The oldest printed receipt for making sealing-wax was found by Von Murr, in a work by Samuel Zimmerman, citizen of Augsburg, printed in 1579[4]. The copy which I have from the library of our university is signed at the end by the author himself. His receipts for making red and green sealing-wax I shall here transcribe.

"To make hard sealing-wax, called Spanish wax, with which if letters be sealed they cannot be opened without breaking the seal:—Take beautiful clear resin, the whitest you can procure, and melt it over a slow coal fire. When it is properly melted, take it from the fire, and for every pound of resin add two ounces of vermilion pounded very fine, stirring it about.

[1] Meusel's Geschichtforscher. Halle, 8vo, vi. p. 270. [2] Ibid. iv. p. 251.

[3] Aromatum et Simplicium aliquot Historia, Garcia ab Horto auctore. Antverpiæ 1574, 8vo, p. 33.

[4] Neu Titularbuch,—sambt etlichen hinzugethanen Gehaimnüssen und Künsten, das Lesen und die Schreiberey betreffendt. 4to, 1579, p. 112

Then let the whole cool, or pour it into cold water. Thus you will have beautiful red sealing-wax.

"If you are desirous of having black wax, add lamp-black to it. With smalt or azure you may make it blue; with white-lead white, and with orpiment yellow.

"If instead of resin you melt purified turpentine in a glass vessel, and give it any colour you choose, you will have a harder kind of sealing-wax, and not so brittle as the former."

What appears to me worthy of remark in these receipts for sealing-wax is, that there is no mention in them of shell-lac, which at present is the principal ingredient, at least in that of the best quality; and that Zimmerman's sealing-wax approaches very near to that which in diplomatics is called *maltha*. One may also conclude therefore that this invention was not brought from the East Indies.

The expression Spanish wax is of little more import than the words Spanish-green, Spanish-flies, Spanish-grass, Spanish-reed, and several others, as it was formerly customary to give to all new things, particularly those which excited wonder, the appellation of Spanish; and in the like manner many foreign or new articles have been called Turkish; such as Turkish wheat, Turkish paper, &c.

Respecting the antiquity of wafers, M. Spiess has made an observation[1] which may lead to further researches, that the oldest seal with a red wafer he has ever yet found, is on a letter written by D. Krapf at Spires in the year 1624, to the government at Bayreuth. M. Spiess has found also that some years after, Forstenhäusser, the Brandenburg factor at Nuremberg, sent such wafers to a bailiff at Osternohe. It appears however that wafers were not used during the whole of the seventeenth century in the chancery of Brandenburg, but only by private persons, and by these even seldom; because, as Spiess says, people were fonder of Spanish wax. The first wafers with which the chancery of Bayreuth began to make seals were, according to an expense account of the year 1705, sent from Nuremberg. The use of wax however was still continued; and among the Plassenburg archives there is a rescript of 1722, sealed with proper wax. The use of wax must have been continued longer in the duchy of Weimar; for in the Electa Juris Publici there is an order of the year 1716, by

[1] Archivische Nebenarbeiten und Nachrichten. Halle, 1785, 4to, ii. p. 3.

which the introduction of wafers in law matters is forbidden and the use of wax commanded. This order however was abolished by duke Ernest Augustus in 1742, and wafers again introduced.

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## CORN-MILLS.

If under this name we comprehend all those machines, however rude, employed for pounding or grinding corn, these are of the highest antiquity. We read in the Scriptures, that Abraham caused cakes to be baked for his guests of the finest meal; and that the manna was ground like corn. The earliest instrument used for this purpose seems to have been the mortar; which was retained a long time even after the invention of mills properly so called, because these perhaps at first were not attended with much superior advantage[1]. It appears that in the course of time the mortar was made rigid and the pestle notched, at least at the bottom; by which means the grain was rather grated than pounded. A passage of Pliny[2], not yet sufficiently cleared up, makes this conjecture probable. When a handle was added to the top of the pestle, that it might be more easily driven round in a circle, the mortar was converted into a hand-mill. Such a mill was called *mola trusatilis, versatilis, manuaria*[3], and was very little different from those used at present by apothecaries, painters, potters and other artists, for grinding coarse bodies, such as colours, glass, chalk, &c. We have reason to suppose that in every family there

[1] Hesiod, Opera et Dies, 421.—It appears that both the mortar and pestle were then made of wood, and that the former was three feet in height; but, to speak the truth, Hesiod does not expressly say that this mortar was for the purpose of pounding corn. The mortar was called ὕπερος, pila; the pestle ὕπερος, or ὕπερον, pistillus or pistillum; to pound, μάσσειν, pinsere, which word, as well as *pinsor*, was afterwards retained when mills came to be used.—Plin. lib. xviii. c. 3.

[2] Plin. xviii. 10. ii. p. 111. This passage Gesner has endeavoured to explain, in his Index to the Scriptores Rei Rusticæ, p. 59, to which he gives the too-dignified title of Lexicon Rusticum.

[3] Gellius, iii. c. 3.

was a mill of this kind. Moses forbade them to be taken in pawn; for that, says he, is the same thing as to take a man's life to pledge. Michaelis, on this passage, observes that a man could not then grind, and consequently could not bake bread for the daily use of his family [1]. Grinding was at first the employment of the women, and particularly of the female slaves, as it is at present among uncivilised nations, and must therefore have required little strength [2]; but afterwards the mills were driven by bondsmen, around whose necks was placed a circular machine of wood, so that these poor wretches could not put their hands to their mouths, or eat of the meal.

In the course of time shafts were added to the mill that it might be driven by cattle, which were, as at present, blindfolded [3]. The first cattle-mills, *molæ jumentariæ*, had perhaps only a heavy pestle like the hand-mills [4]; but it must have been soon remarked that the labour would be more speedily accomplished if, instead of the pestle, a large heavy cylindrical stone should be employed. I am of opinion, however, that the first cattle-mills had not a spout or a trough as ours have at present; at least the hand-mills which Tournefort [5] saw at Nicaria, and which consisted of two stones, had neither; but the meal which issued from between the stones, through an opening made in the upper one, fell upon a board or table, on which the lower stone, that was two feet in diameter, rested.

The upper mill-stone was called *meta*, or *turbo*; and the lower one *catillus*. *Meta* signified also a cone with a blunt apex [6]; and it has on that account been conjectured that corn

[1] Deuteronomy, ch. xxiv. v. 6.

[2] When Moses threatened Pharaoh with the destruction of the first-born in the land of Egypt, he said, "All the first-born shall die, from the first-born of Pharaoh that sitteth on the throne, even unto the first-born of the maid-servant that is behind the mill."—Genesis, ch. xi. v. 5. See Homeri Odyss. vii. 103, and xx. 105. [3] Apulcii Metamorph. lib. ix.

[4] The oldest cattle-mills have, in my opinion, resembled the oil-mills represented in plate 25th of Sonnerat, Voyages aux Indes, &c., i. Zurich, 1783, 4to. To the pestle of a mortar made fast to a stake driven into the earth, is affixed a shaft to which two oxen are yoked. The oxen are driven by a man, and another stands at the mortar to push the seed under the pestle. Sonnerat says, that with an Indian hand-mill two men can grind no more than sixty pounds of meal in a day; while one of our mills, under the direction of one man, can grind more than a thousand.

[5] Voyage du Lévant, 4to, p. 155.

[6] A haycock was called *meta fœni*. Colum. ii. 19. Plin. xxvii. 28.

was at first rubbed into meal by rolling over it a conical stone flatted at the end, in the same manner as painters at present make use of a grinding-stone; and it is believed that the same name was afterwards given to the upper mill-stone. This conjecture is not improbable, as some rude nations still bruise their corn by grinding-stones. I do not, however, remember any passage in the ancients that mentions this mode of grinding; and I am of opinion, that the pestle of the hand-mill, for which the upper mill-stone was substituted, may, on account of its figure, have been also called *meta*. Niebuhr[1] found in Arabia, besides hand-mills, some grinding-stones, which differed from those used by us in their consisting not of a flat, but of an oblong hollow stone, or trough, with a pestle, which was not conical, but shaped like a spindle, thick in the middle and pointed at both ends. In this stone the corn, after being soaked in water, was ground to meal and then baked into cakes.

Respecting the figure and construction of the ancient hand-mills, I expected to find some information from engraved stones, and other remains of antiquity; but my researches would have proved fruitless, had not Professor Diez, to whose memory and erudition I am much indebted, pointed out to me the only figure of one remaining. I say the only one remaining with the more confidence, as Heyne tells us also that he remembers no other. Anthony Francis Gori[2] has described a red jasper, on which is engraved the naked figure of a man, who in his left-hand holds a sheaf of corn, and in his right a machine that in all probability is a hand-mill. Gori considers the figure as a representation of the god Eunostus, who, as Suidas says, was the god of mills. The machine, which Eunostus seems to exhibit, or to be surveying himself, is, as far as one can distinguish (for the stone is scarcely half an inch in size), shaped like a chest, narrow at the top, and wide at the bottom. It stands upon a table, and in the bottom there is a perpendicular pipe from which the meal, represented also by the artist, appears to be issuing. Above, the chest or body of the mill has either a top with an aperture, or perhaps a basket sunk

[1] Niebuhr's Déscription de l'Arabie. A figure of both stones is represented in the first plate, fig. H.

[2] Memorie di varia erudizione della Societa Colombaria Fiorentina. Livorno, 1752, 4to, vol. ii. p. 207.

into it, from which the corn falls into the mill. On one side, nearly about the middle of it, there projects a broken shank, which, without overstraining the imagination, may be considered as a handle, or that part of the mill which some called *molile*. Though this figure is small, and though it conveys very little idea of the internal construction, one may, however, conclude from it, that the roller, whether it was of wood or of iron, smooth or notched, did not stand perpendicularly, like those of our coffee-mills, but lay horizontally; which gives us reason to conjecture a construction more ingenious than that of the first invention. The axis of the handle had, perhaps, within the body of the mill, a crown-wheel, that turned a spindle, to the lower end of the perpendicular axis of which the roller was fixed. Should this be admitted, it must be allowed also, that the hand-mills of the ancients had not so much a resemblance to the before-mentioned colour-mills as to the philosophical mills of our chemists; and Langelott consequently will not be the real inventor of the latter. On the other side, opposite to that where the handle is, there arise from the mill of Eunostus two shafts, which Gori considers as those of a besom and a shovel, two instruments used in grinding; but as the interior part cannot be seen, it appears to me doubtful whether these may not be parts of the mill itself.

The remains of a pair of old Roman mill-stones were found in the beginning of the last century at Adel in Yorkshire, a description of which was given by Thornsby[1], in the Philosophical Transactions. One of the stones was twenty inches in breadth; thicker in the middle than at the edges, and consequently convex on one side. The other was of the same form, but had that thickness at the edges which the other had in the middle, and some traces of notching could be observed upon it.

I shall not here collect all those passages of the ancients which speak of hand- and cattle-mills, because they have been already collected by others, and afford very little information[2].

[1] No. 282, p. 1285, and in the abridgement by Jones, 1700—20, vol. ii. p. 38.

[2] Joh. Heringii Tractatus de Molendinis eorumque jure. Franc. 1663, 4to. A very confused book, which requires a very patient reader. F. L. Gœtzius De Pistrinis Veterum. Cygneæ 1730, 8vo. Extracted chiefly from the

Neither shall I inquire to what Ceres the Grecians ascribed the invention of mills[1]; who Milantes was, to whom that honour has been given by Stephanus Byzantinus[2]; or how those mills were constructed which were first built by Myletes the son of Lelex, king of Laconia[3]. Such researches would be attended with little advantage. I shall proceed therefore to the invention of water-mills.

These appear to have been introduced in the time of Mithridates, Julius Cæsar, and Cicero. Because Strabo[4] relates that there was a water-mill near the residence of Mithridates, some have ascribed the honour of the invention to him; but nothing more can with certainty be concluded from this circumstance, than that water-mills were at that period known, at least in Asia. We are told by Pomponius Sabinus, in his remarks upon a poem of Virgil called Moretus, that the first mill seen at Rome was erected on the Tiber, a little before the time of Augustus; but of this he produces no proof. As he has taken the greater part of his remarks from the illustrations of Servius, and must have had a much completer copy of that author than any that has been printed, he may have derived this information from the same source[5]. The most certain proof that Rome had water-mills in the time of Augustus is

former, equally confused, and filled with quotations from authors who afford very little insight into the history or knowledge of mills. Traité de la Police, par De la Mare.—G. H. Ayrer, De Molarum Initiis; et Prolusio de Molarum Progressibus, Gottin. 1772.—C. L. Hoheiselii Diss. de Molis Manualibus Veterum. Gedani 1728.—Pancirollus, edit. Salmuth. ii. p. 294.—Histoire de la vie privée des Francois, par Le Grand d'Aussy. Paris, 1782, i. p. 33.—See Fabricii Bibliographia Antiq. Hamburgi, 1760, p. 1002.

[1] Plin. lib. vii. c. 56. [2] Stephan. De Urbibus, v. *μυλαντία*.

[3] Pausanias, iii. c. 20. edit. Kuhnii, p. 260.

[4] Strabo, lib. xii. edit. Almelov. p. 834. In the Greek stands the words *ὑδραλέτης*, perhaps an *ἅπαξ λεγόμενον*, which the scholiasts have explained by a water-mill. In many of the later translations of Strabo that word is wanting.

[5] This Pomponius Sabinus, author of a Commentary on the works of Virgil, is called also Julius Pomponius Lætus, though in a letter he denies that he is the author. He died in 1496. A good account of him may be found in Fabricii Biblioth. Med. et Infimæ Latinitatis, iv. p. 594. There are several editions of his Commentary, the first printed at Basil, 1544. The one I have before me is contained in Vergilii Opera, cum Variorum Commentariis, studio L. Lucii. Basiliæ (1613), fol. Where the poet gives an ingenious description of a hand-mill, Pomponius adds, "Usus molarum ad manum in Cappadocia inventus; inde inventus usus earum ad ventum

the description which has been given of them by Vitruvius (lib. x. 10). We learn from this passage, that the ancients had wheels for raising water, which were driven by being trod upon by men. That condemnation to these machines was a punishment, appears from Artemidorus, lib. i. c. 50, and Sueton. Vita Tiber. cap. 51. And the pretty epigram of Antipater; "Cease your work, ye maids, ye who laboured in the mill; sleep now, and let the birds sing to the ruddy morning; for Ceres has commanded the water-nymphs to perform your task: these, obedient to her call, throw themselves on the wheel, force round the axle-tree, and by these means the heavy mill." This Antipater[1], as Salmasius with great probability asserts, lived in the time of Cicero. Palladius[2] also speaks with equal clearness of water-mills, which he advises to be built on possessions that have running water, in order to grind corn without men or cattle.

There are also other passages of the ancients which are commonly supposed, but without certain grounds, to allude to water-mills. Among these is the following verse of Lucretius[3]:

Ut fluvios versare rotas atque haustra videmus.

It appears also that the water-wheels to which Heliogabalus caused some of his friends and parasites to be bound[4], cannot be considered as mills. These, as well as the *haustra* of Lucretius, were machines for raising water, like those mentioned in the before-quoted passage of Vitruvius[5]. It is however

et ad equos. Paulo ante Augustum molæ aquis actæ Romæ in Tiberi primum factæ, tempore Græcorum, cum fornices diruissent."

[1] This Greek epigram was first made known by Salmasius, in his Annotations on the Life of Heliogabalus by Lampridius. See Historiæ Augustæ Scriptores; ed. C. Salmasius, Par. 1620, fol. p. 193. It is to be found also in Mémoires de l'Académie des Inscriptions, ii. p. 315, and in Analecta Veterum Græcorum, edit. Brunk. ii. p. 119, epig. 39.

[2] Pallad. in Script. De Re Rustica, lib. i. 42, edit. Gesn.

[3] Lucret. v. 517. Compare Salmas. ad Solin. p. 416.

[4] Hist. Aug. Scr. Lamprid. in Vita Heliogabali.

[5] Among the doubtful passages is one of Pliny, lib. xviii. c. 10. "Major pars Italiæ ruido utitur pilo; rotis etiam, quas aqua verset obiter, et molat." So reads Hardouin: but the French translator of Pliny divides these words otherwise, and reads thus: "Major pars Italiæ ruido utitur pilo, rotis etiam quas aqua verset; obiter et molit;" which he translates as follows; "Dans la majeure partie de l'Italie, on se sert d'un pilon raboteux, ou de roues que l'eau fait tourner; et par fois aussi on y emploie la meule." This explana-

evident that there were water-mills at Rome at this period; and it affords matter of surprise that we do not find mention oftener made of them, and that they did not entirely banish the use of the laborious hand- and cattle-mills. That this was not the case, and that the latter were very numerous for some time after, may be concluded from various circumstances. When Caligula, about twenty-three years after the death of Augustus, took away all the horses and cattle from the mills, in order to transport effects of every kind which he had seized, there arose a scarcity of bread at Rome; from which Beroaldus justly infers that water-mills must have been then very rare[1]. Nay, more than three hundred years after Augustus, cattle-mills were so common at Rome, that their number amounted to three hundred[2]. Mention of them, and of the hand-mills always occurs, therefore, for a long time after in the laws. The Jurist Paulus, who lived about the year 240, particularizing the bequest of a baker, mentions *asina molendaria* and *mola*, a mill-ass and a mill[3]. In the year 319 Constantine ordered that all the slaves condemned to the mills should be brought from Sardinia to Rome[4]. Such orders respecting mill-slaves occur also under Valentinian[5]. When by the introduction of Christianity, however, the morals of men became improved, slaves were less frequent; and Ausonius, who lived under Theodosius the Great, about the end of the third century, expressly says, that in his time the practice had ceased of condemning criminals to slavery, and of causing mills to be driven by men.

Public water-mills, however, appear for the first time under Honorius and Arcadius; and the oldest laws which mention

tion is in my opinion very proper; Pliny is not speaking here of the labour of grinding corn, but that of freeing it from the husks, or of converting it into grits. For this purpose a mortar was used, the pestle of which could be so managed that the grain remained whole; but water-wheels were sometimes employed also. I agree with Le Prince (Journal des Scavans, 1779, Septem.), who thinks that Pliny here certainly speaks of a water-mill.

[1] Sueton. Vita Calig. cap. 39.

[2] Petr. Victor. De Regionibus urbis Romæ.

[3] Digestorum lib. xxxiii. tit. 7, 18, Cum de lanienis.

[4] Cod. Theodos. lib. ix. tit. 40, 3, or l. 3, Quicunque. C. Th. de pœnis.

[5] Cod. Theodos. lib. xiv. tit. 3, 7, or l. 7. Post quinquennii, C. Th. de pistoribus. We are told in 1778 that there are no other mills in Sardinia than such as are driven by asses. See Fran. Cetti, Quadrupedi di Sardegna. Sessati, 1778, 8vo.

them, about the year 398, show clearly that they were then a new establishment, which it was necessary to secure by the support of government; and the orders for that purpose were renewed and made more severe by Zeno towards the end of the fifth century[1]. It is worthy of remark, that in the whole code of Justinian one does not find the least mention of wooden pales or posts, which occur in all the new laws; and which, when there were several mills situated in a line on the same stream, occasioned so many disputes. The mills at Rome were erected on those canals which conveyed water to the city; and because these were employed in several arts, and for various purposes, it was ordered that by dividing the water the mills should be always kept going. The greater part of them lay under Mount Janiculum[2]; but, as they were driven by so small a quantity of water, they probably executed very little work; and for this reason, but chiefly on account of the great number of slaves, and the cheap rate at which they were maintained, these noble machines were not so much used, nor were so soon brought to perfection as they might have been. It appears, however, that after the abolition of slavery they were much improved and more employed; and to this a particular incident seems in some measure to have contributed.

When Vitiges, king of the Goths, besieged Belisarius in Rome, in the year 536, and caused the fourteen large expensive aqueducts to be stopped, the city was subjected to great distress; not through the want of water in general, because it was secured against that inconvenience by the Tiber; but by the loss of that water which the baths required, and, above all, of that necessary to drive the mills, which were all situated on these canals. Horses and cattle, which might have been employed in grinding, were not to be found: but Belisarius fell upon the ingenious contrivance of placing boats upon the Tiber, on which he erected mills that were driven by the current. This experiment was attended with complete success; and as many mills of this kind as were necessary were constructed. To destroy these, the besiegers threw into the stream logs of wood and dead bodies, which floated down the river

[1] Cod. Theodos. lib. xiv. tit. 15, 4; and Cod. Justin. lib. xi. tit. 42, 10. Many things relating to the same subject may be found in Cassiodorus.

[2] Procopius, Gothicorum lib. i. c. 9. Fabretti Diss. de aquis et aquæductibus vet. Romæ, p. 176. Grævii Thesaur. Antiq. Rom. iv. p. 1677.

into the city; but the besieged, by making use of booms, to stop them, were enabled to drag them out before they could do any mischief[1]. This seems to be the invention of floating-mills, at least I know of no other. It is certain that by these means the use of water-mills became very much extended; for floating-mills can be constructed almost upon any stream, without forming an artificial fall; they can be stationed at the most convenient places, and they rise and fall of themselves with the water. They are however attended with these inconveniences, that they require to be strongly secured; that they often block up the stream too much, and move slowly; and that they frequently stop when the water is too high, or when it is frozen.

After this improvement the use of water-mills was never laid aside or forgotten: they were soon made known all over Europe; and were it worth the trouble, one might quote passages in which they are mentioned in every century. The Roman, Salic, and other laws[2] provided security for these

[1] The account of Procopius, in the first book of the War of the Goths, deserves to be here given at length:—"When these aqueducts were cut off by the enemy, as the mills were stopped for want of water, and as cattle could not be found to drive them, the Romans, closely besieged, were deprived of every kind of food (for with the utmost care they could scarcely find provender for their horses). Belisarius however being a man of great ingenuity devised a remedy for this distress. Below the bridge which reaches to the walls of Janiculum, he extended ropes well-fastened, and stretched across the river from both banks. To these he affixed two boats of equal size, at the distance of two feet from each other, where the current flowed with the greatest velocity under the arch of the bridge, and placing large mill-stones in one of the boats, suspended in the middle space a machine by which they were turned. He constructed at certain intervals on the river, other machines of the like kind, which being put in motion by the force of the water that ran below them, drove as many mills as were necessary to grind provisions for the city," &c.

[2] "Si quis ingenuus annonam in molino furaverit....Si quis sclusam de farinario alieno ruperit....Si quis ferramentum de molino alieno furaverit...."—Leges Francorum Salicæ, edit. Eccardi, Francof. et Lipsiæ 1720, fol. p. 51. *Sclusa* is translated *sluice*, and there is no doubt that the French word *escluse* is derived from it. All these words come from *schliessen* to shut up, or the Low Saxon *schluten*: but by that word in these laws we can hardly understand those expensive works which we at present call sluices, but probably wickets and what else belonged to the dam. Lex Wisigothorum, lib. viii. tit. 4, 30, may serve further to illustrate this subject: "De confringentibus molina et conclusiones aquarum. Si quis molina violenter effre-

mills, which they call *molina* or *farinaria*; and define a punishment for those who destroy the sluices, or steal the mill-irons (*ferramentum*). But there were water-mills in Germany and France a hundred years before the Salic laws were formed. Ausonius, who lived about the year 379, mentions some which were then still remaining on a small stream that falls into the Moselle, and which were noticed also by Fortunatus[1], in the fifth century. Gregory of Tours, who wrote towards the end of the sixth century, speaks of a water-mill which was situated near the town of Dijon; and of another which a certain abbot caused to be built for the benefit of his convent[2]. Brito, who in the beginning of the thirteenth century wrote in verse an account of the actions of Philip Augustus king of France[3], relates how by the piercing of a dam the mills near Gournay (*castrum Gornacum* or *Cornacum*) were destroyed, to the great detriment of the besieged. In the first crusade, at the end of the eleventh century, the Germans burned in Bulgaria seven mills which were situated below a bridge on a small rivulet, and which seem to have been floating-mills[4]. In deeds of the twelfth and thirteenth century, water-mills are often called *aquimollia*, *aquimoli*, *aquismoli*, *aquimolæ*[5]. Petrus Damiani, one of the fathers of the eleventh century, says, "Sicut aquimolum nequaquam potest sine gurgitis inundantia frumenta permolere, ita, &c.[6]"

At Venice and other places, there were mills which righted

gerit, quod fregit intra triginta dies reparare cogatur.—Eadem et de stagnis, quæ sunt circa molina conclusiones aquarum, præcipimus custodire." The *sclusæ* are here called *conclusiones aquarum*, to which belong also the mounds or dykes. See Corpus Juris Germanici Antiqui, ed. Georgisch. Halæ 1738, 4to, p. 2097. Gregory of Tours calls them *exclusas*. But what is *ferramentum*? The iron-work of our mills cannot be so easily stolen as to render it necessary to secure them by particular laws.

[1] Auson. Mosella, v. 362. Fortunati Carmina, Moguntiæ 1617, 4to, p. 83.

[2] Gregorii Turonensis Opera, Paris, 1699, fol. Hist. lib. iii. 19, p. 126. Ibid. Vita Patrum, 18, p. 1242.

[3] Gul. Britonis Philippidos libri xii. lib. vi. v. 220.

[4] Chronicon Hierosolymitanum, edit. a Reineccio. Helms. 1584, 4to, lib. i. c. 10.

[5] See Carpentieri Gloss. Nov. ad Scriptores medii, ævi, (Supp. ad Ducang.) Paris, 1766, fol. vol. i. p. 266. In a chronicle written in the year 1290, a floating-mill is called *molendinum navale*, also *navencum*; and in another chronicle of 1301, *molendinum pendens*.

[6] Damiani Opera, ed. Cajetani. Paris, 1743, fol. i. p. 105, lib. vi. epist. 23.

themselves by the ebbing and flowing of the tide, and which every six hours changed the position of the wheels. Zanetti[1] has shown, from some old charters, that such mills existed about the year 1044; and with still more certainty in 1078, 1079, and 1107. In one charter are the words: *Super toto ipso aquimolo molendini posito in palude juxta campo alto*; where the expression *aquimolum molendini* deserves to be particularly remarked, as it perhaps indicates that the mill in question was a proper grinding-mill. Should this conjecture be well-founded, it would prove that so early as the eleventh century water-mills were used not only for grinding corn, but for many other purposes.

It appears that hand- and cattle-mills were everywhere still retained at private houses a long time after the erection of water-mills. We read in the Life of St. Benedict, that he had a mill with an ass, to grind corn for himself and his colleagues. Among the legendary tales of St. Bertin, there is one of a woman who, because she ground corn on a fast-day, lost the use of her arm; and of another whose hand stuck to the handle, because she undertook the same work at an unseasonable time. More wonders of this kind are to be found at later periods in the Popish mythology. Such small mills remained long in the convents; and it was considered as a great merit in many ecclesiastics, that they ground their own corn in order to make bread. The real cause of this was, that as the convents were entirely independent of every person without their walls, they wished to supply all their wants themselves as far as possible; and as these lazy ecclesiastics had, besides, too little labour and exercise, they employed grinding as an amusement, and to enable them to digest better their ill-deserved food. Sulpicius Severus[2] gives an account of the mode of living of an Eastern monk in the beginning of the fifth century, and says expressly that he ground his own corn. Gregory of Tours mentions an abbot who eased his monks of their labour at the hand-mill, by erecting a water-mill. It deserves here to be remarked, that in the sixth century malefactors in France were condemned to the mill, as is proved by the history of Septimina the nurse of Childebert[3].

[1] Dell' Origine di alcune Arti Principali Appresso i Veneziani. Ven. 1758, 4to, p. 71.

[2] Dialog. i. 2.

[3] Histor. Francorum, lib. ix. 38, p. 462.

The entrusting of that violent element water to support and drive mills constructed with great art, displayed no little share of boldness; but it was still more adventurous to employ the no less violent but much more untractable, and always changeable wind for the same purpose. Though the strength and direction of the wind cannot be any way altered, it has however been found possible to devise means by which a building can be moved in such a manner that it shall be exposed to neither more nor less wind than is necessary, let it come from what quarter it may.

It is very improbable, or much rather false, that the Romans had wind-mills, though Pomponius Sabinus affirms so, but without any proof[1]. Vitruvius[2], where he speaks of all moving forces, mentions also the wind; but he does not say a word of wind-mills; nor are they noticed either by Seneca[3] or Chrysostom[4], who have both spoken of the advantages of the wind. I consider as false also, the account given by an old Bohemian annalist[5], who says that before the year 718 there were none but wind-mills in Bohemia, and that water-mills were then introduced for the first time. I am of opinion that the author meant to have written *hand- and cattle-mills* instead of *wind-mills.*

It has been often asserted that these mills were first invented in the East, and introduced into Europe by the crusaders; but this also is improbable; for mills of this kind are not at all, or very seldom, found in the East. There are none of them in Persia, Palestine, or Arabia, and even water-mills are there uncommon, and constructed on a small scale. Besides, we find wind-mills before the crusades, or at least at the time when they were first undertaken. It is probable that these buildings may have been made known to a great part of Europe, and

[1] See Pomponius Sabinus, *ut supra.*

[2] Lib. ix. c. 9; x. c. 1, 13.

[3] Natur. Quæst. lib. v. c. 18.

[4] Chrysost. in Psalm. cxxxiv. p. 362.

[5] "At the same period (718) one named Halek the son of Uladi the weak, built close to the city an ingenious mill which was driven by water. It was visited by many Bohemians, in whom it excited much wonder, and who taking it as a model, built others of the like kind here and there on the rivers; for before that time all the Bohemian mills were wind-mills, erected on mountains."—Wenceslai Hagecii Chronic. Bohem. translated into German by John Sandel. Nuremberg, 1697, fol. p. 13.

particularly in France and England[1], by those who returned from these expeditions; but it does not thence follow that they were invented in the East[2]. The crusaders perhaps saw such mills in the course of their travels through Europe; very probably in Germany, which is the original country of most large machines. In the like manner, the knowledge of several useful things has been introduced into Germany by soldiers who have returned from different wars; as the English and French, after their return from the last war, made known in their respective countries many of our useful implements of husbandry, such as our straw-chopper, scythe, &c.

Mabillon mentions a diploma of the year 1105, in which a convent in France is allowed to erect water- and wind-mills, *molendina ad ventum*[3]. In the year 1143, there was in Northamptonshire an abbey (Pipewell) situated in a wood, which in the course of 180 years was entirely destroyed. One cause of its destruction was said to be, that in the whole neighbourhood there was no house, wind- or water-mill built, for which timber was not taken from this wood[4]. In the

[1] See De la Mare, Traité de la Police, &c. *ut supra*.—Déscription du Duché de Bourgogne. Dijon, 1775, 8vo, i. p. 163.—Dictionnaire des Origines, par d'Origny, v. p. 184. The last work has an attracting title, but it is the worst of its kind, written without correctness or judgement, and without giving authorities.

[2] There are no wind-mills at Ispahan nor in any part of Persia. The mills are all driven by water, by the hand, or by cattle. Voyages de Chardin. Rouen, 1723, 8vo, viii. p. 221.—The Arabs have no wind-mills; these are used in the East only in places where no streams are to be found; and in most parts the people make use of hand-mills. Those which I saw on Mount Lebanon and Mount Carmel had a great resemblance to those which are found in many parts of Italy. They are exceedingly simple and cost very little. The mill-stone and the wheel are fastened to the same axis. The wheel, if it can be so called, consists of eight hollow boards shaped like a shovel, placed across the axis. When the water falls with violence upon these boards it turns them round and puts in motion the mill-stone over which the corn is poured.—Darvieux, Reisen, Part iii. Copenh. 1754, 8vo. I did not see either water- or wind-mills in all Arabia. I however found an oil-press at Tehama, which was driven by oxen; and thence suppose that the Arabs have corn-mills of the like kind.—Niebuhr, p. 217.

[3] Mabillon, Annales Ord. Benedicti. Paris, 1713, fol. p. 474.

[4] Dugdale, Mon. i. p. 816.—The letter of donation, which appears also to be of the twelfth century, may be found in the same collection, ii. p. 459. In it occurs the expression *molendinum ventriticum*. In a charter also in vol. iii. p. 107, we read of *molendinum ventorium*. See Dugdale's Monasticon, ed. nov. vol. v. p. 431–442.

twelfth century, when these mills began to be more common, a dispute arose whether the tithes of them belonged to the clergy; and Pope Celestine III. determined the question in favour of the church[1]. In the year 1332, one Bartolomeo Verde proposed to the Venetians to build a wind-mill. When his plan had been examined, a piece of ground was assigned to him, which he was to retain in case his undertaking should succeed within a time specified[2]. In the year 1393, the city of Spires caused a wind-mill to be erected, and sent to the Netherlands for a person acquainted with the method of grinding by it[3]. A wind-mill was also constructed at Frankfort in 1442, but I do not know whether there had not been such there before.

To turn the mill to the wind, two methods have been invented. The whole building is constructed in such a manner as to turn on a post below, or the roof alone, together with the axle-tree, and the wings are moveable. Mills of the former kind are called German-mills, those of the latter Dutch. They are both moved round either by a wheel and pinion within, or by a long lever without[4]. I am inclined to believe that the German-mills are older than the Dutch; for the earliest descriptions which I can remember, speak only of the former. Cardan[5], in whose time wind-mills were very common both in France and Italy, makes however no mention of the latter; and the Dutch themselves affirm, that the mode of building with a moveable roof was first found out by a Fleming in the middle of the sixteenth century[6]. Those mills, by which in Holland the water is drawn up and thrown off from the land, one of which was built at Alkmaar in 1408, another

[1] Decretal Greg. lib. iii. tit. 30. c. 23. [2] Zanetti, *ut supra*.

[3] Lehmann's Chronica der Stadt Speyer. Frankf. 1662, 4to, p. 847. "Sent to the Netherlands for a miller who could grind with the wind-mill."

[4] Descriptions and figures of both kinds may be found in Leupold's Theatrum Machinarum Generale. Leipzig, 1724, fol. p. 101, tab. 41, 42, 43.

[5] De Rerum Varietate, lib. i. cap. 10.

[6] This account I found in De Koophandel van Amsterdam, door Le Long. Amst. 1727, 2 vol. 8vo, ii. p. 584. "The moveable top for turning the mill round to every wind was first found out in the middle of the sixteenth century by a Fleming." We read there that this is remarked by John Adrian Leegwater; of whom I know nothing more than what is related of him in the above work, that he was celebrated on account of various inventions, and died in 1650, in the 75th year of his age.

at Schoonhoven in 1450, and a third at Enkhuisen in 1452, were at first driven by horses, and afterwards by wind. But as these mills were immoveable, and could work only when the wind was in one quarter, they were afterwards placed not on the ground, but on a float which could be moved round in such a manner that the mill should catch every wind[1]. This method gave rise perhaps to the invention of moveable mills.

It is highly probable, that in the early ages men were satisfied with only grinding their corn, and that in the course of time they fell upon the invention of separating the meal from the pollard or bran. This was at first done by a sieve moved with the hands; and even yet in France, when what is called *mouture en grosse* is employed, there is a particular place for bolting, where the sieve is moved with the hand by means of a handle. It is customary also in many parts of Lower Saxony and Alsace, to bolt the flour separately; for which purpose various sieves are necessary. The Romans had two principal kinds, *cribra excussoria* and *pollinaria*, the latter of which gave the finest flour, called *pollen*. Sieves of horse-hair were first made by the Gauls, and those of linen by the Spaniards[2]. The method of applying a sieve in the form of an extended bag to the works of the mill, that the meal might fall into it as it came from the stones, and of causing it to be turned and shaken by the machinery, was first made known in the beginning of the sixteenth century, as we are expressly told in several ancient chronicles[3].

[1] See Beschryving der Stadt Delft, Delft, 1729, folio 625.

[2] Plin. lib. xviii. cap. 11.

[3] At Midsummer 1502, machinery for bolting in mills was first introduced and employed at Zwikau; Nicholas Boller, who gave rise to this improvement, being then sworn master of the bakers' company. It may be thence easily seen, that coarse and not bolted flour, such as is still used in many places, and as was used through necessity at Zwikau in 1641, was before that period used for baking. Chronica Cygnea, auct. Tob. Schmidten. Zwikau, 1656, v. vol. 4to, ii. p. 219. See also Theatri Freibergensis Chronicon. Freyberg, 1653, 4to, ii. p 335. Anno 1580, a great drought and scarcity of water. Of all the mills near town there were only fifteen going; and in order that the people might be better supplied with meal, the bolting machinery was removed, and this was attended with such good consequences that each mill could grind as much as before. In Walser's Appenzeller Chronik. 8vo, p. 471, we are told that about that time (1533), a freeman of Memmingen taught the people of Appenzel to make the beautiful white bolted flour so much and so far celebrated.

This invention gave rise to an employment which at present maintains a great many people; I mean that of preparing bolting-cloths, or those kinds of cloth through which meal is sifted in mills. As this cloth is universally used, a considerable quantity of it is consumed. For one bolting-cloth, five yards are required; we may allow, therefore, twenty-five to each mill in the course of a year. When this is considered, it will not appear improbable, that the electorate of Saxony, according to a calculation made towards the end of the seventeenth century, when manufactories of this cloth were established, paid for it yearly to foreigners from twelve to fifteen thousand rix-dollars. That kind of bolting-cloth also which is used for a variety of needle-work, for young ladies' samplers, and for filling up the frames of window-screens, &c., is wove after the manner of gauze, of fine-spun woollen yarn. One might imagine that this manufacture could not be attended with any difficulty; yet it requires many ingenious operations which the Germans cannot easily perform, and with which they are, perhaps, not yet perfectly acquainted. However this may be, large quantities of bolting-cloth are imported from England. It indeed costs half as much again per yard as the German cloth, but it lasts much longer. A bolting-cloth of English manufacture will continue good three months, but one of German will last scarcely three weeks. The wool necessary for making this cloth must be long, well-washed, and spun to a fine equal thread, which, before it is scoured, must be scalded in hot water to prevent it from shrinking. The web must be stiffened; and in this the English have an advantage we have not yet been able to attain. Their bolting-cloth is stiffer as well as smoother, and lets the flour much better through it than ours, which is either very little or not at all stiffened. The places where this cloth is made are also not numerous. A manufactory of it was established at Ostra, near Dresden, by Daniel Kraft, about the end of the seventeenth century; and to raise him a capital for carrying it on, every mill was obliged to pay him a dollar. Hartau, near Zittau, is indebted for its manufactory to Daniel Plessky, a linen-weaver of the latter, who learned the art of making bolting-cloth in Hungary, when on a visit to his relations, and was enabled to carry it on by the assistance of a schoolmaster named Strietzel. Since that period this business

has been continued there, and become common[1]. The cloth which is sent for sale, not only everywhere around the country, but also to Bohemia, Moravia, and Silesia, is wove in pieces. Each piece contains from sixty-four to sixty-five Leipsic ells: the narrowest is ten, and the widest fourteen inches in breadth. A piece of the former costs at present from four to about four dollars and a half, and one of the latter six dollars. This cloth, it must be allowed, is not very white; but it is not liable to spoil by lying in warehouses. Large quantities of bolting-cloth are made also by a company in the duchy of Wurtemberg. At what time this art was introduced there I cannot say; for every thing I know of it I am indebted to a friend, who collected for me the following information in his return through that country. The cloth is not wove in a manufactory, but by eighteen or twenty master weavers, under the inspection of a company who pay them, and who supply all the materials. The company alone has the privilege of dealing in this cloth; and the millers must purchase from their agents whatever quantity they have occasion for[2]. The millers however choose rather, if they can, to supply themselves privately with foreign and other home-made bolting-cloth, as they complain that the weavers engaged by the company do not bestow sufficient care to render their cloth durable: besides, the persons employed to carry about this cloth for sale, often purchase secretly cloth of an inferior quality in other places, and sell it as that of the company. Bolting-cloth is made also at Gera, as well as at Potsdam and Berlin; at the latter of which there is a manufactory of it carried on by the Jews.

For some years past the French have so much extolled a manner of grinding called *mouture économique*, that one might almost consider it as a new invention, which ought to form an epoch in the history of the miller's art. This art, which however is not new, consists in not grinding the flour so fine at once as one may wish, and in putting the meal afterwards several times through the mill, and sifting it through various

[1] Transactions of the Economical Society at Leipsic, 1772. Dresden, 8vo, p. 79.

[2] According to the general rescript of 1750, which has been often renewed. The company obtained this exclusive right as early as the year 1668.

sieves. This method, which in reality has nothing in it either very ingenious or uncommon, was known to the ancient Romans, as we may conclude from the account of Pliny, who names the different kinds of meal, such as *similago*, *simila*, *flos*, *pollen*, *cibarium*, &c.; for these words are not synonymous, but express clearly all the various kinds of meal or flour which were procured from the same corn by repeated grinding and sifting. In general, the Romans had advanced very far in this art[1]; and they knew how to prepare from corn more kinds of meal, and from meal more kinds of bread, than

[1] One may easily perceive by what Pliny says, that the Romans had made a variety of observations and experiments on grinding and baking. By comparing his information with what we know at present, I have remarked two things, which, as they will perhaps be serviceable to those who hereafter may endeavour to illustrate Pliny, I shall lay before the reader. That author says, book xviii. ch. 9, "Quæ sicca moluntur plus farinæ reddunt; quæ salsa aqua sparsa, candidiorem medullam, verum plus retinent in furfure." A question here arises, whether the corn was moistened before it was ground, and whether this was done with fresh or with salt water. If Pliny, as is probable, here means a thorough soaking, he is not mistaken; for it is certain that corn which has been exposed to much wet yields less meal, and that the meal, which is rather gray or reddish than white, will not keep long. The millers also are obliged, when corn has been much wetted, to put it through the mill oftener, because it is more difficult to be ground. It is true also, that when salt water is used for moistening corn, the meal becomes clammier and more difficult to be separated from the bran. It is well known that it is not proper to steep in salt water, malt which is to be ground for beer. On the other hand, a moderate soaking, which requires experience and attention, is useful, and is employed in preparing the finest kinds of flour, such as the Frankfort, Augsburg and Ulm speltmeal, which is exported to distant countries.

There is another passage in the tenth chapter of the same book of Pliny, where he seems to recommend a thorough soaking of corn that is to be ground. "De ipsa ratione pisendi Magonis proponetur sententia: triticum ante perfundi aqua multa jubet, postea evalli, deinde sole siccatum pilo repeti." I am of opinion that we have here the oldest account of the manner of making meal; that is, by pounding. This appears to me probable from the words immediately preceding, which I have above endeavoured to explain, and from the word *evalli*. I do not think that it ought to be translated *to winnow*, as almasius says, in Exercitat. Plinianæ, p. 907; but agree with Gesner in Thesaur. Steph., that it signifies to free the corn from the husk. The corn was first separated from the husks by pounding, which was more easily done after the grain had been soaked; the shelled corn was then soaked again, and by these means rendered so brittle, that it was easily pounded to meal. The like method is employed when people make grits without a mill, only by pounding; a process mentioned by Krünitz in his Encyclopédie, vol. ix. p. 805.

the French have hitherto been able to obtain. Pliny reckons that bread should be one-third heavier than the meal used for baking it; and that this was the proportion in Germany above a hundred years ago, is known from experiments on bread made at different times, which, however uncertain they may always have been, give undoubtedly more bread than meal[1] In latter times the arts of grinding and of baking have declined very much in Italy; and sensible Italians readily acknowledge that their bread is much inferior to that of most parts of Europe, and that in this respect the Germans are their masters[2]. Rome indeed forms an exception; for one can procure there as good bread as in Germany; but it is necessary to acquaint the reader, that it is not baked by Italians but by Germans; and all the bread and biscuit baked at Venice in the public ovens, either for home consumption, the use of shipping, or for exportation, is the work of German masters and journeymen. They are called to Venice expressly for that purpose; and at Rome they form at present a company, and have a very elegant church. The ovens of these German bakers are seldom suffered to cool, and the greater part of the owners of them become rich; but as through avarice they often continue their labour, without interruption, in the greatest heat for several days and nights, scarcely one in ten of them lives to return with his wealth to Germany. The Germans have, it is certain, long supplied the inhabitants of proud Rome, the metropolis of Catholic Christendom, with bread; for in the fifteenth century it was customary in all the great families to use no other than German bread, as is very circumstantially related by Felix Fabri, a Dominican monk, who wrote about the end of the above century, and died in 1502[3].

[1] Further information on this subject may be found collected in Krünitz, Encyclopédie, vol. iii. p. 384. According to experiments mentioned by Köhler, a hundred pounds of meal in Germany produce a hundred and fifty pounds of dough, and these a hundred and fifty-three pounds eleven and a half ounces of good bread.

[2] See the treatise of Rosa, professor of medicine at Pavia, on the baking of bread in Lombardy, in Atti dell' Academia delle Scienze di Siena, tom. iv. p. 321.

[3] "Italy, the most celebrated country in the world, and abundant in grain, has no delicate, wholesome and pleasant bread, but what is baked by a German baker, who, by art and industrious labour, subdues the fire,

The *mouture économique* has been long known in Germany. Sebastian Muller, in the beginning of the seventeenth century, gave so clear a description of it, that the French even acknowledge it[1]. This author says that one Butré, who came to Germany to teach the Germans to grind and to bake, was not a little disconcerted when he found his scholars more expert than their officious master, and that he met with nothing to console him but that, according to his opinion, the mill-stones at Carlsruhe were too small, and that the bolting-sieves were not made in the same manner as those at Paris[2].

Millers and bakers, even in France, practised sometimes this method of grinding so early as the sixteenth century; but it was some time forbidden by the police as hurtful. In the year 1546, those were threatened with punishment who should grind their corn twice[3]; and in 1658 this threat was renewed, and the cause added, that such a practice was prejudicial to the health[4]. Such prohibitions however, made by the police without sufficient grounds, could not prevent intelligent per-

tempers the heat, and equalises the flour in such a manner, that the bread becomes light, fine and delicate; whereas, if baked by an Italian, it is heavy, hard, unwholesome and insipid. His holiness, therefore, prelates, kings, princes and great lords, seldom eat any bread except what is baked in the German manner. The Germans not only bake well our usual bread, but they prepare also biscuit for the use of ships or armies in the time of war, with so much skill, that the Venetians have German bakers only in their public bakehouses; and their biscuit is sent far and wide over Illyria, Macedonia, the Hellespont, Greece, Syria, Egypt, Libya, Mauritania, Spain, France, and even to the Orkney Islands and Britain, to be used by their own seamen, or sold to other nations."—Historia Suevorum, lib. i. c. 8. This history of Felix Fabri may be found in Suevicarum Rerum Scriptores, Goldasti. Franc. 1605, 4to, and Ulm, 1727, fol.

[1] Bericht von Brodtbacken, etc., durch Sab. Mullern, Leipsig, 1616, 4to. Muller's work is republished in Arcana et Curiositates Œconomicæ. By David Maiern, 1706, 8vo.

[2] Schreber, in his Observations on Malouin, shows that the mill-stones in France are too large.

[3] Traité de la Police, par De la Mare, ii. p. 259.

[4] "Défenses sont aussi faites à tous boulangers, tant maîtres que forains, de faire remoudre aucun son, pour par après en faire et fabriquer du pain, attendu qu'il seroit indigne d'entrer au corps humain, sur peine de quarante-huit livres Parisis d'amende."—De la Mare, p. 228. The following was the true cause of this prohibition. As a heavy tax in kind was demanded for all the meal brought to Paris, many sent thither not meal, but

sons from remarking that the bran still contained meal, which, when separated from it, would be as proper for food as the first. Those who had observed this were induced, by the probability of advantage, to try to separate the remaining meal from the bran; and the attempt was attended with success, but it was necessary to keep it concealed. Malouin relates, that above a hundred years before, a miller at Senlis employed this method, and that the same practice was generally, though privately, introduced at all the mills in the neighbourhood. There were people who made a trade of purchasing bran in order to separate it from the meal, which they sold; and it is probable that many of them carried the art too far, and even ground bran along with the meal. This was done chiefly during times of scarcity, as in the year 1709. As men at that time were attentive to every advantage, this art was more known and more used, so that at length it became common. The clergy of the royal chapel and parish church at Versailles sent their wheat to be ground at an adjacent mill; it was, according to custom, put through the mill only once, and the bran, which still contained a considerable quantity of meal, was sold for fattening cattle. In time, the miller, having learned the *mouture économique*, purchased the bran from these ecclesiastics, and found that it yielded him as good flou. as they procured from the whole wheat. The miller at length discovered to them the secret, and gave them afterwards fourteen bushels of flour from their wheat, instead of eight which he had given them before. This voluntary discovery of the miller was made in 1760, and it is probable that the art was disclosed by more at the same time. A baker named Malisset proposed to the lieutenant-général de police to teach a method, by which people could grind their corn with more advantage; and experiments were set on foot and published, which proved the possibility of it. A mealman of Senlis, named Buquet, who had the inspection of the mill belonging to the large hospital at Paris, made the same proposal; the result of his experiments, conducted under the direction of magistrates, was printed; the investigation of this art was

bran abundant in meal, which they caused to be ground and sifted there, and by these means acquired no small gain. When the tax was abolished, an end was put to this deception, which would otherwise have brought the *mouture économique* much sooner to perfection.

now taken up by men of learning, who gave it a suitable name; and they explained it, made calculations on it, and recommended it so much, that the *mouture économique* engaged the attention of all the magistrates throughout France[1]. Government sent Buquet to Lyons in 1764, to Bordeaux in 1766, to Dijon in 1767, and to Montdidier in 1768; and the benefit which France at present derives from this improvement is well worth that trouble. Before that period, a Paris *sétier* yielded from eighty to ninety pounds of meal, and from one hundred and fifty to one hundred and sixty pounds of bran; but the same quantity yields now one hundred and eighty-five, and according to the latest improvements one hundred and ninety-five pounds of meal. In the time of St. Louis, from four to five *sétiers* were reckoned necessary for the yearly maintenance of a man, and these even were scarcely sufficient; as many were allowed to the patients in the hospital aux Quinze-Vingts; and such was the calculation made by Budée in the sixteenth century[2]. When the miller's art was everywhere improved, these four *sétiers* were reduced to three and a half, and after the latest improvements to two.

Mills by which grain is only freed from the husk and rounded, are called barley-mills, and belong to the new inventions. At first barley was prepared only by pounding, but afterwards by grinding; and as it was more perfectly rounded by the latter method, it was distinguished from that made by pounding by the name of pearl-barley. Barley-mills differ very little in their construction from meal-mills; and machinery for striking barley is generally added to the latter. The principal difference is that the mill-stone is rough-hewn around its circumference; and, instead of an under-stone, has below it a wooden case, within which it revolves, and which, in the inside, is lined with a plate of iron pierced like a grater, with holes, the sharp edges of which turn upwards. The barley is thrown upon the stone, which, as it runs round, draws it in, frees it from the husk, and rounds it; after which it is put into sieves and sifted. At Ulm, however, the well-known Ulm barley is struck by a common mill, after the stones have been separated a sufficient distance from each

[1] Histoire de la Vie Privée des François, par M. Le Grand d'Aussy. Paris, 1782, 3 vols. 8vo, i. p. 50.

[2] Budæus De Asse. Basiliæ, 1556, fol. p. 214.

other. The first kind of barley-mills is a German invention. In Holland the first was erected at Saardam not earlier than the year 1660. This mill, which at first was called the Pellikaan, scarcely produced in several years profit sufficient to maintain a family; but in the beginning of the last century there were at Saardam fifty barley-mills, which brought considerable gain to their proprietors[1].

As long as the natural freedom of man continued unrestrained by a multiplicity of laws, every person was at liberty to build on his own lands and possessions whatever he thought proper, and not only water- but also wind-mills. This freedom was not abridged even by the Roman law[2]. But as it is the duty of rulers to consult what is best for the whole society under their protection, princes took care that no one should make such use of common streams as might impede or destroy their public utility[3]. On this account no individual was permitted to construct a bridge over any stream; and it is highly probable that the proprietors of land, when water-mills began to be numerous, restrained, from the same principle, the liberty of erecting them, and allowed them only, when after a proper investigation they were declared to be not detrimental. Water-mills, therefore, were included among what were called *regalia*; and among these they are expressly reckoned by the emperor Frederic I.[4] On small streams however which were not navigable, the proprietors of the banks might build mills everywhere along them[5].

The avarice of landholders, favoured by the meanness and injustice of governments, and by the weakness of the people, extended this regality not only over all streams, but also over the air and wind-mills. The oldest example of this with which I am at present acquainted, is related by Jargow[6]. In the end of the fourteenth century, the monks of the celebrated but long since destroyed monastery of Augustines, at Winds-

[1] De Koophandel van Amsterdam, door Le Long. ii. p. 538.
[2] Digestorum lib. xxxix. tit. 2. 24.
[3] *Ibid.* lib. xliii. tit. 12. 1.
[4] See a diploma of Frederic I., dated 1159, in Tolneri Codex Diplomaticus Palatinus, Franc. 1700, fol. p. 54. In Reliquiæ Manuscriptorum, P. Ludewig. Franc. 1720, 8vo, ii. p. 200, we read an instance of the emperor Frederic I. having forbidden the building of a mill.
[5] Digestor. lib. xliii. tit. 11, 12.
[6] Einleitung in die Lehre von den Regalien. Rostock, 1757, 4to, p. 494.

heim, in the province of Overyssel, were desirous of erecting a wind-mill not far from Zwoll; but a neighbouring lord endeavoured to prevent them, declaring that the wind in that district belonged to him. The monks, unwilling to give up their point, had recourse to the bishop of Utrecht, under whose jurisdiction the province had continued since the tenth century. The bishop, highly incensed against the pretender who wished to usurp his authority, affirmed that no one had power over the wind within his diocese but himself and the church at Utrecht, and he immediately granted full power, by letters patent, dated 1391, to the convent at Windsheim, to build for themselves and their successors a good wind-mill, in any place which they might find convenient[1]. In the like manner the city of Haerlem obtained leave from Albert count palatine of the Rhine to build a wind-mill in the year 1394[2].

Another restraint to which men in power subjected the weak, in regard to mills, was, that vassals were obliged to grind their corn at their lord's mill, for which they paid a certain value in kind. The oldest account of such ban-mills, *molendina bannaria*, occurs in the eleventh century. Fulbert, bishop of Chartres, and chancellor of France, in a letter to Richard duke of Normandy, complains that attempts began to be made to compel the inhabitants of a part of that province to grind their corn at a mill situated at the distance of five leagues[3]. In the chronicle of the Benedictine monk Hugo de Flavigny, who lived in the eleventh and twelfth century, we find mention of *molendina quatuor cum banno ipsius villæ*[4]. More examples of this servitude, *secta ad molendinum*, in the twelfth and thirteenth centuries, may be seen in Du Fresne, under the words *molendinum bannale*.

It is not difficult to account for the origin of these ban-mills. When the people were once subjected to the yoke of slavery, they were obliged to submit to more and severer servitudes, which, as monuments of feudal tyranny, have continued even to more enlightened times. De la Mare[5] gives an instance

[1] Chronicon Canon. reg. ord. August. capituli Windesemensis; auctore Joh. Buschio. Antv. 1621, 8vo, p. 73.

[2] Schrevelii Harlemum. Lugd. Bat. 1647, 4to, p. 181.

[3] This letter of Fulbert may be found in Maxima Bibliotheca Veterum Patrum. Lugduni 1677, fol. tom. xviii. p. 9.

[4] In Labbei Biblioth. Manuscr. i. p. 132.

[5] Traités de la Police, ii. p. 151.

where a lord, in affranchising his subjects, required of them, in remembrance of their former subjection, and that he might draw as much from them in future as possible, that they should agree to pay a certain duty, and to send their corn to be ground at his mill, their bread to be baked in his oven, and their grapes to be pressed at his wine-press. But the origin of these servitudes might perhaps be accounted for on juster grounds. The building of mills was at all times expensive, and undertaken only by the rich, who, to indemnify themselves for the money expended in order to benefit the public, stipulated that the people in the neighbourhood should grind their corn at no other mills than those erected by them.

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## VERDIGRIS, OR SPANISH GREEN.

RESPECTING the preparation of verdigris, various and in part contradictory opinions have been entertained; and at present, when it is with certainty known, it appears that the process is almost the same as that employed in the time of Theophrastus, Dioscorides, and Vitruvius[1]. At that period, however, every natural green copper salt was comprehended under the name of *ærugo*. Dioscorides and Pliny say expressly, that a substance of the nature of those stones which yielded copper when melted, was scraped off in the mines of Cyprus; as is still practised in Hungary, where the outer coat of the copper ore is collected in the like manner, and afterwards purified by being washed in water. Another species, according to the account of Dioscorides, was procured from the water of a grotto in the same island; and the most saleable natural verdigris is still collected by a similar method in Hungary. The clear water which runs from old copper-works is put into large vessels, and after some time the green earth falls to the bottom as a sediment.

[1] Dioscorid. lib. v. cap. 91, 92. Theophrastus De Lapidibus, edit. Heinsii. p. 399. Plin. lib. xxxiv. cap. 11, 12. Oribasius, lib. xiii. Stephani Medicæ Artis Principes, p. 453. Vitruv. lib. vii. cap. 12.

The artificial *ærugo* of the ancients, however, was our verdigris, or copper converted into a green salt by acetic acid. To discover the method of procuring this substance could not be difficult, as that metal contracts a green rust oftener than is wished, when in the least exposed to acids. The ancients, for this purpose, used either vessels and plates of copper, or only shavings and filings; and the acid they employed was either the sourest vinegar, or the sour remains left when they made wine; such as grapes become sour, or the stalks and skins after the juice had been pressed from them[1]. Sometimes the copper was only exposed to the vapour of vinegar in close vessels, so that it did not come into immediate contact with the acid; in the same manner as was practised with plates of lead in the time of Theophrastus, when white-lead was made, and as is still practised at present. Sometimes the metal was entirely covered with vinegar, or frequently besprinkled with it, and the green rust was from time to time scraped off; and sometimes copper filings were pounded with vinegar in a copper mortar, till they were changed into the wished-for green salt. This article was frequently adulterated, sometimes with stones, particularly pumice-stone reduced to powder, and sometimes with copperas. The first deception was easily discovered; and to detect the second, nothing was necessary but to roast the verdigris, which betrayed the iron by becoming red; or to add to the verdigris some gall-nut, the astringent ingredients of which united with the oxide of iron of the copperas, and formed a black ink.

In early periods verdigris was used principally for making plasters, and for other medicinal purposes; but it was employed also as a colour, and on that account it is by Vitruvius reckoned among the pigments. When applied to the former purpose, it appears that the copper salt was mixed with various other salts and ingredients. One mixture of this kind was called vermicular verdigris[2], the accounts of which in ancient

[1] Plinius: *vinacea.* Dioscorides: στέμφυλα. Theophrastus: τρύξ. The last word has various meanings: sometimes it signifies squeezed grapes; sometimes wine lees, &c., of which Niclas gives examples in his Observations on Geop. lib. vi. c. 13, p. 457; but it can never be translated by *amurca,* though that word is used by Furlanus, the translator of Theophrastus. The old glossary says, Ἀμοργὴ, ἐστὶν δὲ τρὺξ ἐλαίου. Oil, however, has nothing to do with verdigris.

[2] Ἰὸς σκώληξ, ærugo scolacea, or vermicularis.

authors seem to some commentators to be obscure; but in my opinion we are to understand by them, that the ingredients were pounded together till the paste they formed assumed the appearance of pieces or threads like worms; and that from this resemblance they obtained their name. For the same reason the Italians give the name of *vermicelli* to wire-drawn paste of flour used in cookery[1]. When the process for making this kind of verdigris did not succeed, the workmen frequently added gum to it, by which the paste was rendered more viscous; but this mixture is censured both by Pliny and Dioscorides. It appears that the greater part of the verdigris in ancient times was made in Cyprus, which was celebrated for its copper-works, and in the island of Rhodes.

At present considerable quantities of verdigris are manufactured at Montpelier in France, and by processes more advantageous than those known to the ancients[2]. The dried stalks of grapes are steeped in strong wine, and with it brought to a sour fermentation. When the fermentation has ceased, they are put into an earthen pot, in alternate layers with plates of copper, the surface of which in a few days is corroded by the acetic acid, and the salt is then scraped off. It is certain, that, even in the fifteenth century, the making of verdigris was an old and profitable branch of commerce in France. The city of Montpelier having been obliged to expend large sums in erecting more extensive buildings to carry it on, and having had very small profits for some years before, received by letters patent from Charles VI., in 1411, permission to demand sixteen sous for every hundred weight of verdigris made there. In later times this trade has decayed very much. Between the years 1748 and 1755, from nine to ten thousand quintals were manufactured annually, by which the proprietors had a clear profit of 50,000 crowns; but a sudden change

[1] Should this explanation be just, we ought for *æruca*, the name given by Vitruvius to verdigris, to read *eruca*: though the conjecture of Marcellus Vergilius (Dioscorides, interprete Mar. Vergilio. Coloniæ, 1529, fol. p. 656), that the reading should be *ænea* or *ærea*, is no less probable; for by this epithet its difference from *ærugo ferri* was frequently distinguished.

[2] [Dr. Ure states, in his Dictionary of Arts and Manufactures, that the manufacture of verdigris at Montpelier is altogether domestic. In most wine farm-houses there is a verdigris cellar; and its principal operations are conducted by the females of the family. They consider the forming the strata, and scraping off the verdigris the most troublesome part.]

seems to have taken place, for in 1759 the quantity manufactured was estimated at only three thousand quintals. This quantity required 630 quintals of copper, valued at 78,750 livres: the expenses of labour amounted to 1323 livres; the necessary quantity of wine, 1033 measures, to 46,485 livres, and extraordinaries to 10,330 livres; so that the three thousand quintals cost the manufacturers about 136,888 livres. In the year 1759, the pound of verdigris sold for nine sous six deniers: so that the three thousand quintals produced 142,500 livres, which gave a net profit of only 5612 livres. Other nations, who till that period had purchased at least three-fourths of the French verdigris, made a variety of experiments in order to discover a method of corroding copper which might be cheaper; and some have so far succeeded that they can supply themselves without the French paint in cases of necessity [1].

In commerce there is a kind of this substance known under the name of distilled verdigris, which is nothing else than verdigris purified, and crystallized by being again dissolved in vinegar [2]. For a considerable period this article was manufactured solely by the Dutch, and affords an additional example of the industry of that people. Formerly there was only one person at Grenoble acquainted with this art, which he kept secret and practised alone; but for some years past manufactories of the same kind have been established in various parts of Europe.

The German name of verdigris (*Spangrün*) has by most authors been translated Spanish green; and it has thence been concluded that we received that paint first from the Spaniards. This word and the explanation of it are both old; for we find *ærugo*, and *viride Hispanicum*, translated *Spangrün*, *Spon-*

[1] [In England large quantities of verdigris are now prepared by arranging plates of copper alternately with pieces of coarse woollen cloth steeped in crude pyroligneous acid, which is obtained by the destructive distillation of wood.]

[2] [Verdigris is a mixture of three compounds of acetic acid with oxide of copper, which contain a preponderance of the base, hence basic acetates; distilled verdigris is made by d gesting verdigris, or the mixture of basic acetates of copper, with excess of acetic acid and crystallizing by evaporation: the acid then exists in such proportions as to form a neutral acetate of copper.]

*grün*, or *Spansgrün*, in many of the earliest dictionaries[1], such as that printed in 1480[2]. For this meaning, however, I know no other proof than the above etymology, which carries with it very little probability; and I do not remember that I ever read in any other works that verdigris first came from the Spaniards.

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## SAFFRON.

That the Latin word *crocus* signified the same plant which we at present call saffron, and which, in botany, still retains the ancient name, has, as far as I know, never been doubted; and indeed I know no reason why it should, however mistrustful I may be when natural objects are given out for those which formerly had the like names. The moderns often apply ancient names to things very different from those which were known under them by the Greeks and the Romans: but what we read in ancient authors concerning *crocus* agrees in every respect with our saffron, and can scarcely be applied to any other vegetable production. *Crocus* was a bulbous plant, which grew wild in the mountains. There were two species of it, one of which flowered in spring, and the other in autumn. The flowers of the latter, which appeared earlier than the green leaves that remained through the winter, contained those small threads or filaments[3] which were used as a medicine and a paint, and employed also for seasoning various kinds of food[4].

[1] Frisch's Worterbuch, p. 291. In the works of George Agricola, printed together at Basle, 1546, fol., we find in p. 473, where the terms of art are explained, "Ærugo, Grünspan, or Spansch-grün, quod primo ab Hispanis ad Germanos sit allata; barbari nominant viride æris."

[2] By Conrad Zeninger, Nuremberg. In that scarce work, Josua Maaler, Teutsche Spraach oder Dictionarium Germano-Latinum, Zurich, 1561, 4to, ærugo is called Spangrüne.

[3] [The stigmata of Botanists.]

[4] Plin. lib. xxi. cap. 6. Geopon. lib. xi. cap. 26, and Theophrast. Histor. Plant. lib. vi. cap. 6, where Joh. Bod. von Stapel, p. 661, has collected, though not in good order, every thing to be found in the ancients respecting saffron. The small aromatic threads, abundant in colour, the only parts of the whole plant sought after, were by the Greeks called γλωχῖνες,

It appears that the medicinal use, as well as the name of this plant, has always continued among the Orientals; and the Europeans, who adopted the medicine of the Greeks, sent to the Levant for saffron[1], until they learned the art of rearing it themselves; and employed it very much until they were made acquainted with the use of more beneficial articles, which they substituted in its stead. Those who are desirous of knowing the older opinions on the pharmaceutical preparation of saffron, and the diseases in the curing of which it was employed, may read Hertodt's Crocologia, where the author has collected all the receipts, and even the simplest, for preparing it[2].

What in the ancient use of saffron is most discordant with our taste at present, is the employing it as a perfume. Not only were halls, theatres, and courts, through which one wished to diffuse an agreeable smell, strewed with this plant[3], but it entered into the composition of many spirituous extracts, which retained the same scent; and these costly smelling waters were often made to flow in small streams, which spread abroad their much-admired odour[4]. Luxurious people even moistened or filled with them all those things with which they were desirous of surprising their guests in an agreeable manner[5], or with which they ornamented their apartments. From saffron, with the addition of wax and other ingredients, the Greeks as well as the Romans prepared also scented salves, which they used in the same manner as our ancestors their balsams[6].

κροκίδες, or τρίχες; and by the Romans *spicæ*. They are properly the end of the pistil, which is cleft into three divisions. A very distinct representation of this part of the flower may be seen in plate 184 of Tournefort's Institut. Rei Herbariæ, [or in Stephens and Churchill's Medical Botany.]

[1] On this account we often find in prescriptions, Recipe croci Orientalis .....

[2] Jena, 1670, 8vo.

[3] See Beroald's Observations on the 54th chapter of the Life of Nero by Suetonius; and Spartian, in the Life of Adrian, chap. 19.

[4] Lucan, in the ninth book of his Pharsalia, verce 809, describing how the blood flows from every vein of a person bit by a kind of serpent found in Africa, says that it spouts out in the same manner as the sweet-smelling essence of saffron issues from the limbs of a statue.

[5] Petron. Satyr. cap. 60.

[6] Of the method of preparing this salve or balsam, mentioned by Athenæus, Cicero, and others, an account is to be found in Dioscorides, lib. i. c. 26.

Notwithstanding the fondness which the ancients showed for the smell of saffron, it does not appear that in modern times it was ever much esteemed. As a perfume, it would undoubtedly be as little relished at present as the greater part of the dishes of Apicius, fricassees of sucking puppies[1], sausages, and other parts of swine, which one could not even mention with decency in genteel company[2]; though it certainly has the same scent which it had in the time of Ovid, and although our organs of smelling are in nothing different from those of the Greeks and the Romans. From parts of the world to them unknown, we have, however, obtained perfumes which far excel any with which they were acquainted. We have new flowers, or, at least, more perfect kinds of flowers long known, which, improved either by art or by accident, are superior in smell to all those in the gardens of the Hesperides, of Adonis and Alcinous, so much celebrated. We have learned the art of mixing perfumes with oils and salts, in such a manner as to render them more volatile, stronger, and more pleasant; and we know how to obtain essences such as the ancient voluptuaries never smelt, and for which they would undoubtedly have given up their saffron. The smelling-bottles and perfumes which are often presented to our beauties, certainly far excel that promised by Catullus to a friend, with the assurance that his mistress had received it from Venus and her Cupids, and that when he smelt it he would wish to become all nose:

> Nam unguentum dabo quod meæ puellæ
> Donarunt Veneres Cupidinesque,
> Quod tu quom olfacies, deos rogabis,
> Totum ut te faciant, Fabulle, nasum.

It cannot, however, be denied that both taste and smell depend very much on imagination. We know that many ar-

[1] Plin. lib. xxix. cap. iv.

[2] Martial, b. xiii. ep. 43, praises a cook who dressed the dugs of a sow with so much art and skill, that it appeared as if they still formed a part of the animal, and were full of milk. A dish of this sort is mentioned by Apicius, lib. vii. cap. 2. The same author gives directions, book vii. chap. i. for cooking that delicious dish of which Horace says, ep. i. 15, 41, "Nil vulva pulchrius ampla." Further information on this subject may be found in the notes to Pliny's Epistles, lib. i. 15; Plin. lib. xi. c. 37; Martial. Epig. xiii. 56; and, above all, in Lotichii Commentar. in Petronium, lib. i. cap. 18.

ticles of food, as well as spices, are more valued on account of their scarcity and costliness than they would otherwise be. Hence things of less value, which approach near to them in quality, are sought after by those who cannot afford to purchase them; and thus a particular taste or smell becomes fashionable. Brandy and tobacco were at first recommended as medicines; they were therefore much used, and by continual habit people at length found a pleasure in these potent and almost nauseating articles of luxury. Substances which gratify the smell become, nevertheless, like the colour of clothes, oft unfashionable when they grow too common. Certain spiceries, in which our ancestors delighted, are insupportable to their descendants, whose nerves are weak and more delicate; and yet many of the present generation have accustomed themselves to strong smells of various kinds, by gradually using them more and more, till they have at length become indispensable wants. Some have taken snuff rendered so sharp by powdered glass, salts, antimony, sugar of lead, and other poisonous drugs, that the olfactory nerves have been rendered callous, and entirely destroyed by it.

That saffron was as much employed in seasoning dishes as for a perfume, appears from the oldest work on cookery which has been handed down to us, and which is ascribed to Apicius. Its use in this respect has been long continued, and in many countries is still more prevalent than physicians wish it to be. Henry Stephen says, "Saffron must be put into all Lent soups, sauces, and dishes: without saffron we cannot have well-cooked peas[1]."

It may readily be supposed that the great use made of this plant in cookery must have induced people to attempt to cultivate it in Europe; and, in my opinion, it was first introduced into Spain by the Arabs, as may be conjectured from its name, which is Arabic, or rather Persian[2]. From Spain it

[1] Apologie pour Herodote, par H. Estiene. A la Haye, 1735, 2 vols. 8vo.

[2] Meninski, in his Turkish Lexicon, has *Zae' feran*, crocus. Golius gives it as a Persian word. That much saffron is still cultivated in Persia, and that it is of the best kind, appears from Chardin. See his Travels, printed at Rouen, 1723, 10 vols. 12mo. iv. p. 37. That the Spaniards borrowed the word *safran* from the Vandals is much more improbable. It is to be found in Joh. Marianæ Histor. de Rebus Hispaniæ. Hagæ, 1733, fol. i. p. 147. The author, speaking of foreign words introduced into the Spanish language, says, "Vandalis aliæ voces acceptæ feruntur, *camara, azafran*," &c.

was, according to every appearance, carried afterwards to France, perhaps to Albigeois, and thence dispersed into various other parts[1]. Some travellers also may, perhaps, have brought bulbs of this plant from the Levant. We are at least assured that a pilgrim brought from the Levant to England, under the reign of Edward III., the first root of saffron, which he had found means to conceal in his staff, made hollow for that purpose[2]. At what period this plant began to be cultivated in Germany I do not know; but that this was first done in Austria, in 1579, is certainly false. Some say that Stephen von Hausen, a native of Nuremberg, who about that time accompanied the imperial ambassador to Constantinople, brought the first bulbs to Vienna, from the neighbourhood of Belgrade. This opinion is founded on the account of Clusius, who, however, does not speak of the autumnal saffron used as a spice, but of an early sort, esteemed on account of the beauty of its flowers[3]. Clusius has collected more species of this plant than any of his predecessors; and has given an account by whom each of them was first made known.

In the fifteenth and following century, the cultivation of saffron was so important an article in the European husbandry, that it was omitted by no writer on that subject; and an account of it is to be found in Crescentio, Serres, Heresbach, Von Hohberg, Florinus, and others. In those periods, when it was an important object of trade, it was adulterated with various and in part noxious substances; and attempts were made in several countries to prevent this imposition by severe penalties. In the year 1550, Henry II., king of France, issued an order for the express purpose of preventing such frauds, the following extract from which will show some of the methods employed to impose on the public in the sale of this article[4]: "For some time past," says the order, "a certain quantity of the said saffron has been found altered, disguised

[1] Rozier, Cours complet d'Agriculture, i. p. 266.

[2] It is reported at Saffron-Walden, that a pilgrim, proposing to do good to his country, stole a head of saffron, and hid the same in his palmer's staff, which he had made hollow before on purpose, and so he brought this root into this realm, with venture of his life; for if he had been taken, by the law of the country from whence it came, he had died for the fact.—Hakluyt, vol. ii. p. 164.

[3] Clusii Rar. Plant. Hist. 1601, fol. p. 207

[4] Traité de Police, par De la Mare, iii. p. 428.

and sophisticated, by being mixed with oil, honey, and other mixtures, in order that the said saffron, which is sold by weight, may be rendered heavier; and some add to it other herbs, similar in colour and substance to beef over-boiled, and reduced to threads, which saffron, thus mixed and adulterated, cannot be long kept, and is highly prejudicial to the human body; which, besides the said injury, may prevent the above-said foreign merchants from purchasing it, to the great diminution of our revenues, and to the great detriment of foreign nations, against which we ought to provide," &c.

[The high price demanded for saffron offers considerable temptation to adulteration, and this is not uncommonly taken advantage of. The stigmata of other plants, besides the true saffron crocus (*Crocus sativus*), are frequently mixed with those which are genuine; moreover, many other foreign substances are added, such as the florets of the safflower (*Carthamus tinctorius*), those of the marigold (*Calendula officinalis*), slices of the flower of the pomegranate, saffron from which the colouring has been previously extracted, and even fibres of smoked beef. Most of these adulterations may be detected by the action of boiling water, which softens and expands the fibres, thus exposing their true shape and nature. The cake saffron of commerce appears entirely composed of foreign substances. Great medicinal virtues were formerly attributed to saffron. Its principal use is now as a colouring matter.]

## ALUM.

THIS substance affords a striking instance how readily one may be deceived in giving names without proper examination. Our alum was certainly not known to the Greeks or the Romans; and what the latter called *alumen*[1] was vitriol, (the green sulphate of iron)[2]; not however pure, but such as forms in mines

[1] Called by the Greeks στυπτηρία.

[2] [It is scarcely necessary to observe, that many of the compounds of sulphuric acid with metallic oxides were formerly commonly termed *vitriols*

To those who know how deficient the ancients were in the knowledge of salts, and of mineralogy in general, this assertion will without further proof appear highly probable[1]. Alum and green vitriol are saline substances which have some resemblance; both contain the same acid called the vitriolic or sulphuric; both have a strong astringent property, and on this account are often comprehended under the common name of styptic salts; and both are also not only found in the same places, but are frequently obtained from the same minerals. The difference, that the vitriols are combinations of sulphuric acid with a metallic oxide, either that of iron, copper or zinc, and alum on the other hand with a peculiar white earth, called on this account alumina, has been established only in modern times[2].

A stronger proof however in favour of my assertion, is what follows:—The Greeks and the Romans speak of no other than natural alum; but our alum is seldom produced spontaneously in the earth, and several of our most accurate mineralogists, such as Scopoli and Sage, deny the existence of native alum[3]. Crystals of real alum are formed very rarely on minerals which abound in a great degree with aluminous particles, when they have been exposed a sufficient time to the open air and the rain; and even then they are so small and so much scattered, that it requires an experienced and attentive observer to know and discover them. The smallest trace of alum-works is not to be found in the ancients, nor even of works for making

from their glassy appearance; thus, the green vitriol, or briefly vitriol, is the sulphate of the protoxide of iron, white vitriol is sulphate of zinc, and blue vitriol is the sulphate of copper. Sulphuric acid is still more generally known by the name of oil of vitriol and vitriolic acid, from its having been originally obtained by distilling green vitriol.]

[1] [There can be little doubt however that even Pliny was acquainted with our alum, but did not distinguish it from sulphate of iron, for he informs us that one kind of alum was white and was used for dyeing wool of bright colours.—Pereira's Materia Medica, vol. i.]

[2] [The alums, for at present several kinds are distinguished, are not merely combinations of sulphuric acid and the earth alumina, but double sulphates, the one constituent being sulphate of alumina, the other either sulphate of potash, sulphate of ammonia, sulphate of soda, &c. The alum of this country generally contains potash, that of France ammonia, or both potash and ammonia, hence the name potash-alum, ammonia-alum, &c.]

[3] [Although native alum is not abundant, there is no question of its occasional occurrence.]

vitriol (sulphate of iron), except what is mentioned by Pliny, who tells us that blue vitriol was made in Spain by the process of boiling; and this circumstance he considers as the only one of its kind, and so singular, that he is of opinion no other salt could be obtained in the same manner[1]. Besides, everything related by the ancients of their alum agrees perfectly with native vitriols: but to describe them all might be difficult; for they do not speak of pure salts, but of saline mixtures, which nature of itself exhibits in various ways, and under a variety of forms; and every small difference in the colour, the exterior or interior conformation, however accidental, provided it could be clearly distinguished, was to them sufficient to make a distinct species, and to induce them to give it a new name[2].

The celebrity which the ancient alum had, as a substance extremely useful in dyeing and medicine, was entirely forgotten when the alum of the moderns became known; but this celebrity was again revived when it was discovered that real alum could be often made from minerals containing sulphur compounds; or that where the latter are found there are generally minerals which abound with it. In many of these places alum-works have in the course of time been erected; and this circumstance has served in some measure to strengthen the opinion that the alum of the ancients and that of the moderns are the same salt; because where the former was found in ancient times, the latter has since been procured by a chemical process. Some historians of the fifteenth century even speak of the alum-works erected at that period, as if the art of making this salt had only been revived in Europe.

The ancients procured their alum from various parts of the world. Herodotus mentions Egyptian alum; for he tells us that when the people of Delphos, after losing their temple by a fire, were collecting a contribution in order to rebuild it, Amasis king of Egypt sent them a thousand talents of alum[3]. In Pliny's time the Egyptian alum was accounted the best. It is well known that real alum is reckoned among the exports

[1] Plin. lib. xxxiv. c. 12. The same account is given by Isidor. Origin. lib. xvi. c. 2, and by Dioscorides, lib. v. c. 114. The latter, however, differs from Pliny in many circumstances.

[2] Those who are desirous of seeing everything that the ancients have left us respecting their alum may consult Aldrovandi Museum Metallicum, Lugd. 1636, fol. p. 334.

[3] Herodot. lib. ii. c. 180.

of Egypt at present, but I am acquainted with no author who mentions the place where it is found or made, or who has described the method of preparing it.

The island of Melos, now called Milo, was particularly celebrated on account of its alum, as we learn from Diodorus Siculus, Celsus, Pliny and others, though none was to be found there in the time of Diodorus[1]. This native vitriol has been observed in the grottos of that island by several modern travellers, especially Tournefort[2], who very properly considers it as the real alum of the ancients.

The islands of Lipara and Strongyle, or, as they are called at present, Lipari and Stromboli, contained so great a quantity of this substance, that the duty on it brought a considerable revenue to the Romans[3]. At one period, Lipari carried on an exclusive trade in alum, and raised the price of it at pleasure; but in that island at present there are neither vitriol nor alum-works. Sardinia, Macedonia, and Spain, where alum was found formerly, still produce a salt known under that name[4].

Whe our alum became known, it was considered as a species of the ancient; and as it was purer, and more proper to be used on most occasions, the name of alum[5] was soon appropriated to it alone. The kinds of alum however known to the ancients, which were green vitriol, maintained a preference in medicine and for dyeing black; and on this account, these impure substances have been still retained in druggists' shops

[1] Diodor. Sic. lib. v. ed. Wesselingii, i. p. 338.

[2] Tournefort, Voyage i. p. 63. Some information respecting the same subject may be seen in that expensive but useful work, Voyage Pittoresque de la Grèce, i. p. 12.

[3] Diodor. Sic. lib. c. Strabo, lib. vi. edit. Almel. p. 423.

[4] Copious information respecting the Spanish alum-works may be found in Introduccion à la Historia Natural de Espagna, par D. G. Bowles: and in Dillon's Travels through Spain, 1780, 4to, p. 220.

[5] The derivation of the Latin name *alumen*, which, if I mistake not, occurs first in Columella and Pliny, is unknown. Some deduce it from ἅλμη; others from ἄλειμμα; and Isidore gives a derivation still more improbable. May it not have come from Egypt with the best sort of alum? Had it originated from a Greek word, it would undoubtedly have been formed from στυπτηρία. This appellation is to be found in Herodotus; and nothing is clearer than that it has arisen from the astringent quality peculiar to both the salts, and also from στύφειν, as has been remarked by Dioscorides, Pliny, and Galen.

under the name of *misy*, *sory*, &c. But a method was at length found out of procuring thence crystallized martial salts (salts of iron), which obtained the new name of *vitriol*. This appellation had its rise first in the eleventh or twelfth century; at least I know no writer older than Albertus Magnus by whom it is mentioned or used. Agricola conjectures that it was occasioned by the likeness which the crystals of vitriol had to glass. This is also the opinion of Vossius[1]; and it is very singular that Pliny says nearly the same thing; for he observes, speaking of blue vitriol, the only kind then known, that one might almost take it for glass[2].

By inquiring into the uses to which the ancients applied their alum, I find that it was sometimes employed to secure wooden buildings against fire. This remark I have here introduced to show that this idea, which in modern times has given occasion to many expensive experiments, is not new. Aulus Gellius[3] relates, from the works of an historian now lost, that Archelaus, one of the generals of Mithridates, washed over a wooden tower with a solution of alum, and by these means rendered it so much proof against fire, that all Sylla's attempts to set it in flames proved abortive. Many have conjectured that the substance used for this purpose was neither vitriol nor our alum, but rather asbestos, which is often confounded with Atlas-vitriol[4]; and against this mistake cautions are to be found even in Theophrastus. But it may be asked, With what was the asbestos laid on? By what means were the threads, which are not soluble in water, made fast to the wood? How could a tower be covered with it? I am rather inclined to believe, that a strongly saturated solution of vitriol might have in some measure served to prevent the effects of the fire, at least as long as a thin coat of potters' earth or flour-paste, which in the present age have been thought deserving of experiments attended with considerable expense. It does not however appear that the invention of Archelaus, which is still

[1] Etymol. p. 779. [2] Plin. lib. xxxiv. c. 12. [3] Noct. Att. lib. xv. c. 1.

[4] The *halotrichum* of Scopoli. The first person who discovered this salt to be vitriolic was Henkel, who calls it *Atlas-vitriol*. [The mineral halotrichite is, in a chemical sense, a true alum in which the sulphate of potash is replaced by the sulphate of the protoxide of iron. It is composed of one atom of protosulphate of iron, one atom of sulphate of alumina, and contains, like all the true alums, twenty-four atoms of water.]

retained in some old books[1], has been often put in practice[2]; for writers on the art of war, such, for example, as Æneas, recommended vinegar to be washed over wood, in order to prevent its being destroyed by fire.

I shall now proceed to the history of our present alum, which was undoubtedly first made in the East. The period of the invention I cannot exactly determine, but I conclude with certainty that it is later than the twelfth century[3]; for John, the son of Serapion, who lived after Rhazes, was acquainted with no other alum than the impure vitriol of Dioscorides[4]. What made the new alum first and principally known was its beneficial use in the art of dyeing, in which it is employed for fixing as well as rendering brighter and more beautiful different colours. This art therefore the Europeans learned from the Orientals, who, even yet, though we have begun to apply chemistry to the improvement of dyeing, are in some respects superior to us, as is proved by the red of Adrianople, their silks and their Turkey leather. The Italians procured their first alum from the Levant, along with other materials for dyeing; but when these countries were taken possession of by the Turks, it grieved the Christians to be obliged to purchase these necessary articles from the common enemy, and bitter complaints on that subject may be seen in the works of various authors. In the course of time the Italians became acquainted with the art of boiling alum; for some of them had rented Turkish alum-works, and manufactured that salt on their own account. They at length found aluminous minerals in their own country, on which they made experiments. These having answered their expectations, they were soon brought into use; and this branch of trade declined afterwards so much in Turkey, that many of the alum-works there were abandoned.

We are told by many historians that the Europeans who first made alum in Italy learned their art, as Augustin Justi-

[1] Wecker De Secretis, lib. ix. 18, p. 445.

[2] One instance of its being used for this purpose is found in Ammianus Marcellinus, lib. xx. c. 12.

[3] [This cannot be correct; for Geber, who is supposed to have lived in the eighth century, was acquainted with three kinds of it, and describes the method of preparing burnt alum.]

[4] Joh. Serapionis Arabis de simplicibus medicinis opus, cap. 410.

nian says, at Rocca di Soria, or Rocca in Syria. Neither in books of geography nor in maps, however, can I find any place of this name in Syria. I at first conjectured that Rocca on the Euphrates might be here meant, but at present it appears to me more probable that it is Edessa, which is sometimes called Roha, Raha, Ruha, Orfa, and also Roccha, as has been expressly remarked by Niebuhr[1]. Edessa is indeed reckoned to be in Mesopotamia, but some centuries ago Syria perhaps was understood in a more extended sense. This much at least is certain, that minerals which indicate alum have been often observed by travellers in that neighbourhood.

It appears that the new alum was at first distinguished from the ancient vitriol by the denomination of *Rocca*, from which the French have made *alun de roche*, and some of the Germans *rotzalaun*[2]. Respecting the origin of this name very different conjectures have been formed. Some think it is derived from *rocca*, which in the Greek signifies a rock, because this salt is by boiling procured from a stone; and these translate the word *alumen rupeum*, from which the French name is formed[3]. Some are of opinion that alum obtained from alum-stone has been so called to distinguish it from that procured from schists, which is generally mixed with more iron than the former[4]; and others maintain that alum acquired the name of *Rocca* from the alum-rocks in the neighbourhood of Tolfa[5]. It is to be remarked, on the other hand, that Biringoccio, that expert Italian, confesses he does not know whence the name has arisen[6]. For my part I am inclined to adopt the opinion of Leibnitz, that *alumen roccæ* was that kind first procured from Rocca in Syria; and that this name was afterwards given to every good species of alum, as we at present call the purest Roman alum[7].

In the fifteenth century there were alum-works in the neighbourhood of Constantinople, from which John di Castro,

[1] Reisebeschreibung, ii. p. 408, 409.

[2] This singular appellation occurs in Valentini Historia Simplicium, and several other works.

[3] Jul. Cæs. Scaligeri Exot. exercitat. Franc. 1612, 8vo, p. 325.

[4] I shall here take occasion to remark, that schist seems to have been employed for making alum in the time of Agricola, as appears by his book De Ortu et Causis Subterraneorum, p. 47.

[5] Mercati, Metallotheca, p. 54. [6] Pyrotechnia. Ven. 1559, 4to.

[7] Leibnitii Protogæa, p. 47.

of whom I shall have occasion to speak hereafter, learned his art. May not these alum-works be those visited by Bellon, and of which he has given an excellent description[1]? He names the place *Cypsella* or *Chypsilar*, and says that the alum in commerce is called *alumen Lesbium*, or *di Metelin*. The alum procured from Constantinople at present may perhaps be brought from the same spot; but I am not sufficiently acquainted with its situation to determine that point with certainty, for Büsching makes no mention of it. In some maps I find the names *Ypsala* and *Chipsilar* on the western side of the river Mariza, Maritz or Maricheh, which was the Hebrus of the ancients; in others stands the name *Scapsiler* on the west bank of the sea Bouron; and it is not improbable that these may be all derived from the old *Scaptesyle* or *Scapta Hyla*, where, according to the account of Theophrastus, Pliny and others, there were considerable mines.

Another alum-work, no less celebrated in the fifteenth century, was established near the city *Phocæa Nova*, at present called *Foya Nova*, not far from the mouth of the Hermus, in the neighbourhood of Smyrna. Of this work, Ducas, who had a house there, has given a particular description, from which we learn that in his time, that is under the reign of Michael Palæologus, it was farmed by Italians, who sold the produce of it to their countrymen, and to the Dutch, French, Spaniards, English, Arabs, Egyptians, and people of Syria. This author relates very minutely in what manner the alum was made, but that work has been long since abandoned[2]: alum however

[1] Bellonii Observationes, cap. lxi.

[2] "In Phocis, which lies close to Ionia, there is a mountain abundant in aluminous mineral. The stones found on the top of this mountain are first calcined in the fire, and then reduced to powder by being thrown into water. The water mixed with that powder is put into a kettle; and a little more water being added to it, and the whole having been made to boil, the powder is lixiviated, and the thick part which falls to the bottom in a cake is preserved; what is hard and earthy is thrown away as of no use. The cake is afterwards suffered to dissolve in vessels for four days; at the end of which the alum is found in crystals around their edges, and the bottoms of them also are covered with pieces and fragments of the like nature. The remaining liquor, which at the end of four days does not harden, is poured into a kettle, more water and more powder are added to it, and being boiled as before, it is put into proper vessels, and the alum obtained in this manner is preserved as an article very necessary for dyers. All masters of ships bound from the Levant to Europe, consider alum as a

made in the neighbourhood is still exported from Smyrna[1]. It is much to be wished that ingenious travellers would examine the alum-works in Thrace, around Smyrna, and in Turkey in general, and give an accurate description of them according to the state in which they are at present[2].

The oldest alum-works in Europe were established about the middle of the fifteenth century, but where they were first erected cannot with certainty be ascertained; for it appears that several were set on foot in different places at the same period. Some affirm that the first alum made in Europe was manufactured in the island Ænaria, or Pithacusa, at present called Ischia, by a Genoese merchant, whom some name Bartholomew Perdix, and others Pernix. This man, who is praised on account of his ingenuity and attachment to the study of natural history, having often travelled through Syria, learned the method of boiling alum at Rocca; and on his return found alum-stones among the substances thrown up by the eruption of a volcano which had destroyed part of the island, and gave occasion to their being first employed in making that salt. Such is the account of respectable historians, Pontanus[3],

very convenient and useful lading for vessels. . . . . In the reign of Michael Palæologus, the first emperor of his family, some Italians requested a lease of that mountain, for which they promised to pay a certain sum annually. . . . . The Romans and the Latins built Phocæa Nova on the sea-shore, at the bottom of that mountain which lies on the east side of it. On the west it has the island of Lesbos, on the north the neighbouring bay of Elæa, and on the south it looks towards the Ionian sea."—Ducæ Historia Byzantina. Venet. 1729, p. 71.

[1] The alum of Smyrna is mentioned by Baumé in his Experimental Chemistry, i. p. 458.

[2] Some account of other Eastern alum-works is contained in a treatise of F. B. Pegolotti, written in the middle of the fourteenth century, on the state of commerce at that time, and printed in a book entitled Della decima e di varie altre gravezze imposte dal commune di Firenze. Lisbona e Lucca, 1765, 4to, 4 vols. It appears from this work, that in the fourteenth century the Italians were acquainted with no other than Turkish alum.

[3] "I shall embrace this opportunity of giving a brief account of the situation of the island, and of the nature of its soil. That Ænaria has been at some time violently separated from the continent by an earthquake, seems proved by a variety of circumstances, such as calcined rocks; the ground full of caverns; and the earth, which, like that of the main land, being abundant in warm springs, and dry, feeds internal fire, and on that account contains a great deal of alum. A few years ago Bartholomew Perdix, a Genoese merchant passing this island in his way to Naples, observed some aluminous rocks scattered here and there along the sea-coast.

Bizaro[1], Augustine Justinian[2], and Bottone[3], who wrote much later. Bizaro says that this happened in the year 1459, which agrees perfectly with the account of Pontanus; for he tells us that it was under the reign of Ferdinand I., natural son of Alphonsus, who ascended the throne in 1458. Besides, the earthquake, which had laid waste the island one hundred and sixty-three years before, took place in 1301, which makes the time of this invention to fall about the year 1464. So seems Bottone also to have reckoned, for he mentions expressly the year 1465.

The alum-work which is situated about an Italian mile north-

About a hundred and sixty-three years before that period, the earth having suddenly burst by the effects of fire confined in its bowels, a considerable part of Ænaria was involved in flames. By this eruption a small town was burned and afterwards swallowed up; and large masses of rock mixed with flames, sand and smoke, thrown up where the shore looks towards Cumæ, fell upon the neighbouring fields, and destroyed the most fruitful and the most pleasant part of the island. Some of these huge pieces of rock being at that time still lying on the shore, Bartholomew, by calcining them in a furnace, extracted alum from them, and revived that art which he had brought from Rocca in Syria, where he had traded for several years, and which had been neglected in Italy for many centuries."—Pontani Hist. Neapol. in Grævii Thesaurus Antiq. Italiæ, ix. part 3. p. 88.

[1] "I must not omit to mention that about this time Bartholomew Pernix, a citizen and merchant of Genoa, who had resided long in Syria for the purpose of commerce, returned to his native country. Soon after, he made a voyage to the island of Ænaria, situated in the Tuscan sea, called formerly Pythacusa, and now in the vulgar Greek Iscla or Ischia; and being a man of an acute genius, and a diligent investigator of natural objects, he observed near the sea-coast several rocks fit for making alum. He took some fragments of them therefore, and having calcined them in a furnace, he procured from them most excellent alum. He was the first person who, to the incredible benefit of many, brought as it were again into use that art long abandoned and almost lost in Italy and the greater part of other countries. On that account his name deserves to be rescued from oblivion."—Genuensis Rerum Annal. auct. P. Bizaro Sentinati. Antv. 1579, fol. p. 302.

[2] "About that period (1459) Bartholomew Pernix, a Genoese merchant, sailing past the island of Ænaria or Ischia, learned that there were near the shore many aluminous rocks, that is to say, fit for making alum. He took some of them, therefore, and having caused them to be calcined in a furnace, he procured from them most excellent alum. This Bartholomew brought back to Italy from the city of Rocca, in Syria, where he had traded many years, the art of making alum, which had been neglected and lost for a long space of time."—Annali della Republica di Genoa, per Agostino Giustiniano. Genoa, 1537, fol. lib. v. p. 214.

[3] Dom. Bottone, Pyrologia Topographica. Neapoli, 1692, 4to. This author calls the inventor Perdix, and not Pernix.

west from Tolfa, and six from Civita Vecchia, in the territories of the Church, is by some Italian historians reckoned to have been the first. However this may be, it is certain that it is the oldest carried on at present. The founder of it was John di Castro, a son of the celebrated lawyer, Paul di Castro[1], who had an opportunity at Constantinople, where he traded in Italian cloths and sold dye-stuffs, of making himself acquainted with the method of boiling alum. He was there at the time when the city fell into the hands of the Turks; and after this unfortunate event, by which he lost all his property, he returned to his own country. Pursuing there his researches in natural history, he found in the neighbourhood of Tolfa a plant which he had observed growing in great abundance in the aluminous districts of Asia: from this he conjectured that the earth of his native soil might also contain the same salt; and he was confirmed in that opinion by its astringent taste. At this time he held an important office in the Apostolic Chamber; and this discovery, which seemed to promise the greatest advantages, was considered as a real victory gained over the Turks, from whom the Italians had hitherto been obliged to purchase all their alum. Pope Pius II., who was too good a financier to neglect such a beneficial discovery, caused experiments to be first made at Viterbo, by some Genoese who had formerly been employed in the alum-works in the Levant, and the success of them was equal to his expectations. The alum, which was afterwards manufactured in large quantities, was sold to the Venetians, the Florentines, and the Genoese. The Pope himself has left us a very minute history of this discovery, and of the circumstances which gave rise to it[2]. Some pretend that Castro was several years a slave

[1] Fabricii Biblioth. Lat. mediæ et infimæ Ætatis, vol. v. p. 617.

[2] "A little before that period came to Rome John di Castro, with whom the Pontiff had been acquainted when he carried on trade at Basle, and was banker to Pope Eugenius. His father, Paul, was a celebrated lawyer of his time, who sat many years in the chair at Padua, and filled all Italy with his decisions; for law-suits were frequently referred to him, and judges paid great respect to his authority, as he was a man of integrity and sound learning. At his death he left considerable riches, and two sons arrived to the age of manhood, the elder of whom, following the profession of the father, acquired a very extensive knowledge of law. The other, who was a man of genius, and who applied more to study, made himself acquainted with grammar and history; but, being fond of travelling, he resided some time at Constantinople, and acquired much wealth by dyeing cloth made

to a Turk who traded in alum[1]; others affirm that he had even been obliged to labour as a slave in alum-works[2]; and

in Italy, which was transported thither and committed to his care. on account of the abundance of alum in that neighbourhood. Having by these means an opportunity of seeing daily the manner in which alum was made, and from what stones or earth it was extracted, he soon learned the art. When, by the will of God, that city was taken and plundered about the year 1453, by Mahomet II., emperor of the Turks, he lost his whole property; but, happy to have escaped the fire and sword of these cruel people, he returned to Italy, after the assumption of Pius II., to whom he was related, and from whom he obtained, as an indemnification for his losses, the office of commissary-general over all the revenues of the Apostolic Chamber, both within and without the city. While, in this situation, he was traversing all the hills and mountains, searching the bowels of the earth, leaving no stone or clod unexplored, he at length found some alum-stone in the neighbourhood of Tolfa. Old Tolfa is a town belonging to two brothers, subjects of the Church of Rome, and situated at a small distance from Civita Vecchia. Here there are high mountains, retiring inland from the sea, which abound with wood and water. While Castro was examining these, he observed that the grass had a new appearance. Being struck with wonder, and inquiring into the cause, he found that the mountains of Asia, which enrich the Turkish treasury by their alum, were covered with grass of the like kind. Perceiving several white stones, which seemed to be minerals, he bit some of them, and found that they had a saltish taste. This induced him to make some experiments by calcining them, and he at length obtained alum. He repaired therefore to the Pontiff, and addressing him said, 'I announce to you a victory over the Turk. He draws yearly from the Christians above three hundred thousand pieces of gold, paid to him for the alum with which we dye wool different colours, because none is found here but a little at the

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[1] "The Frangipani a third time acquired lands in the kingdom of Naples. When they possessed in Maremma di Roma, Tolfa, Castello, and a jurisdiction which brings at present eighty thousand crowns annually to the Church, it happened that a son of Paul di Castro, a celebrated doctor, and a vassal of these lords, who had been many years a slave in Turkey to an alum-merchant, returned free to his own country; and observing that in the territories of Tolfa there was abundance of alum mineral, he gave notice of it to Lodovico Frangipani, his lord, and was the cause of greatly increasing his revenues. Pope Paul II., however, pretending that the mineral belonged to the Apostolic See, as supreme lord of the fief, and not being able to persuade Lodovico to give it up to the Church, he declared war against him, but was vigorously opposed by Lodovico and his brother Peter, lords of Tolfa, assisted by the Orsini their relations; so that the Pope was obliged to bring about an accommodation with them by means of king Ferrante I., and to pay them as the price of Tolfa sixteen thousand crowns of gold, of which Lodovico gave twelve thousand to the king, and was invested by him in the lordship of Serino in the year 1469."

[2] Ferbers Briefe über Welschland, p. 246.

others, that he learned the art of boiling alum from a citizen of Corneto, a town in the dominions of the Pope, and from a Genoese, both of whom had acquired their knowledge in the Levant[1]. But as I do not wish to ascribe a falsehood to the

island of Hiscla, formerly called Ænaria, near Puteoli, and in the cave of Vulcan at Lipari, which, being formerly exhausted by the Romans, is now almost destitute of that substance. I have however found seven hills, so abundant in it, that they would be almost sufficient to supply seven worlds. If you will send for workmen, and cause furnaces to be constructed, and the stones to be calcined, you may furnish alum to all Europe; and that gain which the Turk used to acquire by this article, being thrown into your hands, will be to him a double loss. Wood and water are both plenty, and you have in the neighbourhood the port of Civita Vecchia, where vessels bound to the West may be loaded. You can now make war against the Turk: this mineral will supply you with the sinews of war, that is money, and at the same time deprive the Turk of them.' These words of Castro appeared to the Pontiff the ravings of a madman: he considered them as mere dreams, like the predictions of astrologers; and all the cardinals were of the same opinion. Castro, however, though his proposals were often rejected, did not abandon his project, but applied to his Holiness by various persons, in order that experiments might be made in his presence, on the stones which he had discovered. The Pontiff employed skilful people, who proved that they really contained alum; but lest some deception might have been practised, others were sent to the place where they had been found, who met with abundance of the like kind. Artists who had been employed in the Turkish mines in Asia were brought from Genoa; and these, having closely examined the nature of the place, declared it to be similar to that of the Asiatic mountains which produce alum; and, shedding tears for joy, they kneeled down three times, worshiping God, and praising his kindness in conferring so valuable a gift on our age. The stones were calcined, and produced alum more beautiful than that of Asia, and superior in quality. Some of it was sent to Venice and to Florence, and, being tried, was found to answer beyond expectation. The Genoese first purchased a quantity of it, to the amount of twenty thousand pieces of gold; and Cosmo of Medici for this article laid out afterwards seventy-five thousand. On account of this service, Pius thought Castro worthy of the highest honours and of a statue, which was erected to him in his own country, with this inscription: 'To John di Castro, the inventor of alum;' and he received besides a certain share of the profit. Immunities and a share also of the gain were granted to the two brothers, lords of Tolfa, in whose land the aluminous mineral had been found. This accession of wealth to the Church of Rome was made, by the divine blessing, under the pontificate of Pius II.; and if it escape, as it ought, the hands of tyrants, and be prudently managed, it may increase and afford no small assistance to the Roman Pontiffs in supporting the burdens of the Christian religion." —Pii Secundii Comment. Rer. Memorab. quæ temp. suis contigerunt. Francof. 1614, fol. p. 185.

[1] "This year (1460) is distinguished by the discovery of alum at Tolfa

Pontiff, I am of opinion that the history of this discovery must have been best known to him. He has not, indeed, established the year with sufficient correctness; but we may conclude from his relation that it must have been 1460 or 1465. The former is the year given by Felician Bussi; and the latter that given in the history of the city of Civita Vecchia.

The plant which first induced John di Castro to search for alum was that evergreen, prickly shrub, the *Ilex aquifolium*, or holly, which in Italy is still considered as an indication that the regions where it grows abound with that salt. But though it is undoubtedly certain that the quality of the soil may be often discovered by the wild plants which it produces, it is also true that this shrub is frequently found where there is not the smallest trace of alum; and that it is not to be seen where the soil abounds with it, as has been already remarked by Boccone[1] and Tozzetti[2].

Among the earliest alum-works may be reckoned that which was erected at Volterra, in the district of Pisa, in 1458, by a Genoese named Antonius[3]. Others say that it was constructed by an architect of Sienna; but this opinion has perhaps arisen only from the work having been farmed by a citizen of Sienna, or built at his expense. On account of this alum-work

vecchia, no one there having been acquainted with it till that period: and this happened by means of one John di Castro, who had acquired some knowledge of it from a young man of Corneto, and a Genoese, who had learned in Turkey the whole process of making it. The said John having observed that in the mountains of Tolfa there were undoubtedly veins of alum, he caused some of the earth and stones to be dug up, and the first experiments were made on them at Viterbo in the following manner. The stones were first calcined in a furnace; a large quantity of water was then thrown over them; and when they were entirely dissolved, the water was boiled in great leaden caldrons; after which it was poured into wooden vessels, where, evaporating by degrees, the result was alum of the most perfect kind. Pope Pius II., sensible of the great benefit which might arise from this mineral to the Apostolic Chamber, employed more than eight hundred persons at Tolfa in preparing it."—Historia della Città de Viterbo, di Feliciano Bussi. In Roma 1742, fol. p. 262.

[1] Museo di Fisica, &c. Ven. 1697, p. 152. [2] Viaggi, vii. p. 234.

[3] Anno 1458. "Rock alum, which the Greeks call *pharno*, was at this time first discovered by a Genoese in the territories of Volterra, where being boiled and found to be good, it began to be dug up afterwards in many of the mountains of Italy. Till that period the Italians had made no use of mines of this kind; for our alum was all brought from Turkey. The above discovery was therefore a great advantage to us."

an insurrection of the inhabitants of Volterra broke out in 1472; but it was at length quelled by the Florentines, who took and plundered the city[1]. Brutus, who wrote his History of Florence in the year 1572, says that this alum-work was carried on in his time: but this is certainly false; for Raphael di Volterra[2], who died in 1521 in his native city, expressly tells us that in his time alum was no longer boiled there; and this is confirmed by Baccius[3], who also lived in the sixteenth century. At present no remains of it are left; so that Tozzetti was not able to discover the place where the alum-stones were broken[4].

It appears from what has been said, that the art of boiling alum in Europe was first known in Italy, but not before the year 1548. That document therefore of the year 1284, quoted by Tozzetti, and in which alum-works, *alumifodinæ*, are mentioned, must, as he himself thinks, be undoubtedly false[5].

The great revenue which the Apostolical Chamber derived from alum, induced many to search for aluminous minerals, and works were erected wherever they were found. Several manufactories of this substance were established therefore in various parts, which are mentioned by Baccius[6], Biringoccio, and other writers of the sixteenth century. The pope however understood his own interest so well, that he never rested until he had caused all the works erected in the territories of others to be given up, and until he alone remained master of the prize. He then endeavoured by every method possible to prevent foreigners from acquiring an accurate knowledge of the art of boiling alum; and at the same time found means, by entering into commercial treaties with other nations, and by employing the medium of religion, which has always the greatest effect on weak minds, to extend his commerce in this article more and more. The price was raised from time to time, and it at length became so high that foreigners could purchase this salt at a cheaper rate from the Spaniards, and even when they sent for it to Turkey. His Holiness, that he might convert this freedom of trade into a sin, and prevent it

[1] An account of this dispute between the Florentines and the people of Volterra may be seen in Machiavelli's History of Florence, book vii.
[2] Rap. Volaterrani Comment. Urbani.
[3] De Thermis.
[4] Viaggi, iii. p. 117.
[5] Ibid. vii. p. 51
[6] De Thermis, p. 293. Tozzetti, iv. p. 186.

by the terror of excommunication, artfully gave out that he meant to set apart the income arising from his alum-works to the defence of Christianity; that is, towards carrying on war against the Turks. Prohibitions and threats now followed in case any one should be so unchristian as to purchase alum from the Infidels; but every person was at liberty to make what bargain he could with his Holiness for this commodity.

In the year 1468 Pope Paul II. entered into a commercial treaty respecting alum with Charles the Bold, duke of Burgundy; but in 1504 Roman alum had risen to such an exorbitant price, that Philip the Fair, archduke of Austria, caused a council of inquiry to be held at Bruges, by which it appeared that this article could be purchased at a much cheaper rate in Turkey. Commissions therefore were sent thither for that purpose; but scarcely was this known at Rome, when a prohibition, under pain of excommunication, was issued by Pope Julius II. This pontiff however was not the only one from whom such prohibitions proceeded: bulls of the like kind were issued also by Julius III., Paul III., Paul IV., Gregory XIII. and others[1].

But these means, like all those founded on the simplicity of others, could not be of long duration; and as soon as men became a little more enlightened, they learned to know their own interest, and to discover the selfishness of the Pope's bulls. Unless Biringoccio, who visited a part of the German mines, be under a mistake, the first European alum-work out of Italy was erected in Spain; and is that still carried on with considerable profit at Almacaron, not far from Carthagena[2]. In the beginning of the sixteenth century very large quantities of alum were brought to Antwerp, as we learn from Guicciardini's Description of the Netherlands.

At what time the first alum-work was erected in Germany, I am not able to determine; but it appears that alum began to be made at Oberkaufungen in Hesse in the year 1554. For the alum-work at Commotau in Bohemia, the first letters-patent were granted in 1558. An alum-work was established at Lower Langenau in the county of Glatz in 1563; but it

[1] Nicol. Rodrig. Fermosini Tractatus Criminalium. Lugd. 1670, 2 vol. fol. tom. ii. p. 63.

[2] Pyrotechn. p. 31. He says expressly that this was the only alum-work in Europe in his time without the boundaries of Italy.

was soon after abandoned. Several other manufactories of alum are mentioned by Agricola, such as that of Dieben or Duben, in the circle of Leipsic, and those of Dippoldiswalda, Lobenstein, &c.

In England the first alum-work was erected at Gisborough in Yorkshire, in the reign of queen Elizabeth; though Anderson[1] says in 1608. Sir Thomas Chaloner, who had an estate there, conjecturing from the nature of the plants which grew wild that there must be minerals in the neighbourhood, after making some search, at length discovered alum. As there was however no one in England at that time who understood the method of preparing it, he privately engaged workmen belonging to the Pope's alum-works; and it is said, that as soon as the Pontiff heard this, he endeavoured to recall them by threats and anathemas. These however did no injury to the heretics; and in a little time the alum-work succeeded so well, that several more of the same kind were soon after established[2]. But what more dishonoured the Pontiff's de-

[1] History of Commerce, iv. p. 406. "The manufacture of alum," says he, "was first found out in England, and carried on with success in 1608. It was supported and patronized in the county of York by lord Sheffield, sir John Bourcher, and other landholders of the said county, to the great benefit of England in general, and of the proprietors in particular, to the present day. King James was a great promoter of this alum-work, after he had by the advice of his minister appropriated to himself a monopoly of it, and forbidden the importation of foreign alum."

[2] Such is the account of Pennant in his Tour in Scotland, 1768. "The alum-works in this country are of some antiquity; they were first discovered by sir Thomas Chaloner in the reign of queen Elizabeth, who observing the trees tinged with an unusual colour, made him suspicious of its being owing to some mineral in the neighbourhood. He found out that the strata abounded with an aluminous salt. At that time the English being strangers to the method of managing it, there is a tradition that sir Thomas was obliged to seduce some workmen from the Pope's alum-works near Rome, then the greatest in Europe. If one may judge from the curse which his Holiness thundered out against sir Thomas and his fugitives, he certainly was not a little enraged; for he cursed by the very form that Ernulphus has left us, and not varied a tittle from that most comprehensive of imprecations. The first pits were near Gisborough, the seat of the Chaloners, who still flourish there notwithstanding his Holiness's anathema." The following passage, extracted from Camden's Britannia, is much to the same purpose: "This (alum) was first discovered a few years since (anno 1607) by the admirable sagacity of that learned naturalist sir Thomas Chaloner, knt. (to whose tuition his majesty (king James the First) com-

nunciations was, that in later times the proprietors of the English alum-works farmed those of the Apostolic Chamber, and increased in various ways the benefit derived from them[1].

At what period alum-works were established in other countries I have not been able to learn. I however know that one was erected at Andrarum[2] in Sweden in 1630.

[The process for obtaining alum from the alum-stone of Tolfa, which is also found in Hungary, Auvergne, and other parts of the world, and which contains *all* the ingredients requisite for the production of alum, has been fully described. The greater portion however of the alum manufactured in this country is obtained from alum-slate,—a bituminous schist containing iron-pyrites (sulphuret of iron) diffused in extremely fine particles throughout its mass. Many of these schists crumble to pieces when they are exposed to the air; the sulphur of the pyrites becomes gradually converted by the absorption of oxygen from the atmosphere into sulphuric acid, while, at the same time, the iron is peroxidized, and having in this state no very great affinity for the sulphuric acid, parts with the greater portion of it to the clay, which is thus converted into sulphate of alumina. Many of these schists are of such a loose texture, and contain the pyrites in so fine a state of division, that the requisite heat is generated by the rapidity with which the several chemical changes proceed; others, from their compactness and deficiency in combustible matter, require calcining by a slow smothered fire. When the calcination is complete, the mass is lixiviated, the solutions are run into cisterns for evaporation, and when they have attained a certain strength, are precipitated with sulphate or muriate of potash or ammonia. The precipitated alum is washed, drained,

mitted the delight and glory of Britain, his son prince Henry), by observing that the leaves of trees were of a more weak sort of green here than in other places, &c."

[1] "For some time past the marquis of Lepri has farmed the alum-works at Civita Vecchia for 37,000 scudi. The Apostolical Chamber supplies the necessary wood, which the marquis must be at the expense of cutting down and transporting. About two hundred men are employed in the works; and alum to the amount of from forty-five thousand to fifty thousand scudi is sold annually, particularly to the English and the French." See Voyage en Italie, par le Baron de R. (Riesch.) Dresden, 1781, 2 vols. 8vo.

[2] Voyages Metallurgiques, par M. Jars, vol. iii. p. 297.

and separated from various impurities by re-solution and crystallization, and is then fit for the market.

A very interesting process has recently been patented by Dr. Turner of Gateshead[1]. It consists in fusing felspar, which is a silicate of potash and alumina, with more potash. On treating the fused mass with water, it is separated into two parts; the first, a solution containing silicate of potash, from which the potash may be obtained by passing through it a stream of carbonic acid gas, or by filtering it through a bed of caustic lime; the second, an insoluble residue, consisting of a silicate of alumina and potash. On digesting this with sulphuric acid, the silica is separated and a solution of alum obtained.]

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## FALCONRY.

THE question whether Falconry was known to the ancient Greeks, has been determined in the negative by Flavius Blondus[2], Laurentius Valla[3], both writers of the fifteenth century;

[1] See Chemical Gazette for July 15, 1843.

[2] This author, Blondus or Biondo, describing an Italian village, says, "I shall embrace this opportunity of mentioning a new circumstance, which is, that fowling with that rapacious bird the falcon, a diversion much followed at Arno, by the celebrated Alphonsus king of Arragon, was entirely unknown about two hundred years ago; for though Servius, the grammarian, says that Capua received that name from the augury of a falcon, because the Hetruscans, when founding it, saw one of these birds, which in their language was called *capis*; yet he does not tell us of what use they were to mankind. Besides, Pliny, who gives the names of many rapacious birds of the hawk kind ('accipitres scilicet majores et minores achilvones, quos aliqui falcones fuisse volunt'), says nothing of their being employed to catch game; and, without doubt, had fowling in this manner been practised in the time of Virgil, he would have made Æneas and Dido carry such birds along with them when they went out a hunting, whereas he says only,

'Massylique ruunt equites et odora canum vis.'

I will venture therefore to affirm, that two hundred years ago, as I have already said, no nation or people were accustomed to catch either land- or water-fowls with any rapacious bird tamed for that purpose." I shall here observe, that Biondo must have had a faulty copy of Pliny; for the word *achilvones* is not to be found in that author, who, nevertheless, mentions the practice of fowling with birds of prey.

[3] Valla, the most learned man of the century in which he lived, contra-

and likewise by Rigallius[1], Pancirollus, Salmuth, and many others. It may, nevertheless, be here asked, what is generally understood under that term? However much the thousand barks which carried the Grecians to the siege of Troy might have been inferior to those floating castles lately seen by my countrymen before Gibraltar, they were nevertheless ships; and we cannot, on that account, deny that the Greeks were acquainted with the art of ship-building, though it was evidently then in its infancy. In the like manner I agree with Giraldus[2], in allowing that they had some knowledge of falconry. I do not believe that they knew the art of hawking, that is, of chasing game with birds of prey previously trained, as practised in modern times, and which serves more for the amusement of trifling princes than for any useful purpose; but that they had begun to employ the rapacity of some of the winged tribe in hunting and fowling, cannot, in my opinion, be denied[3].

So early as the time of Ctesias, hares and foxes were hunted in India by means of rapacious birds[4]. The account of Aristotle however is still more to the purpose, and more worthy of notice[5]. "In Thrace," says he, "the men go out to catch birds with hawks[6]. The men beat the reeds and bushes which

dicts Antonius Renaudensis, who says, *Nola* is a hawk's bell. "If *Nola*," says Valla, "be an old word, it cannot signify that bell now worn by hawks, because the ancients never tamed these birds for catching game, as we do, nor ornamented them with bells. If it be a new word, let him produce the author from whom it is taken."—Laurentii Vallæ Opera. Basiliæ, 1543, fol. p. 433.

[1] In the preface to Scriptores Rei Accipitrariæ.

[2] Gyraldi Dialogismi, in Op. Lugd. 1696, fol. ii. p. 870.

[3] Those who are desirous of being acquainted with the art of falconry, may consult Pluche, Spectacle de la Nature, vol. i., or the article Fauconnerie, in the French Encyclopédie.

[4] See Herodotus.

[5] "In that part of Thrace, called formerly Cedropolis, the men go out into the marshes in quest of birds, accompanied by falcons. The men beat the trees and bushes with poles, and put the birds to flight; the hawks fly after them, by which means they are so frightened that they fall to the ground, where the men strike them with their poles and kill them."—Histor. Animal. lib. ix. c. 6.

[6] The Grecian authors above quoted call the rapacious birds used for pursuing game ἱέρακες; and Pliny calls them *accipitres*. It would be

grow in marshy places, in order to raise the small birds, which the hawks pursue and drive to the ground, where the fowler kills them with poles." A similar account is to be found in another book ascribed also to Aristotle, which appears, at any rate, to be the work of an author not much younger, but with two additions, which render the circumstance still more remarkable[1]. The first is, that the falcons appeared when called by their names; and the second, that of their own accord they brought to the fowlers whatever they caught themselves. Nothing is here wanting but the spaniel employed to find out game, the hood which is put upon the head of the hawk while it is perched on the hand, and the thong used for holding it, to form a short description of falconry as still practised. Our falconers, when they have taken the bird from the hawk, give him, in return, a small share of it; and in the like manner the Thracian hawks received some part of their booty. Other writers after Aristotle, such as Antigonus[2],

difficult, perhaps impossible, to distinguish with sufficient accuracy all the species of these birds to which the ancients gave different names. This genus is numerous, and the species often differ so little from each other, that it is not easy to establish their characterizing marks. Besides, they for the most part change their colour, and often their whole appearance, according to their age or the season of the year; so that these characters become very uncertain. It appears that on this account the ancients often divided one species into two or more, and imagined that many species passed one into the other, or that new species were produced by the mixture of different breeds. It seems however certain that the ancients divided those birds of prey which fly abroad in the day-time, into three species: ἀετὸς aquila; γὺψ vultur; and ἱέραξ accipiter. The first and last belong to that genus which Linnæus calls *falco*, and are the large species of it. The vultures are the Ger-falcons, which are sufficiently distinguished by their bald head and neck.

[1] "Respecting Thrace which is situated above Amphipolis, a wonderful thing is related, which might appear incredible to those who had never heard it before. It is said that boys go out into the fields, and pursue birds by the assistance of hawks. When they have found a place convenient for their purpose, they call the hawks by their names, which immediately appear as soon as they hear their voices, and chase the birds into the bushes, where the boys knock them down with sticks and seize them. What is still more wonderful, when these hawks lay hold of any birds, they throw them to the fowlers; but the boys, in return, give them some share of the prey."—De Mirabilibus Auscultat. cap. 128.

[2] Antigoni Carystii Historiæ Mirabiles, cap. 34.

Ælian[1], Pliny[2], and Phile[3], have also given an account of this method of fowling. Ælian, who seldom relates anything without some alteration or addition, says that in Thrace nets were used, into which the birds were driven by the hawks; and in this he is followed by the poet Phile. Ælian, also, in another place describes a manner of hunting with hawks in India, which, as we are told by several travellers, is still practised in Persia, where it is well understood, and by other eastern nations[4].

It seems, therefore, that the Greeks received from India and Thrace the first information respecting the method of fowling with birds of prey; but it does not appear that this practice was introduced among them at a very early period. In Italy, however, it must have been very common, for Martial and Apuleius speak of it as a thing everywhere known.

[1] "Hawks, which are no less fit for fowling than eagles, and which are not inferior to them in size, are of all birds reckoned to be the tamest and the fondest of man. I have heard that in Thrace they accompany people when they go out in quest of birds in the fens. The fowlers, having spread their nets, remain quiet, while the hawks flying about terrify the birds, and drive them into them. When the Thracians catch any birds, they divide them with the hawks, by which means they render them faithful partners in fowling; if they did not give them a share of the booty, they would be deprived of their assistance."—Histor. Anim. lib. ii. cap. 42.

[2] Lib. x. c. 8. In a part of Thrace above Amphipolis, men and hawks go out a-fowling, as it were in company. The former drive the birds from among the bushes and reeds, and the latter flying after them strike them down. The fowlers divide with them their prey.

[3] Phile De Animal. Proprietate, p. 36. Gesner, in his Hist. Anim. lib. iii., has collected all the information to be found respecting that species of hawk or falcon called *κίρκος*, circus.

[4] "The Indians hunt hares and foxes in the following manner. They do not employ dogs, but eagles, crows, and, above all, kites, which they catch when young, and train for that purpose. They let loose a tame hare or fox, with a piece of flesh fastened to it, and suffer these birds to fly after it, in order to seize the flesh, which they are fond of, and which, on their return, they receive as the reward of their labour. When thus instructed to pursue their prey, they are sent after wild foxes and hares in the mountains; these they follow in hopes of obtaining their usual food, and soon catch them and bring them back to their masters, as we are informed by Ctesias. Instead of the flesh, however, which was fastened to the tame animals, they receive as food the entrails of the wild ones which they have caught."—Æliani Hist. Animal. lib. iv. c. 26. Compare with this what Pluche says in Nature Displayed, and the accounts given by Chardin and Gemelli Carreri.

The former calls a hawk a fowler's servant, and the latter makes use of a kind of pun on the word *accipiter*, which signified also a species of fish[1]. It cannot indeed be said that this art was ever forgotten; but, like other inventions, though at first much admired, it was afterwards neglected, so that it remained a long time without improvement. It is however certain that it was at length brought to the utmost degree of perfection. It is mentioned in the Roman laws[2], and in writers of the fourth and fifth centuries.

Julius Firmicus Maternus, who in the time of Constantine the Great, about the year 336, wrote his Astronomicon, in which he teaches the art of casting nativities, assures us that those who are born under certain signs will become great sportsmen, and keep hounds and falcons[3]. Caius Sollius Apollinaris Sidonius, who lived about the year 480, celebrates Herdicius, his wife's brother, and son of the emperor Avitus, because he first practised in his territories hunting and fowling with dogs and hawks. The same author mentions hawking also in other parts of his work. That this diversion, however, has not been oftener spoken of and praised, needs excite little wonder. Hunting, and all the concomitant arts, were at first employed for use; in the course of time they were practised by servants, and easy means only of catching game were sought for. But when luxury was introduced into states, and the number of those who lived by other people's labour increased, these idlers began to employ that time which they had not learned to make a proper use of, or which they were not compelled to apply to more valuable purposes, in catching wild animals by every method that ingenuity could suggest, or in tormenting them by lingering deaths. Hunting and fowling, therefore, received many improvements by the

[1] Martial. Epigr. lib. xiv. 216. [2] Digest. lib. xliii. tit. 24, 22.

[3] "Those born when the planet Venus is in Aquarius will be much given to hunting and fowling; in other things they will be slow, indolent, inactive, and melancholy, and will apply to no laudable pursuit. They will, however, be fond of breeding hawks, falcons, eagles, and other birds of the like kind, and horses for hunting. They will be also very ingenious in such exercises, and acquire by them a comfortable subsistence."—Lib. v. c. 7. This nativity displays a knowledge of mankind; for one may without much difficulty find princes and great men with whose lives it exactly corresponds, and who, to the great misfortune of their subjects and tenants, have undoubtedly been born under the sign Aquarius.

assistance of art; and the indolent clergy even indulged in these cruel sports, though often forbidden by the church. Such prohibitions were issued by the council of Agda in the year 506; by that of Epaon in 517; by that of Macon in 585, and perhaps oftener, but never with much effect.

Before I proceed further, I shall make two remarks. First, that Pietro Crescentio gives one Daucus as the inventor of the art of taming hawks, but without proof, or even probability. Secondly, that the ancients bred up to hunting and fishing several rapacious animals which at present are not used for that purpose, such as the seal[1] and sea-wolf[2]. Astruc[3] has endeavoured to confute this idea; but his reasoning appears to me to have little weight; and I agree in opinion with Rondeletius and Isaac Vossius[4], that seals might be instructed to catch fish; I myself have seen some, that, when commanded by their master, exhibited a variety of movements and tricks which undoubtedly prove their aptness to learn.

The art of falconry seems to have been carried to the greatest perfection, and to have been much in vogue at the principal courts of Europe in the twelfth century. Some on that account have ascribed the invention of it to the emperor Frederic I., and others to Frederic II. Frederic I., called Barbarossa, was the first who brought falcons to Italy; at least Pandolfo Collenuccio[5] says that this was the common report, and Radevicus[6] seems to confirm it; but I do not know from what authority Pancirollus tells us that that emperor invented falconry at the time when he was besieging Rome. Rainaldo, marquis of Este, was the first among the Italian princes who used this method of fowling[7]; and that the emperor Henry followed the example of his father, seems proved by the words of Collenuccio. The service rendered by Frederic II. to this art, if it can be said to deserve service, is shown by the book which he wrote in Latin on it, entitled De Arte Venandi cum Avibus, and which was printed for the first time at Augsburg

[1] Plin. lib. ix. Ælian. Hist. Anim. l. ii. Oppiani Halieut. l. v.
[2] Plin. lib. x. cap. 8. Aristot. Hist. an. l. ix. c. 36. Ælian. Hist. An. l. vi. c. 65. Antigonus Caryst. cap. 33.
[3] Histoire Nat. de Languedoc, p. 568. [4] In Obs. on Pomp. Mela, ii. 5.
[5] Istoria di Napoli, Ven. 1613, 4to, i. p. 88.
[6] Radevicus de Gestis Frid. I. lib. ii. cap. ultimo.
[7] See Grævii Thesaurus Antiq. et Hist. vol. vii. p. 12.

in the year 1596, from a manuscript belonging to Joachim Camerarius, a physician of Nuremberg. It has here and there deficiencies, because the manuscript was torn, and some additions by the author's son Manfred, king of Sicily. In the second book, there is an account of the use and manner of making hoods, called *capellæ*, which we are there told were invented by the Arabs. The emperor received as a present some hooded falcons from Arabian princes, and procured people from Arabia who understood the management of them[1]. Albertus Magnus has inserted a great deal from the work of this emperor in his book upon animals.

In none of the sports of the field have the fair sex partaken so much as in falconry. The ladies formerly kept hawks, in which they greatly delighted, and which were as much fondled by those who wished to gain their favour as lap-dogs are at present[2]. What tended principally, however, to bring it into disuse, was the invention of gunpowder. After that, hawks were discarded, and the whole enjoyment of fowling was confined to shooting. Less skill and labour were indeed required in this new exercise; but the ladies abandoned the pleasures of the chase, because they disapproved of the use of fire-arms, which were attended both with alarm and danger.

Among the oldest writers on falconry, we may reckon Demetrius, who about the year 1270 was physician to the emperor Michael Palæologus. His book, written in Greek, was first printed at Paris in 1612, by Nicholas Rigaltius, from a manu-

[1] As this work is extremely scarce, I shall here quote the following passage from it:—"The hood had its origin among the Oriental nations; for the eastern Arabs used it more than any other people with whom we are acquainted, in taming falcons and birds of the same species. When I crossed the sea, I had an opportunity of observing that the Arabs used hoods in this art. Some of the kings of Arabia sent to me the most expert falconers, with various kinds of falcons; and I did not fail, after I had resolved to collect into a book every thing respecting falconry, to invite from Arabia and every other country such as were most skilful in it; and I received from them the best information they were able to give. Because the use of the hood was one of the most effectual methods they knew for taming hawks, and as I saw the great benefit of it, I employed a hood in training these birds; and it has been so much approved in Europe, that it is proper it should be handed down to posterity."

[2] Sainte-Palaye, Mémoires sur l'Ancienne Chevalerie, tom. iii. p. 183. In this work may be found many anecdotes respecting the taste of the French ladies for the sports of the field in the ages of chivalry.

script in the king's library, and with the Latin translation of Peter Gyllius[1]. Some other works on the same subject, the antiquity of which is unknown, were printed at the same time. One in the Catalonian dialect has the forged title of Epistola Aquilæ, Symmachi et Theodotionis ad Ptolemæum regem Ægypti de re accipitraria. All these writings treat chiefly on the rearing and diseases of hawks; and contain cures, which, though some of them perhaps may be good enough, would not undoubtedly be all approved by any person of skill at present[2]. Aloes, to the size of about a bean, are ordered as a purge; and quicksilver is prescribed for the itch and outbreaking. We are told also, that a wild and untractable falcon was confined some time with a hood on in a smith's shop, where it was soon tamed by the continual thumping of the hammers. One precept in Demetrius respecting the art of falconry seems very ill-suited to the practice of modern times. He desires sportsmen to say their prayers before they go out to the field. Had this custom been continued to the present day, many great men would be like the people mentioned by a certain traveller, who solicit the assistance of God when they are preparing for a piratical expedition[3]; but with this difference, that these rovers plunder only strange ships, whereas the latter destroy the property and possessions of their own subjects.

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## TURF.

The discovery, that many kinds of earth, when dried, might be employed as fuel, may have easily been occasioned by an accident in some place destitute of wood. A spark falling fortuitously on a turf-moor during a dry summer often sets it on fire, and the conflagration it occasions generally lasts so

[1] Rei Accipitrariæ Scriptores. Lutet. 1612, 4to.

[2] Among the works of Sir Thomas Brown, there is one on Hawks and Falconry, Ancient and Modern, which, however, consists chiefly of old medical prescriptions.

[3] Remarques d'un Voyageur Moderne au Lévant. Amst. 1773, 8vo.

long that it cannot escape notice[1]. Of the earth taking fire in this manner there are many instances to be found in the ancients. One of the most remarkable is that mentioned by Tacitus, who relates, that not long after the building of the city of Cologne, the neighbouring land took fire, and burned with such violence that the corn, villages, and every production of the fields were destroyed by the flames, which advanced even to the walls of the city[2]. This remarkable passage is not to be understood as alluding to a volcanic eruption, but to a morass which had been set on fire. In the duchy of Berg and around Cologne there are very extensive morasses, from which turf is dug up for fuel, and which undoubtedly serve to confirm this idea.

That the use of turf was well known in the earliest periods in the greater part of Lower Saxony, and throughout the Netherlands, is fully proved by Pliny's account of the Chauci, who inhabited that part of Germany which at present comprehends the duchies of Bremen and Verden, the counties of Oldenburg, Delmenhorst, Diepholz, Huy and East Friesland. Pliny says expressly, that the Chauci pressed together with their hands a kind of peat earth, which they dried by the wind rather than by the sun, and which they used not only for cooking their victuals, but also for warming their bodies[3]. I explain also by turf a short passage of Antigonus Carystius, quoted from Phanias, in which it is said that a morass in Thessaly having become dry, took fire and burned.

The account therefore given in some Dutch chronicles, that turf and the manner of preparing it were first found out about the year 1215, and that about 1222 it had become common, is certainly false[4]. This information may be applicable to

[1] In Siberia, a village which stood on a turf-moor was, on account of its marshy situation, removed to another place; and that the remains might be more easily destroyed, they were set on fire. The flames having communicated to the soil, which was inflammable, occasioned great devastation; and when Gmelin was there, it had been continually burning for half a year. See Gmelin's Reisen durch Russland, vol. i. p. 22.

[2] The rustics, in despair, when they found the fire was unquenchable either by rain or by the river-water which they poured over it, threw in heaps of stones, beat down the flames issuing from the interstices with clubs, and as the fire became subdued flung on their clothes, which being made of skins and wetted, eventually extinguished the conflagration. See Tacitus, An. xiii. 57.

[3] Hist. Nat. lib. xvi. c. 1.

[4] "The foresters, who had then got a new employment, that of turf-

certain lands and districts, and correct as to the introduction of this kind of fuel in those parts; for the use of it was not extended far till a late period; and even yet turf is neither employed nor known in many places which possess it, even though they are destitute of wood [1]. Some improvement in the manner of preparing turf may have also been considered as the invention of this fuel, which is undoubtedly of greater antiquity. What induced Monconys to ascribe the invention of turf to Erasmus, or who first propagated that error, I can as little conjecture as Misson [2].

Scaliger has erred [3] no less than Monconys, whose account was doubted by Uffenbach [4]. According to the first-mentioned author, turf had been used in the Netherlands only about three hundred years before his time, and he adds that he did not know that this kind of fuel had ever been mentioned by the ancients.

Those however are mistaken also who believe that it is to be found in the Salic laws and those of the Alemanni. It is true that the word *turpha* occurs in the former, and that Wendelin and others have declared it to mean turf; but the asser-

digging, which had been before unknown, or at least very uncommon, gave as a present to the monastery of Mariengard, in 1215, several turf-bogs in and near Backefeen."—Chronique van Vriesland door P. Winsemium, 1622, p. 158. That monastery was situated at the distance of two miles from Leeuwaarden.

In Kronijck der Kronijcken, door S. de Vries, printed at Amsterdam in 1688, the following passage occurs, vol. v. p.553:—"About this time (1221) the digging of turf was first practised, which in some measure made amends for the damage occasioned by the sea-water, and by which several acquired great riches."

Some Dutch writers make turf-digging to be of much higher antiquity, and in support of this opinion quote an old chronicle in rhyme, in which mention is made of a donation by Gerolf count of Friesland; but I am not acquainted with the antiquity of that chronicle, and of the letter of donation there is only a Flemish translation. See Berkhey, Nat. Hist. v. Hol. vol. ii. p. 552.

[1] The use of turf was first made known in France in the year 1621, by Charles de Lamberville, advocate of the parliament of Paris, who resided some time in Holland, to which he had been sent by the king on public business. See Anciens Mineralogistes, par Gobet, i. p. 302.

[2] Voyages de Monconys. Lyons, 1666, 2 vol. 4to, ii. p. 129. C'est lui (Erasme) qui a donné l'invention de la tourbe, qu'on brusle au lieu du charbon. See also Misson's Travels.

[3] Scaligerana, ii. p. 243; Je ne sçache aucun ancien, qui fasse mention de tourbes.

[4] Voyages, vol. iii.

tion of Eccard, that it signifies a village, called in German *Dorf*[1], is more probable. Still less can the doubtful word *curfodi*, in the laws of the Alemanni, be supposed to allude to this substance, though we are assured by Lindenbrog that he found in a manuscript, in its stead, the term *zurb*[2]. It is also not credible that turf should be employed at that period, as wood was everywhere superabundant.

The oldest certain account of turf in the middle ages with which I am at present acquainted, is that pointed out by Trotz[3], who says that it occurs in a letter of donation of the year 1113. He has given the words in the Dutch language, as if they had stood so in the original. But he has quoted his authority in so careless a manner, that I have not been able to conjecture what kind of book he meant. I have however found a Latin copy of the letter of donation in a work pointed out to me by Professor Reuss[4]. An abbot Ludolph, in the year 1113, permitted a nunnery near Utrecht to dig *cespites* for its own use in a part of his *venæ*, but at the same time he retained the property of these *venæ*. Now there can be no doubt that *vena* signifies a turf bog, and *cespites* turf. The former is the same word as *Fenne* or *Venne*, which occurs in the old Frisic and the present *Veen*[5] of the Dutch. The nuns also could make no other use of the turf but employ it as fuel. This passage however proves nothing; though Trotz says that a great trade was carried on with turf in the twelfth century, and that the abbot wished to interdict the nuns from using it.

It is worthy of remark that the words *turba*, *turbo*, *turbæ ad focum*, *turfa*, occur for turf, in the years 1190, 1191, 1201 and 1210, as is proved by the instances quoted by Du Cange. *Turbaria* for a turf-moor is found in Matthew Paris, who died in 1259; *Turbagium*, in a diploma of Philip the Fair in the year 1308, signifies the right of digging turf, as *turbare* does to dig up turf. The word *mor* also is found in a document of

[1] Leges Salicæ, ed. Eccardi, p. 42.

[2] Lindenbrogii Codex Legum Antiquarum. Franc. 1613.

[3] Trotz Jus Agrarium Fœd. Belgii, ii. p. 643.

[4] Historia Episcopatuum Fœderati Belgii. Lugd. Bat. 1719, 2 vols. fol. i. p. 130.

[5] Wiarda Altfrisisches Wörterbuch; where it is conjectured, not without probability, that the name Finland is thence derived.—Du Cange, Glossarium, under the word Venna.

the year 1246, quoted by Du Cange; who however has not introduced it into his dictionary [1]. It seems to be the same as *mariscus* and *marescus*. Brito, who lived about 1223, describing the productions of Flanders, says, "Arida gleba foco siccis incisa marescis[2]." That the last of these words signifies a turf-bog is proved by a passage of Lambert, who lived at Ardres about the year 1200: "Quendam similiter mariscum, ut aiunt, proprium perfodi fecit, et in turbas dissecari."

The assertion of Winsem and others, that the practice of digging turf first became common after the year 1215, is undoubtedly founded on information obtained from Sibrand Leo's Vitæ Abbatum Horti Divæ Virginis seu Mariengard[3]; but this writer died in 1588, and can by no means be adduced as an evidence: he even says himself that turf-digging in 1212 was a new occupation.

The conjecture that the Netherlanders, who in the twelfth century established themselves as colonists in some districts of Germany, and particularly Lower Saxony, first made known there the preparation and use of this kind of fuel is improbable, or at any rate not proved [4]. It is improbable, because the Chauci, the oldest inhabitants of that country, burnt turf before that period.

It is related by the Icelanders that Einar, Count or Earl of Orkney or of the Orkney islands, discovered turf there, and on that account was named Torffeinar. He was the son of Raugnwauld, or Rognwald, earl of Mören, Sued and Nordmör in Norway, in the time of the celebrated Norwegian King Harold, commonly called Haarfager or Pulcricomus, on account of his beautiful hair [5]. He must have lived therefore in the middle of

[1] The words are, "Morum dedit dictus comes dictæ ecclesiæ ad turfas fodiendas."

[2] Britonis Philippidos lib. ii. v. 144.

[3] These lives are in Matthæi Veteris Ævi Analecta, Hag. 1738, v. p. 247.

[4] I find quoted for this conjecture the Dissertation, Eelking de Belgis sæculo xii. in Germaniam advenis, Gottingæ, 1770, pp. 162, 164. But nothing further is found there than that the right of digging turf was in all probability confirmed to the colonists. This important Dissertation was written by Professor Wundt of Heidelberg.

[5] This information may be found in Crymogæa, sive rerum Islandicarum libri iii. per Arngrimum Jonam Islandum. Hamburgi (1609), 4to, p. 50. "Torf cujus inventor perhibetur in Orcadibus dux quidam Orcadensis, Einarus Raugnvaldi ducis Norvegici de Maere filius, tempore pulcricomi Norveg. regis, qui idcirco Torffeinarus dictus est."

the ninth century; but on so trifling a subject I shall enter no further into the labyrinth of the Icelandic Saga.

In Sweden turf was first made known at a very modern period by some navigators in the district of Halland; and in the time of Charles XI. much trouble was taken to introduce it as fuel. In 1672 the town of Laholm obtained an exemption from duty for the turf dug up in the lands belonging to it.

In later times turf began to be burned to charcoal, sometimes in kilns, and sometimes in furnaces built for that purpose, by which this advantage is obtained, that it kindles sooner, burns with less air, and forms a more moderate and uniform fire without much smoke. This method of reducing turf to charcoal, which is still practised in some parts of Bohemia, Silesia, and Upper Saxony, was, it appears, proposed about the year 1669, by the well-known John Joachim Becher, who recommended at that time a method of depriving coals of their sulphur by burning them, and the use of naphtha or rock-oil procured from them by that process[1]. The burning of turf to coal seems to have been first made known in Germany by

[1] "In Holland there is turf, and in England there are coals, neither of which are good for burning either in apartments or in melting-houses. I have, however, discovered a method of burning both these to good coals, so that they shall not only produce no smoke or bad smell, but yield a heat as strong for melting metals as that of wood, and throw out such flames that a foot of coal shall make a flame ten feet long. This I have demonstrated at the Hague with turf, and proved here in England with coals, in the presence of Mr. Boyle, by experiments made at Windsor on a large scale. It deserves to be remarked on this occasion, that as the Swedes procure their tar from fir-wood, I have procured tar from coals, which is in everything equal to the Swedish, and even superior to it for some purposes. I have tried it both on timber and ropes, and it has been found excellent. The king himself ordered a proof of it to be made in his presence. This is a thing of very great importance to the English, and the coals after the tar has been extracted from them are better for use than before."—Narrische Weisheit und weise Narrheit. Frankfurt, 1683, 12mo, p. 91. Boyle seems to speak of this invention in The Usefulness of Natural Philosophy, London, 1774, fol. i. p. 515. The burning of coals in order to procure from them rock-oil, which was used particularly by the leather manufacturers, and which on that account could not be exported, was much practised in England. It appears, however, that something of the like kind was attempted before Becher's time; for in the year 1627, John Hacket and Octav. Strada obtained a patent for their invention of rendering coals as useful as wood for fuel in houses without hurting anything by their smoke. See Anderson's History of Commerce.

Hans Charles von Carlowitz, chamber-counsellor, and principal surveyor of the mines of the electorate of Saxony [1]. To save wood and promote the benefit of the mines he sought for turf; and having discovered it, he then endeavoured to find out some method of rendering it fit to be employed in the melting-houses, and this was the reducing to coal, which, as he himself says [2], he first attempted in kilns at Scheibenberg, in the year 1708. At the Brocken the first experiments were made in 1744, with turf which had been dug up several years. This was announced by F. C. Brückman in 1745 [3], as a new invention; but an anonymous writer stated [4] soon after, that this charring had been long used in the district of Hadeln, and that the smiths there employed no other kind of coals for their work.

[In 1842 a patent was taken out by Mr. Williams for compressing peat into a dense mass, resembling coals. It is said to be superior to coal in its properties of producing heat by combustion, forming an excellent charcoal or coke. It is asserted that this charcoal is much more combustible than that of wood, and very useful in the manufacture of fire-works. The process is as follows:—Immediately after being dug it is triturated under revolving edge-wheels faced with iron plates perforated all over the surface, and is forced by the pressure through these apertures, till it becomes a kind of pap, which is freed from the greater part of its moisture by a hydraulic press. It is then dried, and converted into coke in the same manner as pit-coal. The factitious coal of Mr. Williams is made by incorporating pitch or rosin, melted in a caldron with as much peat-charcoal ground to powder as will form a tough doughy mass, which is then moulded into bricks.]

[1] The practice of charring turf appears however to be much older, if it be true that charred turf was employed about the year 1560 at the Freiberg smelting-houses, though that undertaking was not attended with success.—See Hoy's Anleitung zu einer bessern Benutzung des Torfs. Altenburg, 1781.

[2] Von Carlowitz, Sylvicultura Œconomica. Leipzig, 1713, fol. p. 430, where an account is given of the first experiment.

[3] In Hamburgischen Berichten, p. 93.

[4] Ib. p. 170.

## ARTICHOKE.

THAT I might be able to investigate whether our artichoke was known to the ancients, I have not only collected a variety of scattered passages, compared them with one another and with nature, and laboured through a tedious multitude of contradictions and a confusion of names, but I have also been obliged to examine a load of groundless conjectures, heaped together by commentators[1], in order that I might understand them and ascertain their value. By these means I have learned more than seems hitherto to have been known; and I have found that more is believed than can be proved; but that the fruits of my toil will give complete satisfaction to my readers, I do not pretend to hope. Before the botany, however, and the natural history in general of the ancients can be properly elucidated, before truth can be separated from falsehood, what is certain from what is uncertain, and things defined from those which are undefined, researches of this kind must be undertaken, and the same method as that which I have followed must be adopted.

The names of plants in ancient authors which have been applied to our artichoke, are the following: *Cinara*, *Carduus*, *Scolymus*, and *Cactus*.

The *Cinara*, which is originally a Greek word, belonged certainly to the thistle species; and the description of its top, as given by Columella[2], seems, as has already been remarked by Nonnius[3] and others, to agree perfectly with that of our artichoke. The *cinara* was commonly furnished with prickles, but that was preferred which had lost them by cultivation, and for which means were prescribed that did not produce the desired effect[4]. It was raised from seed sown in spring, but was propagated also from slips or shoots which in Italy were

[1] See Stapel, über die Pflanzen des Theophrast. p. 618. Salmasius ad Solinum, p. 159. Casauboni Animadv. in Athen. Lugd. 1621, fol. p. 146. Bauhini Hist. Plant. iii. p. 48.

[2] Colum. lib. x. ver. 235.

[3] Lud. Nonnii Diæteticon. Antv. 1646, 4to, p. 56.

[4] It was said, that if the corners of the seeds were bruised, no prickles would be produced. See Geopon. lib. xii. cap. 39. [It is a well-known physiological fact in botany, that many plants which are naturally spinous, when cultivated in gardens or rich soil, become unarmed. The production

planted in autumn, that they might bear earlier the next summer[1]. The direction given to water these plants frequently, is still followed by our gardeners in respect to their artichokes, and they expect from this attention that the fruit will be more abundant and tender. By this method many give to their artichokes a superiority which others that have not been watered so carefully cannot attain. A complaint, which occurs in ancient authors, is also prevalent, that the roots are often destroyed by mice. I do not, however, find it remarked what part of the *cinara* was properly used, but it may be conjectured it was the top, because the tender fruit is praised[2].

*Carduus*, among the Romans, was the common name of all plants of the thistle kind. It occurs among those of weeds[3], and may be then properly translated by the word *thistle*. It, however, often signified an eatable thistle; and this has given Pliny occasion to make use of an insipid piece of raillery, when he says that luxury prepared as food for man what would not be eaten by cattle.

It is an old and common fault, that when the Greek and Roman authors have not given us such descriptions of natural objects as are sufficient to enable us to ascertain exactly what they are, we suppose that they have been known under different names, and a variety of characteristics are drawn together to enable us to determine them. What, for example, we find respecting the *cinara* is too little to give a just idea of the plant; we read somewhat more of the *carduus*; and because between these there seems to be an affinity, it is concluded that the *cinara* and the *carduus* were the same plant; and everything told us respecting both of them is thrown into one. Some even go further, and add what they find under a third or a fourth name. It is indeed true, that many natural objects have had several names, and the species may sometimes be rightly guessed; but conjecture ought never to be admitted

of spines seems to arise from an imperfect development of the growing point of a plant; when this development is increased by the greater supply of nutriment, the spines disappear, their places being supplied by a branch having leaves. We have instances of this in the apple, pear, &c., which are naturally spinous.]

[1] Geopon. *l. c.* Columella, xi. cap. 3.

[2] Geopon. 925, where repeated watering is directed; it is said you will then have tenderer fruit, and in more abundance.

[3] Virgil. Geor. i. 150. Plin. xviii. cap. 17.

unless the identity can be fully established; else one may form such a monstrous production as Horace has delineated, when he says,

> Humano capiti cervicem pictor equinam
> Jungere si velit, et varias inducere plumas,
> Undique collatis membris—

I wish commentators would follow the example of our naturalists, who consider a plant as a distinct species until it has been proved on sure grounds that it is nothing else than a variety of a plant already characterized. I should not therefore affirm that the *cinara* and the *carduus* are the same, were I not able to produce the following incontestable proofs in support of my assertion.

In the first place, the Latins, Palladius and Pliny, give us the same account of the *carduus* that Columella and the Greeks do of the *cinara*. The former lost its prickles through cultivation [1]; its flowers were also of a purple colour [2]; it was propagated by seed and by shoots; it required frequent watering; and it was remarked that it throve better when the earth was mixed with ashes. Had not the *carduus* and the *cinara* been the same, Palladius and Pliny would have mentioned the latter; for we cannot suppose that they otherwise would have omitted a plant that formed a dish so much esteemed and so well-known among their countrymen. The latter claims to himself the merit of having passed over no one that was held in estimation. In the second place, Virgil has translated the word *cynaros* in a part of Sophocles now lost, by *carduus* [3]; thirdly, Athenæus says expressly, that the *cinara* was by the Latins named *cardus* and *carduus* [4]; and, lastly, the old glossaries explain *cinara* by *carduus*, as we are told by Salmasius. On these grounds, therefore, I am of opinion that the *cinara* and the *carduus* were the same.

[1] Palladius, iv. 9, p. 934, and lib. xi. Octob. p. 987. In the first-mentioned place he gives the same direction for preventing prickles, as that quoted respecting the *cinara*.

[2] Pliny, lib. xx. says, "The wind easily carries away the withered flowers on account of their woolly nature."

[3] Κύναρος ἄκανθα πάντα πληθύει γύην.—Sophocles, in Phœnice.

> . . . . . Segnisque horreret in arvis
> Carduus . . . . . .—Virgil. Georg. i. 50.

[4] Athen. Deipnos. at the end of the second book, p. 70. Salmasius, in his Remarks on Solinus, p. 159, is of opinion that Athenæus wrote κάρδον, not κάρδυον; and the Latins not *carduus*, but *cardus*.

We are informed by Apicius[1] and Pliny[2] in what manner the *carduus* was dressed by the ancient cooks. The latter gives directions for pickling it in vinegar; but neither of them tells us what part of it was eaten. Lister thinks that Apicius speaks of the tops of the young shoots, which, as far as I know, are parts of the artichoke never eaten at present. It is, however, worthy of remark, that the tops (*turiones*) of certain kinds of the thistle family of plants, and among these the common burr[3], are in some countries dressed and eaten like asparagus. It is not improbable also that Pliny and Apicius may have meant the ribs of the leaves; though none of the ancients has taught us the art of binding up, covering with earth, and blanching the *cinara* or *carduus*. This, perhaps, was a new invention of the gardeners; and the cooks may have had other methods of rendering the ribs of the leaves tender and eatable. Had they meant the bottom of the calyx, they would not have omitted to give a circumstantial account of the preparation previous to its being pickled.

The *Scolymus* is by Pliny and Theophrastus reckoned to belong to the genus of the thistles. The former says, that, like most others of the same kind, the seeds were covered by a sort of wool (*pappus*). It had a high stem, surrounded with leaves, which were prickly, but which ceased to sting when the plant withered[4]. It flowered the whole summer through, and had often flowers and ripe seed at the same time; which is the case also with our artichoke plants. The calyx of the *scolymus* was not prickly[5]; the root was thick, black and sweet, and contained a milky juice. It was eaten both raw and cooked; and Theophrastus observes, as something very remarkable, that when the plant was in flower, or, as others explain the words, when it had finished blowing, it was most

[1] Lib. iii. cap. 19. [2] Lib. xix. cap. 8.

[3] *Arctium Lappa*, an indigenous weed, difficult to be rooted out. Elsholz, in his Gartenbau, speaking of the Spanish cardoons, says, "The strong stem of the large burr, *Arctium Lappa*, may be dressed in the same manner, and is not much different in taste." See also Thomas Moufet's Health's Improvement. Lond. 1746, 8vo, p. 217.

[4] Plin. lib. xxi. cap. 16.

[5] Theophrastus: "Conceptus non spinosus, sed oblongus." But Dioscorides says, "Capitulum spinosum." This contradiction, and other small variations, have induced some to consider the *scolymus* of Theophrastus and that of Dioscorides as two different plants.

palatable. What renders this circumstance singular is, that most milky roots used for food lose their milk and become unfit to be eaten as soon as they have blown. This is the case with the goat's beard, which is eatable only the first year.

The *scolymus* however is not the only plant which forms an exception; for the garden Scorzonera retains its milk, and continues eatable after it has bloomed, and as long as it has milk it may be used. According to Theophrastus and Pliny, the roots of the *scolymus* are eatable. On the other hand, Dioscorides says that the roots were not eaten, but the young leaves only: as he informs us, however, that they were dressed like asparagus, it would appear that he meant the young shoots[1]. Theophrastus expressly tells us, that, besides the roots, the flowers also were used as food; and he calls that which was eatable the pulpy part. We have, therefore, full proof that the ancients ate the tops of some plants in the same manner as we eat our artichokes.

It may however be asked, what kind of a plant was the *scolymus*? That it was different from the *cinara* is undoubtedly certain; for Dioscorides[2] expressly distinguishes them; nor was it the eatable *carduus*, for Pliny compares it with the *carduus*, and says that it was characterized from the latter by having roots fit to be eaten. Stapel is of opinion that the *scolymus* is our artichoke; but this seems to me improbable, for the leaves and roots of the latter are not sweet, but harsh and bitter, and the calyx is prickly, which was not the case in the *scolymus* of Theophrastus. Besides, I find nothing in the whole description of the *scolymus* or in the accounts given us by the ancients of the *cinara* and *carduus*, that can be applied to our artichoke alone, and not to any other plant. It may be here replied, that it would be very difficult to ascertain plants from the names of the ancients, were such strong proofs required, because they had not the art of separating the different genera correctly, and of assigning to each certain characterizing marks. This I allow; and for that reason it is impossible to elucidate properly the Greek and Latin names of plants; but, in my opinion, it is better to confess this impossibility, than to deceive oneself with distant probabilities. Let the genus be

[1] Dioscor. iii. 16.

[2] Dioscor. lib. iii. cap. 10, where he says of a plant that its leaves were like those of the *Scolymus*, and its stem like that of the *Cinara*.

ascertained when one cannot ascertain the species; let the order to which the plant belongs be determined when one cannot determine the genus; or, at least, let the class be assigned when there is sufficient authority to do so. The *cinara*, *carduus* and *scolymus* were therefore species of the thistle, of which the roots and young shoots, and also the bottom of the calyx of the last, were eaten. Were I appointed or condemned to form a new Latin dictionary, I should explain the article *Scolymus* in the following manner:—Planta composita, capitata. Caulis longus, obsitus foliis spinosis. Radix carnosa, lactescens, nigra, dulcis, edulis. Calyx squamis inermibus, disco carnoso, ante efflorescentiam eduli. Semina papposa. Turiones edules. This description, short as it is, contains every thing that the ancients have said in order to characterize that plant. It can, indeed, be understood only by those who are acquainted with the terms of botany; but what follows will require no explanation or defining of botanical names.

Should it be said that the *scolymus* must be our artichoke because no other plant of the thistle kind is known the bottom of the calyx of which is eatable, I would in answer observe:—First, other species may have been known in ancient times, which perhaps have been disused and forgotten since the more pleasant and delicious artichoke became known. It is certain that many old plants have in this manner been banished from our gardens by the introduction of new ones. Thus have common alexanders (*Smyrnium olusatrum*) fallen into neglect since celery was made known by the Italians, about the end of the seventeenth century; and so at present has the cultivation of winter-cresses (*Erysimum barbarea*), bulbous-rooted chærophyllum (*Chærophyllum bulbosum*), rocket (*Brassica eruca*), and others, been abandoned since better vegetables have been obtained to supply their place. Secondly, it is certain that, even at present, the bottom of the calyx of some others of the thistle-kind, besides the genus of the artichoke, is eaten; su h as the cotton-thistle (*Onopordum acanthium*), and the carline thistle (*Carlina acaulis*), without mentioning the sun-flowers which has been brought to us in modern times from South America.

Without engaging to examine all the hypotheses of commentators and ancient botanists on this subject, I shall take notice of one conjecture, which, upon mature consideration,

appears to have some probability. Clusius[1] is of opinion that the plant called by the botanists of the seventeenth century *Carduus chrysanthemus*, and by those of the present age *Scolymus hispanicus*, the golden thistle, is the *scolymus* of Theophrastus; because its leaves, beset with white prickles, and its pulpy, sweet, milky roots are eaten, and excel in taste all roots whatever, even those of skirret; and because it was collected and sold in Spain, Italy, and Greece. But what has principally attracted my attention to this conjecture, is the account of Bellon[2], that this plant in Crete or Candia is called still by the Greeks there *ascolymbros*. This name seems to have arisen from *scolymos*; and besides Stapel[3] found in an old glossary the word *ascolymbros*. I am likewise convinced that, as Tournefort[4] has said, the botany of the ancients would be much illustrated and rendered more certain, were the names used by the modern Greeks known. It is certain that many old names have been preserved till the present time with little

[1] Rariorum Plantarum Historiæ, lib. iv. p. 153.

[2] "In Crete there is a kind of prickly plant, which in the common Greek idiom is generally called *ascolimbros*. The ancient Latins called it also by a Greek name, *glycyrrhizon*, though different from *glycyrrhiza* (liquorice). It grows everywhere spontaneously, has a yellow flower, and abounds with a milky juice. The roots and leaves are usually eaten before it shoots up into a stem. We saw it exposed for sale with other herbs in the market-place of Ravenna, and at Ancona, where the women who were digging it up, gave it the name of *riuci*. We saw it gathered also in the Campagna di Roma, where the inhabitants called it *spinaborda*. This is the plant which by the modern Greeks is named *ascolimbros*."—Bellonii Observationes, lib. i. cap. 18. "In Crete it is called *ascolymbros*, and in Lemnos *scombrouolo*, that is *scombri carduus*. This thistle abounds with a milky juice, like succory, has a yellow flower, and is excellent eating; so that I know no root cultivated in gardens which can be compared to it in taste, the parsnip not even excepted."

[3] Theophrast. Hist. Plant. p. 620. The figure which Stapel gives, p. 621, is not of the *Scolymus hispanicus*, but of *Scolymus maculatus*. It is taken from Clusius, who has also a figure of the former.

[4] "I considered the heads of these poor Greeks as so many living inscriptions, which preserve to us the names mentioned by Dioscorides and Theophrastus. Though liable to different variations, they will. doubtless, be more lasting than the hardest marble, because they are every day renewed, whereas marble is effaced or destroyed. Inscriptions of this kind will preserve, therefore, to future ages the names of several plants known to those skilful Greeks who lived in happier and more learned times."—Voyage du Levant, i. p. 34. Compare with the above what Haller says in his Biblioth. Botan. i. p. 28.

variation; but nevertheless I can as little admit the assertion of Clusius as that of Stapel; for *Scolymus hispanicus* has neither the bottom of the calyx pulpy, nor wool adhering to the seeds, like the *scolymus* of Theophrastus; and the young roots only can be eaten, because, like those of most plants of the genus of the thistle, they lose their milk when the flower is in bloom; lastly, the leaves retain their power of pricking, even after they have become withered.

The fourth name which, with any kind of probability, has been translated by the word artichoke is *cactus*. This plant, which, in the time of Theophrastus and Pliny, grew only in Sicily and not in Greece, had broad prickly leaves [1]; the flower was filled with a kind of wool, which, when eaten inadvertently, was pernicious [2]; the calyx was prickly: and, besides a long stem, it shot forth branches which crept along the ground [3], and which, when the outer rind had been peeled off, were eaten either fresh, or pickled in salt water [4]. The bottom of the calyx of this plant was likewise used, after it had been freed from its seeds and woolly substance [5]. It had a great resemblance to the pith of the palm-tree [6].

That the *cactus* was different from the *scolymus* we are expressly told by Theophrastus; and Pliny also distinguishes them both from each other and from the *carduus*. Athenæus [7] is the only author who says that the *cactus* and the *cinara* were the same; but he gives no other proof than a very simple

[1] Plin. lib. xxi. cap. 16. See Theophrast. lib. vi. cap. 4. Theoocritus, Idyll. x. 4, mentions a lamb wounded in the foot by a *cactus*. Tertullian names this plant among prickly weeds, together with the *rubus*, in the end of the second chapter of that unintelligible book De Pallio. De la Cerda, in his excellent edition of Opera Tertulliani, Lutetiæ Paris. 1624, 2 vols. fol. i. p. 13, reads *carecto* instead of *cacto*; but Salmasius, in his edition of that work, p. 172, has sufficiently vindicated the latter.

[2] Dioscorid. Alexipharm. cap. 33.

[3] Theoph. p. 613.

[4] The creeping branches were in particular called *cacti*, the upright stem *pternix*.

[5] Theophrastus calls the bottom of the calyx περικάρπιον, a word which is still retained in botany. But he also says that the same part of the *cactus* was called also σκαλία; from which is derived the *ascalia* of Pliny. Galen calls it σπόνδυλον.

[6] Theoph. This term is explained by Pliny, lib. xiii. c. 4:—"Dulcis medulla palmarum in cacumine, quod cerebrum appellant."

[7] Athen. Deipnos. at the end of the second book, p. 70. He gives everything to be found in Theophrastus; but either the author or some of his transcribers have so confused what he says, that it is almost unintelligible.

etymology. It must therefore be admitted that the *cactus* was a species of the thistle kind entirely different from any of the former.

I think I have proved, therefore, that the Greeks and the Romans used the pulpy bottom of the calyx, and the most tender stalks and young shoots of some plants reckoned to belong to the thistle kind, in the same manner as we use artichokes and cardoons; and that the latter were unknown to them. It appears to me probable that the use of these plants, at least in Italy and Europe in general, was in the course of time laid aside and forgotten, and that the artichoke, when it was first brought to Italy from the Levant, was considered as a new species of food. It is undoubtedly certain that our artichoke was first known in that country in the fifteenth century. Hermolaus Barbarus, who died in 1494, relates that this plant was first seen at Venice in a garden in 1473, at which time it was very scarce[1]. About the year 1466, one of the family of Strozzi brought the first artichokes to Florence from Naples[2]. Politian, in a letter in which he describes the dishes he found at a grand entertainment in Italy in 1488, among these mentions artichokes[3]. They were introduced into France in the beginning of the sixteenth century[4]; and into England in the reign of Henry the Eighth[5].

Respecting the origin of the name various conjectures have been formed, none of which, in my opinion, are founded even on probability. Hermolaus Barbarus, Henry Stephen, Ruellius, Heresbach, and others think that *artichoke* or *artichaut*, as it is called by the French, and *arciocco* by the Italians, is derived from the Greek word *coccalus*, which signifies a fir-cone, with the Arabic article *al* prefixed, from which was formed *alcocalon*, and afterwards the name now used[6]. This etymology is contradicted by Salmasius[7], who denies that *coccalus* had ever that signification. He remarks also that artichokes were by the Arabs called *harsaf*, *harxaf*, or *harchiaf*; and he seems not disinclined to derive the name from these

[1] Herm. Barbar. ad Dioscor. iii. 15.
[2] Manni de Florentinis inventis commentarium, p. 34.
[3] Politiani Opera. Lugd. 1533, 8vo, p. 444.
[4] Ruellius De Natura Stirpium. Bas. 1543, fol. p. 485.
[5] Hakluyt, vol. ii. p. 164. Biographia Britannica, vol. iv. p. 2462; and Anderson's History of Commerce.
[6] Herm. Barbarus, in his Observations on Dioscorides.
[7] Salmas. ad Solin. p. 160.

appellations[1]. Grotius, Bodæus, and some others, derive it from a Greek word[2], which occurs in Alexander Trallianus, and which is supposed to signify our plant; but that word is to be found in this author alone, and in him only once; so that the idea of these critics appears to me very improbable. Frisch affirms, in his dictionary, that our modern name is formed from *carduus* and *scolymus* united. Ihre[3] considers the first part of the name as the German word *erde* (the earth), because it is often pronounced *erdschoke*; but I rather think that the Germans changed the foreign word *arti* into the word *erde*, which was known to them, in the same manner as of *tartuffolo* we have made *erdtoffeln*[4]; besides, Ihre leaves the latter part unexplained[5]. In the seventeenth century the plant was often called *Welsch distel* (Italian thistle), because the seeds were procured from Italy, and also *Strobeldorn*, a word undoubtedly derived from *strobilus*.

Were the original country of the artichoke really known, the etymology of the name, perhaps, might be easily explained. Linnæus says that it grew wild in Narbonne, Italy, and Sicily, and the cardoons in Crete; but, in my opinion, the information respecting the latter has been taken only from the above-quoted passage of Bellon, which is improperly supposed to allude to the artichoke. As far as I know, it was not found upon that island either by Tournefort or any other traveller. Garidel, however, mentions the artichoke under the name given it by Bauhin, *cinara sylvestris latifolia*, among the plants growing wild in Provence; but later authors assure us that they sought for it there in vain[6]. I shall here remark that the artichoke is certainly known in Persia; but Tavernier says expressly that it was carried thither, like asparagus, and other European vegetables of the kitchen-garden, by the Carmelite and other monks; and that it was only in later times that it became common[7].

[1] It is remarked in Golius's Dictionary, p. 597, that this word signifies also the scales of a fish, and the strong scales of the calyx of the plant may have given rise to the name.

[2] The Greek word is *αρτυτική*.

[3] Glossarium Suiogothicum, i. p. 411.

[4] Potatoes.

[5] A variety of derivations may be found in Menage's Dictionnaire Etymologique.

[6] See Rozier, Cours Complet d'Agriculture, vol. ii. p. 14.

[7] See his Travels. Geneva, 1681, fol. p. 164.

## SAW-MILLS.

In early periods, the trunks of trees were split with wedges into as many and as thin pieces as possible [1]; and if it was necessary to have them still thinner, they were hewn on both sides to the proper size. This simple and wasteful manner of making boards has been still continued to the present time. Peter the Great of Russia endeavoured to put a stop to it by forbidding hewn deals to be transported on the river Neva. The saw, however, though so convenient and beneficial, has not been able to banish entirely the practice of splitting timber used in building, or in making furniture and utensils, for I do not speak here of fire-wood; and, indeed, it must be allowed that this method is attended with peculiar advantages, which that of sawing can never possess. The wood-splitters perform their work more expeditiously than sawyers, and split timber is much stronger than that which has been sawn; for the fissure follows the grain of the wood, and leaves it whole; whereas the saw, which proceeds in the line chalked out for it, divides the fibres, and by these means lessens its cohesion and solidity. Split timber, indeed, turns out often crooked and warped; but in many purposes to which it is applied this is not prejudicial; and such faults may sometimes be amended. As the fibres, however, retain their natural length and direction, thin boards, particularly, can be bent much better. This is a great advantage in making pipe-staves, or sieve-frames, which require still more art, and in forming various implements of the like kind.

Our common saw, which needs only to be guided by the hand of the workman, however simple it may be, was not known to the inhabitants of America when they were subdued by the Europeans [2]. The inventor of this instrument has by the Greeks

[1] Virgil. Georg. lib. i. v. 144. Pontoppidan says, "Before the middle of the sixteenth century all trunks were hewn and split with the axe into two planks; whereas at present they would give seven or eight boards. This is still done in some places where there are no saw-mills in the neighbourhood; especially at Sudenoer and Amte Nordland, where a great many boats and sloops are built of such hewn boards, which are twice as strong as those sawn; but they consume too many trunks." See Natürliche Historie von Norwegen. Copenhagen, 1753, 2 vols. 8vo, i. p. 244.

[2] De Garcilasso de la Vega, Histoire des Incas.

been inserted in their mythology, with a place in which, among their gods, they honoured the greatest benefactors of the earliest ages. By some he is called Talus, and by others Perdix. Pliny[1] alone ascribes the invention to Dædalus; but Hardouin, in the passage where he does so, chooses to read Talus rather than Dædalus. In my opinion, Pliny may have committed an error as well as any of the moderns; and as one writer at present misleads another, Seneca[2], who gives the same inventor, may have fallen into a mistake by copying Pliny. Diodorus Siculus[3], Apollodorus[4], and others name the inventor Talus. He was the son of Dædalus's sister; and was by his mother placed under the tuition of her brother, to be instructed in his art. Having once found the jaw-bone of a snake, he employed it to cut through a small piece of wood; and by these means was induced to form a like instrument of iron, that is, to make a saw. This invention, which greatly facilitates labour, excited the envy of his master, and instigated him to put Talus to death privately. We are told, that being asked by some one, when he was burying the body, what he was depositing in the earth, he replied, a serpent. This suspicious answer discovered the murder; and thus, adds the historian, a snake was the cause of the invention, of the murder, and of its being found out[5]

Hyginus[6], Servius[7], Fulgentius[8], Lactantius Placidus[9], Isidorus[10], and others call the inventor Perdix. That he was the son of a sister of Dædalus they all agree; but they differ respecting the name of his parents. The mother, by Fulgentius, is called Polycastes, but without any proof; and Lactantius gives to the father the name of Calaus. In Apollodorus, however, the mother of Talus is called Perdix; and the same name is given by Tzetzes to the mother of the inventor, whose name Talus he changes into Attalus[11]. Perdix, we are told, did not employ for a saw the jaw-bone of a snake, like Talus, but the

[1] Lib. vii. 1. cap. 56. [2] Epist. 90. [3] Diodor. Sicul. iv. cap. 78.
[4] Apollodori Bibl. lib. iii. cap. 16.
[5] Those who are desirous of seeing the whole account may consult Diodorus, or Banier's Mythology, [or Keightley's Mythology of Ancient Greece and Italy, p, 398, Lond. 1838.]
[6] Hygin. Fab. 39, 244, 274. [7] Ad Georg. i. 143.
[8] Mythographi, ed. Van Staveren, lib. iii. 2, p. 708.
[9] In Mythogr. et in Ovid. Burm. lib. viii. fab. 3.
[10] Orig. lib. xix. cap. 19. [11] Chiliad. i. 493.

back-bone of a fish; and this is confirmed by Ovid[1], who nevertheless is silent respecting the name of the inventor.

What may be meant by *spina piscis* it is perhaps difficult to conjecture; but I can by no means make *spina dorsi* of it, as Dion. Salvagnius has done, in his observations on the passage quoted from Ovid's Ibis. The small bony processes which project from the spine of a fish have some similitude to a saw; but it would be hardly possible to saw through with them small pieces of wood. These bones are too long, as well as too far distant from each other; and the joints of the back-bone are liable to be dislocated by the smallest force. I am not acquainted with the spine of any fish which would be sufficiently strong for that purpose. The jaw-bone of a fish furnished with teeth would be more proper; but the words *spina in medio pisce* prevent us from adopting that alteration. I should be inclined rather to explain this difficulty by the bone which projects from the snout of the saw-fish, called by the Romans *serra*, and by the Greeks *pristis*. That bone, indeed, might not be altogether unfit for such a use: the teeth are strongly united to the broad bone in the middle, and are capable of resisting a great force; but they are placed at rather too great a distance. The old inhabitants of Madeira, however, we are told, really used this bone instead of a saw[2]. That Talus found the jaw-bone of a snake with teeth like a saw is extremely probable, for there are many snakes which have teeth of that kind.

The saws of the Grecian carpenters had the same form, and were made in the like ingenious manner as ours are at present. This is fully shown by a painting still preserved among the antiquities of Herculaneum[3]. Two genii are represented

[1] Metamorph. lib. viii. 244. The folowing line from the Ibis, ver. 500, alludes to the same circumstance:

"Ut cui causa necis serra reperta fuit."

[2] See Cadomosto's Voyage to Africa, in Novi Orbis Navigat. cap. 6. This account is not so ridiculous as that of Olaus Magnus, who says that the saw-fish can with his snout bore through a ship. [There are however many well-authenticated instances of the planks of ships being perforated by the upper jaw of this powerful animal, which it has been supposed occasionally attacks the hulls of vessels in mistake for the whale.]

[3] Le Pitture antiche d'Ercolano, vol. i. tav. 34.

at the end of a bench, which consists of a long table that rests upon two four-footed stools. The piece of wood which is to be sawn through is secured by cramps. The saw with which the genii are at work has a perfect resemblance to our frame-saw. It consists of a square frame, having in the middle a blade, the teeth of which stand perpendicular to the plane of the frame. The piece of wood which is to be sawn extends beyond the end of the bench, and one of the workmen appears standing and the other sitting on the ground. The arms, in which the blade is fastened, have the same form as that given to them at present. In the bench are seen holes, in which the cramps that hold the timber are stuck. They are shaped like the figure seven; and the ends of them reach below the boards that form the top of it. The French call a cramp of this kind *un valet*[1].

Montfaucon[2] also has given the representation of two ancient saws taken from Gruter. One of them seems to be only the blade of a saw without any frame; but the other figure I consider as a cross-cut saw; and I think I can distinguish all the parts, though it is imperfectly delineated. One may however perceive both the handles between which the blade is fastened; the wooden bar that binds them together, though the blade is delineated too near it; and about the middle of this bar, the piece of wood that tightens the cord which keeps the handles as well as the whole instrument firm. Saws which were not placed in a frame, but fastened to a handle, are thus described by Palladius[3]:—"Serrulæ manubriatæ minores majoresque ad mensuram cubiti, quibus facile est, quod per serram fieri non potest, resecando trunco arboris, aut vitis interseri."

The most beneficial and ingenious improvement of this instrument was, without doubt, the invention of saw-mills, which are driven either by water, wind, [or by steam]. Mills of the first kind were erected so early as the fourth century,

[1] That cramps or hold-fasts are still formed in the same manner as those seen in the ancient painting found at Herculaneum, particularly when fine inlaid works are made, is proved by the figure in Roubo, l'Art du Menuisier, tab. xi. fig. 4, and xii. fig. 15.

[2] L'Antiquité Expliquée, vol. iii. pl. 189.

[3] Pallad. De Re Rust. lib. i. tit. 43.—Cicero, in his oration for Cluentius, chap. lxiv., speaks of an ingenious saw, with which a thief sawed out the bottom of a chest.

in Germany, on the small river Roer or Ruer[1]; for though Ausonius speaks properly of water-mills for cutting stone, and not timber, it cannot be doubted that these were invented later than mills for manufacturing deals, or that both kinds were erected at the same time. The art however of cutting marble with a saw is very old. Pliny[2] conjectures that it was invented in Caria; at least he knew no building incrusted with marble of greater antiquity than the palace of king Mausolus, at Halicarnassus. This edifice is celebrated by Vitruvius[3], for the beauty of its marble; and Pliny gives an account of the different kinds of sand used for cutting it; for it is the sand properly, says he, and not the saw, which produces that effect. The latter presses down the former, and rubs it against the marble; and the coarser the sand is, the longer will be the time required to polish the marble which has been cut by it. Stones of the soap-rock kind, which are indeed softer than marble, and which would require less force than wood, were sawn at that period[4]: but it appears that the far harder glassy kinds of stone were sawn then also; for we are told of the discovery of a building which was encrusted with cut agate, cornelian, lapis-lazuli, and amethysts[5]. I have, however, found no account in any of the Greek or Roman writers of a mill for sawing wood; and as the writers of modern times speak of saw-mills as new and uncommon, it would seem that the oldest construction of them has been forgotten, or that some important improvement has made them appear entirely new.

Becher says, with his usual confidence, that saw-mills were invented in the seventeenth century[6]. Though this is certainly false, I did not expect to find that there were saw-mills in the neighbourhood of Augsburg so early as the year 1337, as Stetten[7] has discovered by the town-books of that place. I shall here insert his own words, in answer to a request I

[1] Ausonii Mosella, v. 361.
[2] Plin. lib. xxxvi. cap. 6.
[3] Vitruv. lib. ii. cap. 8.
[4] Plin. lib. xxxvi. cap. 22.
[5] See Jannon de S. Laurent's treatise on the cut stones of the ancients, in Saggi di Dissertazioni nella Acad. Etrusca di Cortona, tom. vi. p. 56.
[6] "Saw-mills are useful machines, first introduced in this century; and I do not know any one who can properly be called the real inventor."—Närrische Weisheit. Frankf. 1683, 12mo, p. 78.
[7] In that excellent work, Kunst-und-handwerks Geschichte der Stadt Augsburg, 1779, 8vo, p. 141.

made that he would be so kind as to communicate to me all the information he knew on that subject:—"You are desirous of reading that passage in our town-books, where saw-mills are first mentioned; but it is of very little importance. There is to be found only under the year 1338 the name of a burgher called Giss Saegemuller; and though it may be objected that one cannot from the name infer the existence of the employment, I am of a different opinion; especially as I have lately been able to obtain a proof much more to be depended on. In the surveyors' book, which I have often before quoted, and which, perhaps, for many centuries has not been seen or consulted by any one, I find under the year 1322, and several times afterwards, sums disbursed under the following title: Molitori dicto Hanrey pro asseribus et swaertlingis. Schwartlings, among us, are the outside deals of the trunk, which in other places are called *Schwarten*. This word, therefore, makes the existence of a saw-mill pretty certain. As a confirmation of this idea, we have still a mill of that kind which is at present called the Hanrey-mill; and the stream which supplies it with water is called the Hanrey-brook. Since the earliest ages, the ground on which this mill, and the colour, stamping, and oil-mills in the neighbourhood are built, was the property of the hospital of the Holy Ghost. By that hospital it was given as a life-rent to a rich burgher named Erlinger, but returned again in 1417 by his daughter Anna Bittingerin, who had, above and under the Hanrey-mill, two other saw-mills, which still exist, and for which, in virtue of an order of council of that year, she entered into a contract with the hospital in regard to the water and mill-dams." There were saw-mills, therefore, at Augsburg so early as 1322. This appears to be highly probable also from the circumstance, that such mills occur very often in the following century in many other countries.

When the Infant Henry sent settlers to the island of Madeira, which was discovered in 1420, and caused European fruits of every kind to be carried thither, he ordered saw-mills to be erected also, for the purpose of sawing into deals the various species of excellent timber with which the island abounded, and which were afterwards transported to Portugal[1]. About

[1] This we are told by Abraham Peritsol, the Jew, in Itinera Mundi,

the year 1427 the city of Breslau had a saw-mill which produced a yearly rent of three marks; and in 1490 the magistrates of Erfurt purchased a forest, in which they caused a saw-mill to be erected, and they rented another mill in the neighbourhood besides. Norway, which is covered with forests, had the first saw-mill about the year 1530. This mode of manufacturing timber was called the new art; and because the exportation of deals was by these means increased, that circumstance gave occasion to the deal-tythe, introduced by Christian III. in the year 1545[1]. Soon after the celebrated Henry Ranzau caused the first mill of this kind to be built in Holstein[2]. In 1552 there was a saw-mill at Joachimsthal, which, as we are told, belonged to Jacob Geusen, mathematician. In the year 1555 the bishop of Ely, ambassador from Mary queen of England to the court of Rome, having seen a saw-mill in the neighbourhood of Lyons, the writer of his travels thought it worthy of a particular description[3]. In the sixteenth century, however, there were mills with different saw-blades, by which a plank could be cut into several deals at the same time. Pighius saw one of these, in 1575, on the Danube, near Ratisbon, when he accompanied Charles, prince of Juliers and Cleves, on his travels[4]. It may here be asked whether the Dutch had such mills first, as is commonly believed[5]. The first saw-mill was erected in Holland at Saar-

printed with the learned annotations of Thomas Hyde, in Ugolini Thesaur. Antiq. Sacr. vol. vii. p. 103. Peritsol wrote before the year 1547.

[1] Nic. Cragii Historia regis Christiani III. Hafniæ 1737, fol. p. 293. See also Pontoppidan's History of Norway.

[2] Allgemeine Welthistorie, xxxiii. p. 227.

[3] The account of this journey may be found in Hardwicke's Miscellaneous State Papers, from 1501 to 1726, i. p. 71:—"The saw-mill is driven with an upright wheel; and the water that maketh it go, is gathered whole into a narrow trough, which delivereth the same water to the wheels. This wheel hath a piece of timber put to the axle-tree end, like the handle of a broch, and fastened to the end of the saw, which being turned with the force of the water, hoisteth up and down the saw, that it continually eateth in, and the handle of the same is kept in a rigall of wood from swerving. Also the timber lieth as it were upon a ladder, which is brought by little and little to the saw with another vice."

[4] Hercules Prodicus. Coloniæ 1609, 8vo, p. 95.

[5] Leupoldi Theatrum Machinarum Molarium. Leipzig, 1735, fol. p. 114. I shall here take occasion to remark, that in the sixteenth century there were boring-mills driven by water. Felix Fabri, in his Historia Suevorum, p. 81, says that there were such mills at Ulm.

dam, in the year 1596; and the invention of it is ascribed to Cornelis Cornelissen[1]; but he is as little the inventor as the mathematician of Joachimsthal. Perhaps he was the first person who built a saw-mill at that place, which is a village of great trade, and has still a great many saw-mills, though the number of them is becoming daily less; for within the last thirty years a hundred have been given up[2]. The first mill of this kind in Sweden was erected in the year 1653[3]. At present, that kingdom possesses the largest perhaps ever constructed in Europe, where a water-wheel, twelve feet broad, drives at the same time seventy-two saws.

In England saw-mills had at first the same fate that printing had in Turkey, the ribbon-loom in the dominions of the Church, and the crane at Strasburgh. When attempts were made to introduce them they were violently opposed, because it was apprehended that the sawyers would be deprived by them of their means of getting a subsistence. For this reason it was found necessary to abandon a saw-mill erected by a Dutchman near London[4], in 1663; and in the year 1700, when one Houghton laid before the nation the advantages of such a mill, he expressed his apprehension that it might excite the rage of the populace[5]. What he dreaded was actually the case in 1767 or 1768, when an opulent timber-merchant, by the desire and approbation of the Society of Arts, caused a saw-mill, driven by wind, to be erected at Limehouse under the direction of James Stansfield, who had learned, in Holland and Norway, the art of constructing and managing machines of that kind. A mob assembled and pulled the mill to pieces; but the damage was made good by the nation, and some of the rioters were punished. A new mill was afterwards erected, which was suffered to work without molestation, and which gave occasion to the erection of others[6]. It appears, however, that this was not the only mill of the kind then in Britain;

[1] De Koophandel van Amsterdam. Amst. 1727, ii. p. 583.
[2] La Richesse de la Hollande. Lond. 1778, 4to, i. p. 259.
[3] Clason, Sweriges Handel Omskiften 1751.
[4] Anderson's History of Commerce.
[5] Houghton's Husbandry and Trade Improved, Lond. 1727, iii. p. 47.
[6] Memoirs of Agriculture and other Œconomical Arts, by Robert Dossie. Lond. 1768, 8vo, i. p. 123. Of Stansfield's mill, on which he made some improvements, a description and figure may be seen in Bailey's Advancement of Arts, Manufactures and Commerce. Lond. 1772, i. p. 231.

for one driven also by wind had been built at Leith, in Scotland, some years before[1].

[The application of the steam-engine has in modern times almost entirely displaced the use of either water or wind as sources of power in machinery, and most of the saw-mills now in action, especially those on a large scale, are worked by steam. Some idea of the precision with which their operations are now accomplished may be obtained from the following fact. At the City of London saw-mills, the largest log of wood which had been placed on the carriage in one piece—a log of Honduras mahogany 18 feet long and three feet one inch square,—was cut into unbroken sheets at the rate of ten to an inch, and so beautifully smooth as to require scarcely any dressing.]

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## STAMPED PAPER.

PAPER stamped with a certain mark by Government, and which in many countries must be used for all judicial acts, public deeds, and private contracts, in order to give them validity, is one of those numerous modes of taxation invented after the other means of raising money for the service of states, or rather of their rulers, became exhausted. It is not of great antiquity; for before the invention of our paper it would not have been a very productive source of finance. When parchment and other substances employed for writing on were dear, when greater simplicity of manners produced more honesty and more confidence among mankind, and when tallies supplied the place of notes, bonds, and receipts, writings of that kind were very little in use.

De Basville, however, in his Mémoires pour servir à l'histoire de Languedoc, affirms that stamped paper was introduced so early as the year 537, by the emperor Justinian. This book, written by the author, intendant of that province in 1697, for the use of the duke of Burgundy, was printed, in octavo, at Marseilles in 1734, and not at Amsterdam, as announced

[1] Anderson *ut supra.*

in the title; but it was carefully suppressed by the Government, and on that account is very scarce even in France[1]. I have never seen it; but I know the author's ideas respecting stamped paper, from an extract in Variétés Historiques, Physiques, et Littéraires, printed at Paris in the year 1752[2]. The author of this work supports the opinion of his countryman: but it is undoubtedly false; for the law quoted as a proof requires only that documents should be written on such paper as had marked at the top (which was called the protocoll) the name of the intendant of the finances, and the time when the paper was made; and this regulation was established merely with a view to prevent the forging and altering of acts or deeds[3]. A kind of stamped paper therefore was brought into use, though different from what we have at present, the principal intention of which is not to render writings more secure, but by imposing a certain duty on the stamps, proportioned to the importance of the purpose it is employed for, to make a considerable addition to the public revenue[4]. The stamps serve as a receipt to show that the tax has been paid; and, though many law papers must be stamped, that burthen has tended as little to prevent law-suits as the stamping of cards has to lessen gaming: though some think differently. In both too much is risked and too much expected for taxes to deter mankind from engaging in either.

If in this historical research we look only to the antiquity of stamping, we shall find that both the Greeks and the Romans had soldiers marked in that manner; and, if we may be allowed to bring together things so different, we might include under the like head those runaway slaves who were marked by being branded; but I allude here only to the stamped paper now in use, which was certainly invented in Holland, a country where every necessary of life is subjected to taxation. The States of the United Provinces having promised a reward to any one who should invent a new impost, that might at the

[1] An account of this book may be found in Anecdotes secr. sur divers sujets de littérat. 1734, p. 573, and in the preface to Etat de la France, de M. de Boulainvilliers, fol. p. 12.

[2] Inserted in the Encyclopédie, vol. xi. p. 862.

[3] Novell. coll. iv. tit. 23. cap. 2. nov. 44.

[4] Such is the idea of Stryk in Continuat. altera usus moderni pandectarum, lib. xxii. tit. 4. p. 856.

same time bear light on the people and be productive to the government, some person proposed that of *bezegelde brieven*, or stamped paper, which was approved; and which Boxhorn, to whom we are indebted for this information, considers as a very proper tax. He is of opinion also that it might with great advantage be adopted in other countries[1]; and this was really the case soon after his death, which happened in 1653.

[1] "The States of Holland having laid sufficiently heavy duties on merchandise of every kind, and these not being equal to the expenditure, which was daily increasing, began to think of imposing new ones. For that purpose they issued an edict, inviting the ingenious to turn their thoughts towards that subject, and offering a very ample reward to whoever should invent a new tax, that might be as little burdensome as possible, and yet productive to the republic. Some shrewd, deep-thinking person, at length devised one on stamped paper (called *de impost van bezegelde brieven*), to be paid for all paper impressed with the seal of the States. The inventor proposed, that it should be enacted by public authority, that no petitions from the states, or from the magistrates of any city or district, or any public bodies, should be received; that no documents should be admitted in courts of justice; that no receipts should be legal, and that no acts signed by notaries, secretaries, or other persons in office, and, in short, no contracts should be valid, except such as were written upon paper to which the seal of the States had been affixed, in the manner above mentioned. It was proposed, also, that this paper should be sold by the clerks of the different towns and courts at the following rate; paper impressed with the great seal of the States for sixpence, and that with the less seal for twopence per sheet: for according to the importance of the business it was necessary that the great or less seal should be used. The States approved this plan, and it was immediately put in execution."—Boxhornii Disquisitiones Politic. casus 59. In this collection there is also Boxhornii Reip. Bataviæ Brevis et Accurata Descriptio, in the eighth chapter of which the author gives the following account of the origin of stamped paper:—"A very ingenious method has lately been invented of raising large sums of money for the use of the republic. As there are many rich people who have entrusted a considerable share of their property to the public treasury, the interest of which they receive annually on giving receipts; as many law-suits are carried on which are generally entered into by the wealthy, and which cannot be brought to a conclusion until a variety of instruments, as they are called, have been executed on each side; and as, on account of the flourishing state of trade, many contracts are made, which, for the sake of security, must be mutually signed, the States thought proper to enact by a public edict, that no receipts, law-papers, contracts, or instruments of the like kind, should be legal or valid, unless written on paper impressed with the great or small seal of the States. A price was also fixed on the paper, to be paid by those who had occasion for it; so that a sheet which before could be purchased for a halfpenny, was raised to several pence; and it is incredible how great a revenue these sheets bring to the public, by so many of them being used. The poor,

Stamped paper was introduced in Holland on the 13th of August, 1624, by an ordinance which represented the necessity and great benefit of this new tax. Among other things advanced in its favour, it was said that it would tend to lessen law-suits, and, on that account, would soon recommend itself to neighbouring nations. What we are told therefore by the author of an extract in Variétés Historiques, before quoted, that stamped paper began to be used in Holland and Spain so early as the year 1555, is certainly false. The Spaniards may, indeed, have been the first people who followed the example of the Dutch; for the author above mentioned asserts, that he saw an act, executed by a notary at Brussels, in 1668, which was written on stamped paper.

This tax was introduced in the electorate of Saxony by an ordinance of the 22nd of March 1682; and into that of Brandenburg on the 15th of July, in the same year. Bartholdus however says, but without producing any proof[1], that stamped paper was used before that period in Denmark, Florence, and Silesia. In Hanover it was first introduced, as I think, on the 20th of February, 1709.

[The stamp-tax was first introduced into this country in the reign of William and Mary, in 1693 (5 W. & M. c. 21). This act imposes stamps upon grants from the crown, diplomas, contracts, probates of wills and letters of administration, and upon all writs, proceedings, and records in courts of law and equity; it does not however seem to impose stamps upon deeds, unless these are enrolled at Westminster or other courts of record. Two years afterwards, conveyances, deeds and leases, were subjected to the stamp duty, and by a series of acts in the succeeding reigns, every instrument recording a transaction between two individuals was subjected to a stamp duty before it could be used in a court of justice. These laws have been variously altered in later times, but it is beyond our province to trace them further.]

however, and those of small fortune, feel little of this burden, as the rich principally are concerned in the transactions above mentioned."

[1] Fr. Jac. Bartholdi Diss. de Charta Signata; resp. P. Kolhart, Franc. 1690, cap. 2, § 16, p. 36.

## INSURANCE.

INSURANCE, that excellent establishment by which losses that would entirely ruin a merchant, being divided among a company, are rendered supportable, and almost imperceptible; by which undertakings too great for one person are easily accomplished, and by which commodities brought from the most distant regions are made cheaper[1], appears not to have been known to the Romans, however near they may have come to the invention of it. If we examine closely the information from which some endeavour to prove the contrary, it will be found that it is far from sufficient to support their opinion.

Puffendorf[2], Barbeyrac[3], Loccenius[4], Kulpis[5], and others, ground their assertions on a passage of Livy[6], who says, that when the Roman army in Spain was distressed for provisions, clothing and other necessaries, a company engaged to convey to them everything they stood in need of, under the stipulation that the State should make good their loss, in case their vessels should be shipwrecked by storms, or be taken by the enemy; and we are told that these terms were agreed to. This was undoubtedly a promise of indemnification, but by no means an insurance, in which it is always necessary that a premium should be given. On occasions of this kind, however, acts of fraud were practised, like those committed at present, to the prejudice of insurers. Shipwrecks were pretended to have happened which never took place; and old shattered vessels, freighted with articles of little value, were purposely sunk, and the crew saved in boats; and large sums were then demanded as a reimbursement for the loss[7].

Little more is proved by a passage of Suetonius[8], which

[1] "As the Turks are unacquainted with insurance, they do not lend money but at the rate of fifteen or twenty per cent. But when they lend to merchants who trade by sea, they charge thirty per cent."—Remarques d'un Voyageur Moderne au Lévant. Amst. 1773, 8vo.

[2] De Jure Naturæ et Gentium.

[3] Droit de la Nature.

[4] De Jure Maritimo. Holmiæ, 1650.

[5] Collegium Grotianum, Francof. 1722, 4to.

[6] Lib. xxiii. cap. 44.

[7] Lib. xxv. cap. 3.

[8] Lib. v. cap. 18. Langenbec, in his Anmerkungen über das Hamburgische Schiff-und-Seerecht, p. 370, is of opinion that no traces of insurance are to be found either in Livy or Suetonius.

Kulpis and others consider as affording an instance of insurance. That author tells us, that the emperor Claudius promised to indemnify merchants for their losses, if their ships should perish by storms at sea. This passage Anderson must not have read; else he would not have said that Suetonius ascribed the invention of insurance to Claudius.

In Simon's edition of Grotius, a passage is quoted from Cicero's epistles[1] as an instance of insurance among the Romans, which seems to be more probable. Cicero says he hopes to find at Laodicea security, by means of which he can remit the money of the republic, without being exposed to any danger on its passage. The word *prædes* may here signify insurers; but, in my opinion, this quotation ought rather to be classed among those which have been collected by Ayrer, as the first traces of bills of exchange[2].

Those remains of the ancient laws which, according to Kulpis and others, allude to insurance, concern bottomry (*fœnus nauticum*) only; and that this is much older than insurance has been already fully proved by Stypman[3].

Malynes[4], Anderson, and others affirm, that insurance is mentioned in the marine laws of the Isle of Oleron. This island, which lies opposite to the mouth of the Charente, on the coast of France, was much celebrated in the eleventh, twelfth, and following centuries on account of its trade. It belonged then to the duke of Aquitaine, and came to the crown of England by the marriage of Eleonora, daughter of the last duke, with Henry II. Under Eleonora were framed in the island those laws so well-known by the names *Roole d' Oleron*, *Roole des Jugemens d' Oleron*, that, like the laws of the Rhodians, they were used also by foreigners. These laws were afterwards enlarged and improved by Richard I., Eleonora's son; at least we are assured so by the French historians: but the English ascribe them to Richard alone. In order to determine the period when they were framed, I shall only observe that Eleonora died in the year 1202, and Richard in 1199; and

[1] Epist. ad Famil. ii. ep. 17.

[2] Ayreri Diatribe de Cambialis Instituti Vestigiis apud Romanos, added to Uhle's edition of Heineccii Elementa Juris Cambialis.

[3] De Jure Maritimo et Nautico. Gryphis. 1652.

[4] Lex Mercatoria, or the Ancient Law-Merchant, by Gerard Malynes. London, 1656, fol. p. 105.

Anderson, therefore, not without probability, places the origin of them in the year 1194. A copy of these laws, printed at Rouen, is still preserved, in which it is said that they were first drawn up in 1266. This, however, the French and the English declare to be false[1]. They are written in French, that is, in the old Gascon dialect. I am acquainted with them from the following scarce book, the author of which, in the preface, calls himself Cleirac: Us et Coutumes de la Mer[2]; but I find no traces in them of insurance. Even Cleirac himself, who has given an excellent explanation of the laws of Oleron, seems not to have found any; for where he relates everything he knew respecting the history of it, he ascribes this invention, and also that of bills of exchange, to the Jews, who made use of it when they were expelled from France. According to Cleirac, insurance was long detested by the Christians, who at that time considered it as a sin to take interest; and the use of it, as well as of bills of exchange, was first made common by the Guelphs and Ghibelines. Of this pretended service of the Jews in regard to insurance, I know no proof.

The celebrated maritime laws of the city of Wisby, in the island of Gothland, whether of later date, as the French assert, or older, which is more probable, than those of Oleron, are equally silent with respect to insurance. These laws were not written originally in Swedish, as l'Estocq[3] says, but in the Low-German. The translation into High-German by Marquard[4] is incorrect, and the French one of Cleirac is too free and too much abridged. The Dutch translation published at Amsterdam is the completest[5].

Insurance was, undoubtedly, not known at the time when the later Hanseatic maritime laws were framed, else it would have been mentioned in them. Of these laws there are various editions. One of those most used is that by Kericke, which is inserted also in Heineccii Scriptorum de Jure Nautico et Maritimo Fasciculus. Cleirac has given a French translation of them.

As little respecting insurance is to be found in Il Consolato del Mare. These maritime laws, highly worthy of notice,

[1] Seldeni Mare Clausum. Lond. 1636, p. 428. [2] Bourdeaux, 1661, 4to.
[3] Auszug der Historie des Allgemeinen und Preussischen See-rechts. Konigsberg, 1747. 4to, p. 32. [4] De Jure Mercatorum et Commerciorum.
[5] Entitled, 'T boek der Zee-rechten. Amst. 1664, 4to.

were originally written in the Catalonian dialect; and it seems very probable that they were drawn up at Barcelona. A part of them appears to have been framed in the eleventh, but the greater part in the thirteenth century; for the book itself proves, in more than one place, that they are not all of the same antiquity. The most correct edition is that published at Leyden in 1704[1]. Those writers who have pretended that insurance is mentioned in these Catalonian maritime laws have, perhaps, been led into this error, because, in an appendix to some of the common editions, there is a short account of insurance as once practised at Barcelona. As I have never seen this small treatise, I do not know whether it contains anything respecting the history of it. The oldest laws and regulations concerning insurance, with which I am at present acquainted, are the following.

On the 28th of January 1523, five persons appointed for that purpose drew up at Florence some articles which are still employed on the exchange at Leghorn. These important regulations, together with the prescribed form of policies, which may be considered as the oldest[2], have been inserted, i-

[1] The title runs thus: Il consolato del mare, nei quale si comprendono tutti gli statuti et ordini, disposti da gli antichi per ogni cosa di mercantia et di navigare. Leyden, 1704, 4to.

[2] In that old treatise, Le Guidon, inserted in Cleirac, it is remarked, chap. i. art. i. that in old times insurances were made without any writings: they were then called *Assecurances en confiance*; Confidential insurances.

[M'Culloch, in his Dictionary of Commerce, art. *Insurance*, observes respecting this passage, that "Beckmann seems to have thought that the practice of insurance originated in Italy, in the latter part of the fifteenth or the early part of the sixteenth century. But the learned Spanish antiquary, Don Antonio de Capmany, has given, in his very valuable publication on the History and Commerce of Barcelona (Memorias Historicas sobre la Marina, &c., de Barcelona, t. ii. p. 383), an ordinance relative to insurance, issued by the magistrates of that city in 1435; whereas the earliest Italian law on the subject is nearly a century later, being dated in 1523. It is however exceedingly unlikely, had insurance been as early practised in Italy as in Catalonia, that the former should have been so much behind the latter in subjecting it to any fixed rules; and it is still more unlikely that the practice should have escaped, as is the case, all mention by any previous Italian writer. We therefore agree entirely in Capmany's opinion, that until some authentic evidence to the contrary be produced, Barcelona should be regarded as the birth-place of this most useful and beautiful application of the doctrine of chances." Had M'Culloch consulted the treatise on Bills of Exchange, given in a subsequent part of the

Italian and German, by Magens, in his Treatise on Insurance, Average and Bottomry[1], published at Hamburgh in 1753. I should have been glad to have found in Italian authors some information respecting the antiquity of these regulations[2], a copy of which Magens says he procured from Leghorn; but I have hitherto sought for it in vain. Straccha however mentions a Florentine order of June the 15th, 1526, which forbids common insurance, unless the goods and commodities are specified[3].

There is still preserved a short regulation of the 25th May 1537, by the emperor Charles V., respecting bills of exchange and insurance, in which the strictly fulfilling only of an agreement of insurance is commanded.

In 1549 the same emperor issued an express order, "Op 't faict van der zee-vaerdt," in which occur some articles repecting insurance[4], and additions were afterwards made to it in 1561.

In the year 1556, Philip II., king of Spain, gave to the Spanish merchants certain regulations respecting insurance, which are inserted by Magens, with a German translation, in his work before mentioned. They contain some forms of policies on ships going to the Indies.

On the last of October 1563, Philip II. published his maritime laws, in which some forms of policies are given[5]; but on the last of March 1568 that prince forbade the practice of insurance, on account of the bad use to which it had been often applied. This prohibition I have not been able to find.

work (vol. iii. p. 430), he would have found that Beckmann, in noticing the curious memoirs of Capmany, with which he had *then* become acquainted, distinctly mentions "An ordinance of the year 1458 respecting insurance, which required that underwriting should be done in the presence of a notary, and declared *polices o scriptores privades* to be null and void."]

[1] Versuche über Assecuranzen, etc. Hamb. 1753, 4to.

[2] I found nothing on the subject, either in Della decima—e della Mercatura de' Fiorentini, fino al secolo xvi. Lisbona e Lucca, 1765, 1766, 4 vols. 4to, which contains a variety of useful information respecting the history of the Florentine trade, or in Mecatti, Storia Chronologica della città di Firenze. In Napoli 1775, 2 vols. 4to.

[3] Stracchæ aliorumque Jurisconsultorum de Cambiis, Sponsionibus, &c., Decisiones. Amst. 1669, fol. p. 24.

[4] It may be found in Ordonantien ende Placcaeten ghepubliceert Vlaenderen. Antwerp, 1662, fol. i. p. 360.

[5] Ordonantien ende Placcaeten, ii. p. 307. Groote Placaet-boeck der Ver. Nederlanden, i. p. 796. Magens, p. 397.

I am acquainted with it only by an order of the 20th of January 1570, in which the king expressly recals it, because the merchants at Antwerp, both subjects and foreigners, had presented strong remonstrances against it[1].

In the year 1598, the Kamer von Assurantie, Chamber of Insurance, was established at Amsterdam. An account of the first regulations of this insurance-office may be seen in Pontanus's History of the City of Amsterdam, and in other works[2].

In the year 1600, regulations respecting insurance were formed by the city of Middelburg in Zealand.

It appears that the first regulations respecting insurances in England, which may be seen in Anderson's History of Commerce, were made in the year 1601. We find by them that insurers had before that period conducted themselves in such a manner, that the utmost confidence was reposed in their honesty, and that on this account few or no disputes had arisen[3].

In the year 1604, regulations were formed respecting insurance at Rotterdam; and in 1610 were drawn up those of Genoa, which Magens has inserted in his work, taken from the Latin statutes of the Republic, together with a German translation.

In 1612 the Insurance Chamber at Amsterdam was established by public authority, and received several privileges.

Malynes asserts, but without either proofs or probability, that the people of Antwerp were first taught insurance by the English; and says that, as the merchants assembled for transacting business in Lombard-street, so called because certain

[1] Ordonantien ende Placcaeten, ut supra, p. 335. Groote Placaetboeck, i. p. 828, and in the additions, ii. p. 2116.

[2] The changes which this institution afterwards underwent, with an extract from its regulations, may be seen in La Richesse de la Hollande. Lond. 1778, 4to, i. p. 81.

[3] [The marine insurers are called in this country *under-writers*, because they write their names under the policy. Under the authority of statute 6 George I. cap. 18, two corporate bodies, called the *Royal Exchange Assurance Company* and the *London Assurance Company*, were chartered by the crown. There are at present seven marine insurance companies in London:—the two old chartered companies above-mentioned; two established immediately upon the passing of the act of the year 1824, the *Alliance* and the *Indemnity Mutual*; the *Marine*, established in 1836; and the *General Marine* and *Neptune*, established in 1839.]

Italians from Lombardy had *lombards* there, or houses for lending money on pledges, long before the building of the Exchange, it became customary, as it was in his time (1622), to be guided in policies by what was done in Lombard-street, in London.

[M'Culloch states[1] that it is probable insurance was introduced into England some time about the beginning of the sixteenth century, for it is mentioned in the statute 43 Eliz. c. 12, in which its utility is very clearly set forth, that it had been an *immemorial usage* among merchants, both English and foreign, when they made any great adventure, to procure insurance to be made on the ships or goods adventured. From this it may reasonably be supposed that insurance had been in use in England for at least a century previous. It appears from the same statute, that it had originally been usual to refer all disputes that arose with respect to insurances to the decision of "grave and discreet" merchants appointed by the lord mayor. But abuses having grown out of this practice, the statute authorized the lord chancellor to appoint a commission for the trial of insurance cases; and in the reign of Charles II. the powers of the commissioners were enlarged. But this court soon after fell into disuse; and, what is singular, no trace can now be discovered of any of its proceedings.]

Guicciardini, who wrote his Account of the Netherlands in 1567, remarks, in describing Antwerp, that the merchants there were accustomed to insure their ships. Anderson says that this is the first instance of maritime insurance, which is very astonishing, as he thinks the invention of insurance is to be found in Suetonius, and in the laws of the Isle of Oleron.

A most useful imitation of insurance in trade is the institution of insurance-offices, to indemnify losses sustained by fire. As far as I have been able to learn, companies for that purpose were first formed towards the middle of the last century, though houses were insured by individuals much earlier. The fire-office at Paris was established in 1745; that of the electorate of Hanover in 1750; that of Nassau-Weilburg in 1751; those of Brunswick-Wolfenbuttel and Wirtemberg in 1753; that of Anspach in 1754; that of Baden-Durlach in 1758; that of the county of Mark in 1764; those of Saxe-Weimar and Eisenach in 1768; and that of the Society of the Clergy

[1] Dictionary of Commerce.

in the Mark of Brandenburg[1], to insure goods and household furniture, was established in 1769.

It is perhaps known to few, that even in the beginning of the seventeenth century, a proposal was made by some ingenious person, that all the proprietors of land should insure the houses of their subjects against fire, on their paying so much per cent. annually, according to the value of them. The author of this scheme presented it to count Anthony Gunther von Oldenburg, in the year 1609, as a means of finance not to be found in any work printed on that subject. The author in his plan said[2], that "as many fires happened by which a great number of people lost their property, the count might lay before his subjects the danger of such accidents; and propose to them, that if they would, either singly or united, put a value on their houses, and for every hundred dollars valuation pay to him yearly one dollar; he, on the other hand, would engage, that in case by the will of God their houses should be reduced to ashes, the misfortunes of war excepted, he would take upon himself the loss, and pay to the sufferers as much money as might be sufficient to rebuild them; and that all persons, both natives and foreigners, who might be desirous of sharing in the benefits of this institution, should not be excluded. The author was confident that, though the damage might fall heavy at first, a considerable sum would be gradually raised, from year to year; and that every one might thus insure his houses against accidents. He had no doubt that it would be fully proved, if a calculation were made of the number of houses consumed by fire, within a certain space, in the course of thirty years, that the loss would not amount, by a good deal, to the sum that would be collected in that time. He did not however advise that all the houses in every town should be comprehended, as the money claimed might amount to too much; but only that some and certain houses should be admitted into this association."

I shall here insert, from the same author, the count's reflections on this plan, and the conclusion which he formed:—"It is to be considered," says he, "what sum every proprietor of

[1] Krunitz, Oekonomische Encyclopedie, xiii. p. 221; where an account may be found of other companies.

[2] Winkelmanns Oldenburgischen Friedens- und der benachbarten Oerter Kriegshandlungen. 1671 fol. p. 67.

land may with certainty raise and receive; whether the proposed plan can, to the undoubted benefit of the subjects, and the advantage of their lord, be honourably, justly, and irreproachfully instituted without tempting Providence; without incurring the censure of neighbours; and without disgracing one's name and dignity; in the next place, that this institution may not have the appearance of a scheme to bring money into the country; and still more that it may have no resemblance to a duty, tax, or impost, but rather to a free contribution, or unconstrained remuneration for being insured from danger, and by which losses being made good, houses can be sooner rebuilt, and put in their former condition." The count allowed that the object of the plan was good, considered in every point of view, and that a company composed of common individuals might be formed to insure each other's houses, and pay the losses sustained by fire: but he concluded, that, if he undertook the plan, Providence might be tempted; that his own subjects might be displeased; and that, improper ideas being formed of his conduct, he might be accused unjustly of avarice. "God," he said, "had without such means preserved and blessed, for many centuries, the ancient house of Oldenburg; and he would still be present with him, through his mercy, and protect his subjects from destructive fires." He dismissed, therefore, the ingenious author of this plan, but not without rewarding him according to his usual liberality.

[Insurance against fire has been known and carried on in England for nearly a century and a half; at present the number of British Fire Offices amounts to nearly twenty. The premium demanded for insurance varies from 1*s.* 6*d.* to 10*s.* 6*d.* per £100 according to the supposed risk; the duty is enormous, being no less than 3*s.* per cent on the amount insured. This tax yields a considerable addition to the revenue; in 1842 it amounted to £986,420, which corresponds to £563,668,571 value of property insured, leaving out of consideration the value of insured farming stock, the duty on which was repealed in the year 1833. On common risks the duty is no less than 200 per cent. upon the premium! "Such a duty" observes M'Culloch, "is in the last degree oppressive and impolitic. There cannot, in fact, be the slightest doubt that, were it reduced, as it ought to be, to one-third its present amount, the business of insurance would be very much ex-

tended; and as it could not be extended without an increase of security and without lessening the injurious consequences arising from the casualties to which property is exposed, the reduction of the duty would be productive of the best results in a public point of view; while the increase of business would prevent the revenue from being materially diminished." Several attempts have of late been made in Parliament to induce the government to lower the amount of duty, hitherto without success; it is however to be hoped that some other mode of raising the revenue may be devised than that of taxing so enormously the prudence of the industrious classes[1].

In addition to the marine and fire insurance, a somewhat similar speculation has been applied to human life, in the formation of life-insurance companies. These receive small annual payments in consideration of securing to the relations of the assured, or others to whom his property may be bequeathed, a stipulated sum. This arrangement we consider of the highest importance in mercantile countries, particularly to persons engaged in professional or personal occupations, where on the decease of the principal, the agency or appointment is not usually susceptible of transfer or bequest. By means of this species of insurance property is secured to descendants, who, but for some such precaution, might be left destitute. The oldest life-assurance office in London is the *Amicable*. This company was chartered in 1706, in consequence of application made to her majesty, Queen Anne, by Sir Thomas Allen and others. There are now in London nearly eighty life-assurance companies, of which about sixty are exclusively devoted to that object, and the remainder unite fire-insurance. The terms vary in the different offices, although not considerably, being founded upon recognised sets of tables. A comparative table of the annual rates of premium charged by each British office will be found in Waterston's Cyclopædia of Commerce. The premium is of course adapted to the probable duration of life; the lowest being £1 7*s*. 9*d*. per £100 on a healthy life at the entrance age of 15, the highest, at the age of 60, being about 7 per cent. A diseased condition in most incapacitates for insurance, but in some offices even diseased lives and

[1] [The publisher of the present volumes pays upwards of £200 per annum for insurance on his stock in trade, and therefore feels strongly the force of this observation.—H. G. B.]

risks of every kind are insured, of course at a proportional rate[1].

In the reign of Queen Anne several offices were opened for making insurances on marriages, births, christenings, service, &c., and fraudulent practices prevailed to such a degree that by Stat. 9 Ann. c. 6, § 37, a penalty of £500 is imposed on every person setting up such office, and £100 for any person making such assurance in any office already established.

The assurance principle has within the last few years likewise been applied, with the prospect of success, to the guaranteeing of fidelity in persons holding situations of trust. In this case the calculation is, that out of a large range of instances where individuals of good moral character are entrusted with sums belonging to their employers, a nearly regular amount of defalcation will take place annually, or within some other larger space of time. This may give an unpleasant view of human nature, but it is found to be a true one, and the question which arises with men of business is, by what means may the defalcation be best guarded against. The choice is between a guarantee from one or two persons, and from a trading company. By the former plan, the risk is concentrated upon one or two, who may be deeply injured in consequence: by the other plan, the risk is not merely diffused, it is *extinguished*, for the premiums paid by the insuring parties stand for the losses, besides affording a profit upon the business. Nor have we only thus a protection for private parties against the dangers of security; but individuals, who have the offer of situations on the condition of giving a sufficient guarantee, may now be able to take, where formerly they would have had to decline them, seeing that they might have failed to induce any friend to venture so far in their behalf. Practically, it has also been found that, so far from parties being more ready to give way to temptation when they know that the loss will fall upon a company, they are less so, seeing that the company exercises a more rigid supervision, and presents a sterner front to delinquents, than is the case with private securities in general. Guarantee companies are now established in London, Edinburgh, Glasgow, and other large cities. See Chambers' Tracts, No. 44.]

[1] Life insurances have been forbidden by the laws of France and of many other foreign states, as being of a gambling nature, and opening the door to a variety of abuses and frauds.

## ADULTERATION OF WINE.

No adulteration of any article has ever been invented so pernicious to the health, and at the same time so much practised, as that of wine with preparations of lead; and as the inventor must have been acquainted with its destructive effects, he deserves, for making it known, severer execration than Berthold Schwartz, the supposed inventor of gunpowder.

The juice of the grape, when expressed, undergoes what is termed vinous fermentation and so becomes converted into wine, but very soon, if great care be not taken, it passes into a different kind of fermentation, called the acetic; its spirit then becomes changed into an acid, which renders it unfit to be drunk, and of much less utility. The progress of the fermentation may be stopped by care and attention; but to bring the liquor back to its former state is impossible. Ingenuity, however, has invented a fraudulent method of rendering the acid in spoilt wine imperceptible; so that those who are not judges are often imposed on, and purchase sweetened vinegar instead of wine. Were no other articles used for sweetening it than honey or sugar, the adulterator would deserve no severer punishment than those who sell pinchbeck for gold; but saccharine juices can be used only when the liquor begins to turn sour; and even then in very small quantities, else it would betray the imposition by its sweetish-sour taste, and hasten that change which it is intended to prevent. A sweetener therefore, has been invented much surer for the fraudulent dealer, but infinitely more destructive to the consumer; and those who employ it, undoubtedly, merit the same punishment as the most infamous poisoners.

Lead and its oxide or carbonate, dissolved in the acid which spoils wine, give it a saccharine taste not unpleasant, without any new, or at least perceptible tint, and arrest the progress of the acid fermentation. The wine, however, occasions, according as it is used in a great or small quantity, and according to the constitution of the consumer, a speedy or lingering death, violent colics, obstructions and other maladies; so that one may justly doubt whether, at present, Mars, Venus, or Saturn is most destructive to the human race.

The ancients, in my opinion, knew that lead rendered harsh wine milder, and preserved it from acidity, without being aware that it was poisonous. It was therefore long used with confidence; and when its effects were discovered they were not ascribed to the metal, but to some other cause. When more accurate observation, in modern times, fully established the noxious property of lead, and when it began to be dreaded in wine, unprincipled dealers invented an artful method of employing it, which the law, by the severest punishment, was not able wholly to prevent.

The Greeks and the Romans were accustomed to boil their wine over a slow fire, till only a half, third, or fourth part remained, and to mix it with bad wine in order to improve it. When, by this operation, it had lost part of its watery particles, and had been mixed with honey and spices, it acquired several names, such as *mustum*, *mulsum*, *sapa*, *carenum*, or *caroenum*, *defrutum*[1], &c. Even at present the same method is pursued with sack, Spanish, Hungarian, and Italian wines. In Italy, new wine, which has been thus boiled, is put into flasks, and used for salad and sauces. In Naples it is called *musto cotto*; but in Florence it still retains the name of *sapa*. Most of those authors who have described this method of boiling wine expressly say that leaden or tin vessels must be employed; because the wine, by these, is rendered more delicious and durable, as well as clearer. It is, however, certain that must and sour wine by slow boiling, for according to their directions it should not be boiled quickly, must dissolve part of these dangerous metals, otherwise the desired effect could not be produced[2]. Some also were accustomed to add to their wine, before it was boiled, a certain quantity of sea water, which by its saline particles would necessarily accelerate the solution[3].

That the acid of wine has the power of dissolving lead was not unknown to the ancients; for when the Greek and Roman wine-merchants wished to try whether their wine was

[1] Plin. lib. xxiii. cap. 2. Palladius, Octob. 18. edit. Gesneri, ii. p. 994.

[2] Proofs of this will be found in Columella De Re Rustica, lib. xii. c. 19, 20. Cato De Re Rust. cap. cv. and cap. cvii., and Plin. lib. xiv. cap. 21.

[3] Proofs that the ancients mixed their wine with sea-water may be found in Pliny, lib. xxiii. cap. 1. and lib. xiv. cap. 20. Celsus exclaims against it, lib. ii. cap. 25. Dioscorides, lib. v. cap. 7, 9, &c. p. 573. See Petri Andreæ Matthioli Commentarii in sex libros Dioscoridis de materia medica. Venetiis, in officina Erasmi Vincentii Valgrisii, 1553, fol.

spoiled, they immersed in it a plate of lead[1]. If the colour of the lead was changed, which undoubtedly would be the case when its surface was corroded, they concluded that their wine was spoiled. It cannot, however, be said that they were altogether ignorant of the dangerous effects of solutions of that metal; for Galen and other physicians often give cautions respecting white lead. Notwithstanding this, men fell upon the invention of conveying water for culinary purposes in leaden pipes[2]; and even at present at London, Amsterdam, Paris, and other places water is conveyed through lead, and collected in leaden cisterns, though that practice has, on several occasions, been attended with alarming consequences[3]. This negligence in modern times makes us not be surprised when we read that the ancients employed leaden vessels. It appears, however, that it was not merely through negligence that this practice prevailed. They were acquainted, and particularly in Pliny's time, with various processes used in regard to wine[4]; and among these was that of boiling it with lime or gypsum[5]; and the ancient physicians, who had not the assistance of our mo-

[1] Plin. lib. xiv. cap. 20. This method of proof is given more circumstantially in Geopon. lib. vii. cap. 15.

[2] Pallad. August. c. ii. vol. ii. p. 977.

[The solvent action of water upon lead is highly interesting on account of the very general use of leaden pipes and cisterns lined with this metal. From the researches of Lieut.-Col. Yorke, published in the Philosophical Magazine for August 1834 and January 1846, it would appear that a bright leaden vessel containing pure water, such as distilled water, and *exposed to the air*, soon becomes oxidized and corroded; oxide of lead being readily detected *in solution* by means of sulphuretted hydrogen and other sensitive tests; but river and spring water exert a much less or no such solvent power, the carbonates and sulphates in such water preventing it. It is on this account that leaden vessels are used with such impunity, the crust which forms upon the metal entirely preventing all further action. However, as this crust consists partially of carbonate of lead, which is a very dangerous poison, great care should be taken on cleaning or scraping such cisterns to avoid using the water in which particles of the salt may have become diffused. Leaden cisterns are sometimes rendered unsafe in consequence of iron or zinc pipes being soldered or let into them, thus giving rise to galvanic action, which greatly facilitates the solution of the lead.]

[4] Plin. lib. xiv. cap. 20. The same author relates a great many arts practised in regard to wine.

[5] Plin. lib. xiv. cap. 19. That this method was practised in Italy is confirmed by Columella, lib. xii. cap. 20, and Didymus in Geopon. lib. vi. cap. 18. It is mentioned also by Dioscorides and Theophrastus.

dern chemistry, thought it more probable that their wine was rendered noxious by the addition of these earths[1], than by the vessels in which it was boiled; and they were the more inclined to this opinion, as they had instances of the fatal effects produced by the use of them[2]. They decried them, therefore, so much, that laws were afterwards made by which they were forbidden to be used, as poisonous and destructive to the human body.

Wine which has once begun to spoil cannot be perfectly restored by lime; for it cannot bring back to it the spirituous part which it has lost, neither can it remove the acid with which it is incorporated; but it can render it imperceptible to the tongue by uniting with it, and forming an earthy salt of an almost insipid taste. This method of improving sour wine is still practised in the island of Zante[3], in Spain[4], on the coast of Africa[5], and in many other countries. It is, however, condemned by several physicians and chemists; because obstructions and other bad effects are to be apprehended from it. Some, on the contrary, consider it as harmless[6]; and I must confess that I should expect no bad consequences from such a small quantity of lime as would be necessary for that purpose. It will produce a salt which will have the same effects as that tartareous crust called wine-stone, and will act as a laxative, like the salts which our apothecaries prepare from that calcareous stone crab's-eyes, by means of vinegar or lemon-juice. The lime, which the acid of the wine cannot

[1] Plin. lib. xxiii. cap. 1. [2] Ibid. lib. xxxvi. cap. 24.

[3] "The wine of the island of Zante is almost as strong as brandy. It is supposed that this proceeds from the unslaked lime which is usually mixed with it, under the pretence that it then keeps better, and is fitter to be transported by sea."—D'Arvieux, Voyages.

[4] Christophori a Vega de Arte Medendi, lib. ii. cap. 2.

[5] "No one sells wine at Tunis but the slaves, and this wine is not under the jurisdiction of the Tunisian government. They put lime in it, which renders it very intoxicating."—Thevenot's Voyages.

[6] In Anleitung zur Verbesserung der Weine in Teutschland, Franck. and Leipsic, 1775, 8vo, the moderate use of lime is recommended. In France crude potash is put into wine instead of lime. [Acidity in wine was formerly corrected in this country by the addition of quick-lime. This furnishes a clue to Falstaff's observation that there was "lime in the sack," which was a hit at the landlord, as much as to say his wine was worth little, having its acidity thus disguised. Carbonate of soda is now most frequently used for the purpose.]

dissolve, will fall to the bottom as a sediment, and assist to clarify the wine. Used however in too great quantity, it may hasten the destruction of the still remaining spirituous part, and render the wine weak; a caution which has been given to wine-merchants by Neumann.

Gypsum is a compound of sulphuric acid with lime, and were it always pure, its effects upon wine would be imperceptible; but as the most kinds of common gypsum contain abundance of carbonate of lime, they effervesce with acids, are dissolved in part by them, and form that salt which I have before said I consider as harmless. By means of this carbonate gypsum improves sour wine, as well as common wine. I took half an ounce of that gypsum which at Osterode is pounded and used as mortar, and which is hard, white, and shining, and almost of the nature of alabaster. When I had pounded it, I put it into strong vinegar in a glass vessel, and suffered it to boil for a few minutes. I then strained it through filtering-paper; and what remained, after it was washed and dried, weighed 215 grains; so that the vinegar had dissolved 25 grains, which were precipitated afterwards by carbonated alkali. I pursued the like process with half an ounce of burnt gypsum, such as is used here for floors; and I found that two ounces of the same vinegar dissolved half a drachm of it, which was somewhat more in proportion than of the former. Every one whom I caused to taste of this vinegar remarked that both had lost a considerable share of their acidity; but that the vinegar which had been boiled with burnt gypsum had lost the most. Few kinds of native gypsum are perfectly pure; and at any rate we have no reason to suppose that the ancients sought pure gypsum for their wines. This method is not yet disused. We are told by Arvieux, that it is still employed in the island of Milo; and I shall here take occasion to observe that salt water also is added to wine there, even at present. Christopher Vega, whom I have before quoted, reproaches the Spaniards with the use of gypsum; and it has been condemned by the modern as well as the ancient physicians. An Englishman of the name of Hardy seems to suspect that gypsum contains lead and arsenical earth[1];

[1] "The properties of lead and arsenic are well understood; but what those of the ancient gypsums were, will require an explanation; as there seems to be just reason to believe, that some of them contained a portion

but it appears that this writer doubted whether our gypsum be the same as that of the ancients; and indeed it is necessary, before we use their information respecting natural objects, to examine carefully whether they understood by any name what we understand by it; and what they meant by gypsum has been determined neither by Stephanus, Ferber, nor Gesner. We however know this much, that the ancients burnt their gypsum, and that they formed and cast images of it[1]. In my opinion wine cannot be poisoned by gypsum; and wine-merchants who employ it and lime deserve no severer punishment than brewers, who, in the like manner, render sour beer fitter to be drunk and more saleable

That the ancients were accustomed to clarify their wine with gypsum, is proved by different passages of the Greek writers on husbandry. They threw gypsum into their new wine; stirred it often round, then let it stand for some time, and, when it had settled, poured off the clear liquor[2]. It would, however, appear that they had remarked that gypsum caused the spirituous part to disappear; for we read that the wine acquired by it a certain sharpness which it afterwards lost, but that the good effects of the gypsum were lasting[3]. This process in modern times has been publicly forbidden, in many countries, as it was in Spain in the year 1348.

Calcined shells were in ancient times used instead of lime[4]. Potters-earth was also thrown into wine, in order to clarify it by carrying the muddy particles with it to the bottom. This method I have seen employed in the breweries at Amsterdam, to purify the water. In the south of France it is used for clarifying wine-stone ley; and in my opinion it might be useful on many other occasions[5].

The ancients poisoned their wine with lead without knowing it; but at what period did that pernicious practice begin of employing sugar of lead and litharge? Litharge was not unknown to the ancients; for it is mentioned by Dioscorides, Aëtius, and others. Sugar of lead is, indeed, more modern; but I have found no information respecting the invention of it, except that it was known to Paracelsus, who died in 1541,

of metallic or arsenical earth."—A Candid Examination of what has been advanced on the Colic of Poitou and Devonshire, by James Hardy, London, i. 8vo, p. 84. [1] Plin. lib. xxxv. [2] Geopon. pp. 462, 483, 494. [3] Ibid. vii. 12, p. 483. [4] Ibid. p. 486. [5] Ibid. p. 486.

and who ventured to prescribe it for some disorders. It was known also to Angelus Sala, one of the most ingenious of the early chemists. In the Roman laws no particular orders occur against the adulteration or poisoning of wine; for what we read in the Institutiones[1] is applicable only to the spoiling of another person's wine, and thereby occasioning a loss to him; and this explanation is confirmed by the Digesta[2]. The German prohibitions against the adulteration of wine began in the fifteenth century, and were from time to time renewed with additional severity. In that century, we find complaints against this practice with lime, sulphur, and milk; but no instance occurs of the poisoning with lead. I however conjecture that the use of litharge was introduced in the twelfth or thirteenth century; but the framers of the laws were not acquainted with the real poison; and instead of causing it to be examined by the chemists, who it must be confessed had not advanced far in their art, they contented themselves with prohibiting the use of those things which they found considered by the ancients as dangerous.

Among the oldest German prohibitions against the adulteration of wine is that of Nuremberg in the year 1409; in which however there is no notice taken of litharge. Another of the year 1475 is mentioned by Datt[3]; but some Imperial ones of an earlier period may have been lost[4]. In the year 1487 the emperor caused an order against the adulteration of wine to be published by the governments in Swabia, Franconia and Alsace; and this practice was a subject of deliberation at the diet of Rothenburg the same year, and also at the diet of Worms, under Maximilian I., in 1495. At the diet of Lindau the use of sulphur was in particular prohibited, and also at Freyburg in Brisgau in 1498. In the year 1500 the same affair was discussed at Augsburg, and again at that city in 1548, under Charles V. It appears that this business was left afterwards to the care of the different princes, who from time to time issued prohibitions against so destructive a fraud.

Older and severer prohibitions are however to be found in other countries. By an order of William count of Hennegau,

[1] Lib. iv. tit. 3. § 13. [2] Digestor. lib. ix. tit. 2. leg. 27. § 15. Later jurists call the adulteration of wine *crimen stellionatus*..

[3] De pace imperii publica. Ulmæ 1698, p. 632.

[4] Goldast. Constit. Imper. tom. ii. p. 114.

Holland and Zeeland, of the year 1327, we find that long before that period it was customary to adulterate wine with noxious and dangerous substances. In the year 1384 the government at Brussels issued a severer order of the like kind, in which vitriol, quicksilver and lapis calaminaris are mentioned[1]. In France we find an old *ordonnance du prevôt de Paris*, for the same purpose, dated September the 20th and December the 2nd, 1371, in which no minerals are mentioned; but in that of 1696 litharge is particularly noticed[2].

Conrade Celtes, who in the year 1491 was first crowned in Germany as a poet, gives in his panegyric on Nuremberg some information respecting the adulteration of wine, from which we learn that he considered it as a new invention, and ascribed it to a monk called Martin Bayr; but his expressions are so figurative, that little can be gathered from them[3]. We are however told by Zeller, that it was believed that this dangerous

[1] Mémoires sur les questions proposées par l'Académie de Bruxelles en 1777. A Bruxelles 1778, 4to.

[2] Traité de la Police, par De la Mare, p. 514. ["In France it does not appear that lead in any form has been employed in making or altering their wines. On the 13th of March 1824, a member of the Chamber of Deputies moved for a law to punish the practice. The motion was rejected, because neither litharge nor any other preparation of lead was shown to have been used, nor was any instance cited in which it had been detected, though an ordinance was made against its use in 1696."—Redding's History and Description of Wines. Lond. 1836, p. 336.]

[3] "I wish those who adulterate wine were punished with greater severity; for this execrable fraud, as well as many more deceptions, has been invented in the present age; and a villany by which the colour, taste, smell and substance of wine are so changed as to resemble that of another country, has been spread not only through Germany, but also through France, Hungary and other kingdoms. It was invented, they say, by a monk named Martin Bayr, of Schwarzen-Eychen in Franconia. He undoubtedly merits eternal damnation for rendering noxious and destructive a liquor used for sacred purposes, and most agreeable to the human body; thus contaminating and debasing a gift of nature inferior to none called forth from the bosom of the earth by the influence of the solar rays; and for converting, like a sanguinary destroyer of the human race, that bestowed upon us by Nature to promote mirth and joy, and as a soother of our cares, into a poison and the cause of various distempers. But if the debasers of the current coin are punished capitally, what punishment ought to be inflicted upon the person who hath either killed or thrown into diseases all those who used wine? The former by their fraud injure a few, but the latter exposes to various dangers people of all ages, and of both sexes; occasions barrenness in women; brings on abortions and makes them miscarry; corrupts and dries up the milk of nurses; excites gouty

fraud was invented in France[1]. Martin Zeiler, in his Chronicle of Swabia (p. 65), says, "In the year 1453, the citizens of Augsburg began to observe this fraud in the wine-market; for during four years before, Martin Bayr, at Schwarzen-Eychen in Franconia, first taught the German tavern-keepers and the waggoners to preserve new wine from becoming sour; to clarify wine by sulphur; and likewise to counterfeit it by spices, to the great prejudice of people's health." In this passage there is no mention of litharge, but of other mixtures. The oldest account of the poisonous sweetening of wine is that which occurs in the French ordinance of 1696[2]; and Zeller's conjecture that it was invented or first remarked in France, seems to me the more probable, as it appears that it was practised at Wurtemberg about the same period. In the year 1697 it was known there that some wine-merchants, particularly Hans George Staltser at Goppingen, used litharge for refining wine, and by these means deprived many persons of life, and occasioned the loss of health to others. Staltser pleaded in excuse, that he considered the process he had employed as harmless, and that Masskosky, physician to the town of Goppingen, who was accounted a man of knowledge, had employed the same for his wine. Brugel also, physician to the town of Heidenheim, had declared that litharge was not prejudicial; and as he was a person of reputation, his opinion had tended not a little to establish the use of that practice. This report was so hurtful to the wine-trade of Wurtemberg, which at that time brought a great deal of money into the

pains in the body; causes others in the bowels and reins, than which none can be more excruciating; and produces ulcers in the intestines; in short, his poison inflames, corrodes, burns, extenuates, and dries up; nor does it allay, but increase thirst; for such is the nature of sulphur, which, mixed with other noxious and poisonous things, the names of which I should be ashamed to mention, is added to wine, before it has done fermenting, in order to change its nature. This poison we have been obliged to purchase for our friends, wives, children and selves, at a high price; as wine has been scarce for several years past; and it would seem that Nature had denied this liquor so long out of revenge against her enemies and the destroyers of the whole human race. You ought, therefore, most prudent fathers, not only to empty their vessels, by throwing this poison into your river; but to cast alive into the flames the sellers of this wine, and thus to punish poisoning as well as robbery."—Pirkheimeri Opera, Franck. 1610, fol. p. 136. [This writer was the friend and contemporary of Albert Durer.]

[1] De docimasia vini lithargyrio mangonisati. Tubingæ 1707.

[2] De la Mare, Traité de la Police, i. 615.

duchy from other countries, that the wine at Ulm remained unsold; and duke Everhard Louis was obliged to cause experiments to be made to ascertain the nature of the substances mixed with it. Solomon Keysel, the duke's physician, and J. Gaspar Harlin, physician to the court, both declared that litharge was noxious, but that sulphur besprinkled with bismuth was still more so. They strongly advised, therefore, that both these substances should be forbidden to be used, under the heaviest penalties; and this prohibition was put in force with the greater severity as some persons of the first rank had for several years before caused their spoiled and sour wine to be made sweet and clear in this manner by a weaver of Pforzheim, who resided at Stutgart. An order was issued on the 10th of May 1697, forbidding this adulteration under pain of death and confiscation of property, as well as of being declared infamous; and the duke requested the neighbouring states, particularly Bavaria and Eychstat, to keep a more watchful eye over their wine-merchants and waggoners, by which means it was supposed all danger would be avoided.

In the following year, the city of Ulm discovered a poor man at Giengen, within its own jurisdiction, who had sweetened with litharge some sour wine purchased at Wurtemberg. He was accordingly banished from the country; and several other persons in the duchy were condemned to labour at the fortifications. This example was attended with so good an effect, that for some time adulteration was not heard of; but eight years after, John Jacob Ehrni of Eslingen introduced that practice again with some variation, and not only employed it himself, but induced others to follow it in several other places. Greater severity was at length exercised. Ehrni was beheaded; the possessors of adulterated wine were fined. and the wine was thrown away. After this second example, which was followed in other parts of the country, the art of adulterating wine seems to have been more carefully concealed, or to have been entirely abandoned. But in the present century treatises have been published on the management of wine, in which the art of improving it by litharge has been taught, as a method perfectly free from danger[1].

For detecting metal in wine, the arsenical liver of sulphur

[1] William Graham's Art of making Wines from Fruit, Flowers and Herbs. Sixth edit. London, 8vo.