# JOHANN BECKMANN

## A HISTORY OF INVENTIONS, DISCOVERIES, AND ORIGINS, VOLUME II (OF 2)

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# Содержание

# A History of Inventions, Discoveries, and Origins, Volume II (of 2)

## THE STEAM-ENGINE, AND THE DISCOVERIES OF JAMES WATT

Although the plan of this new edition of Beckmann's 'History of Inventions and Discoveries' was to confine it to the subjects treated of in the original work, yet we feel it imperative to make an exception in favour of the *Steam-Engine*, the most important of all modern inventions.

The power of steam was not entirely unknown to the ancients, but before the æra rendered memorable by the discoveries of James Watt, the steam-engine, which has since become the object of such universal interest, was a machine of extremely limited power, inferior in importance and usefulness to most other mechanical agents used as prime movers. Hero of Alexandria, who lived about 120 years before the birth of Christ,

has left us the description of a machine, in which a continued rotatory motion was imparted to an axis by a blast of steam issuing from lateral orifices in arms placed at right angles to it. About the beginning of the seventeenth century, a French engineer, De Caus, invented a machine by which a column of water might be raised by the pressure of steam confined in the vessel, above the water to be elevated; and in 1629, Branca, an Italian philosopher, contrived a plan of working several mills by a blast of steam against the vanes; from the descriptions, however, which have been left us of these contrivances, it does not appear that their projectors were acquainted with those physical properties of elasticity and condensation on which the power of steam as a mechanical agent depends.

In 1663, the celebrated Marquis of Worcester described in his Century of Inventions, an apparatus for raising water by the expansive force of steam only. From this work we extract the following short account of the first steam-engine. "68. An admirable and most forcible way to drive up water by fire; not by drawing or sucking it upwards, for that must be as the philosopher calleth it, *intra sphæram activitatis*, which is but at such a distance. But this way hath no bounder, if the vessel be strong enough: for I have taken a piece of whole cannon, whereof the end was burst, and filled it three-quarters full of water, stopping and screwing up the broken end as also the touch-hole; and making a constant fire under it, within twenty-four hours it burst and made a great crack; so that having a way

to make my vessels so that they are strengthened by the force within them, and the one to fill after the other, I have seen the water run like a constant stream, forty feet high: one vessel of water rarefied by fire, driveth up forty of cold water; and a man that tends the work is but to turn two cocks, that one vessel of water being consumed, another begins to force and refill with cold water, and so successively; the fire being tended and kept constant, which the self-same person may likewise abundantly perform in the interim, between the necessity of turning the said cocks."

The next name to be mentioned in connection with the progressive history of the invention of the steam-engine, is that of Denis Papin, a native of France, who, being banished from his country, was established Professor of Mathematics at the University of Marburg, by the Landgrave of Hesse. He first conceived the important idea of obtaining a moving power by means of a piston working in a cylinder (1688), and subsequently (1690) that of producing a vacuum in the cylinder by the sudden condensation of steam by cold. In accordance with these ideas he constructed a model consisting of a small cylinder, in which was inserted a solid piston, and beneath this a small quantity of water; on applying heat to the bottom of the cylinder, steam was generated, the elastic force of which raised the piston; the cylinder was then cooled by removing the fire, when the steam condensed and became again converted into water, thus creating a vacuum in the cylinder, into which the piston was forced by

the pressure of the atmosphere; there is, however, no evidence of his having carried that or any other machine into practical use, before machines worked by steam had been constructed elsewhere.

The first actual working steam-engine of which there is any record, was invented by Captain Savery an Englishman, to whom a patent was granted in 1698 for a steam-engine to be applied to the raising of water, &c. This gentleman produced a working-model before the Royal Society, as appears from the following extract from their Transactions: – "June 14th, 1699. Mr. Savery entertained the Royal Society with showing a small model of his engine for raising water by help of fire, which he set to work before them: the experiment succeeded according to expectation, and to their satisfaction." This engine, which was used for some time to a considerable extent for raising water from mines, consisted of a strong iron vessel shaped like an egg, with a tube or pipe at the bottom, which descended to the place from which the water was to be drawn, and another at the top, which ascended to the place to which it was to be elevated. This oval vessel was filled with steam supplied from a boiler, by which the atmospheric air was first blown out of it. When the air was thus expelled, and nothing but pure steam left in the vessel, the communication with the boiler was cut off, and cold water poured on the external surface. The steam within was thus condensed and a vacuum produced, and the water drawn up from below in the usual way by suction. The oval steam-vessel was thus filled with

water; a cock placed at the bottom of the lower pipe was then closed, and steam was introduced from the boiler into the oval vessel above the surface of the water. This steam being of high pressure, forced the water up the ascending tube, from the top of which it was discharged; and the oval vessel being thus refilled with steam, the vacuum was again produced by condensation, and the same process was repeated by using two oval steam-vessels, which would act alternately; one drawing water from below, while the other was forcing it upwards, by which an uninterrupted discharge of water was produced. Owing to the danger of explosion, from the high pressure of the steam which was used, and from the enormous waste of heat by unnecessary condensation, these engines soon fell into disuse.

Several ingenious men now turned their attention to the improvement of the steam-engine, with a view to reduce the consumption of fuel, which was found to be so immense as to preclude its use except under very favourable circumstances; and in 1705, Thomas Newcomen, a blacksmith or ironmonger, and John Cawley, a plumber and glazier, patented their atmospheric engine, in which at first condensation was effected by the affusion of cold water upon the external surface of the cylinder, which was introduced into a hollow casing by which it was surrounded. Having accidentally observed that an engine worked several strokes with unusual rapidity without the supply of condensing water, Newcomen found, on examining the piston, a hole in it through which the water poured on to keep it air-

tight issued in the form of a little jet, and instantly condensed the steam under it; this led him to abandon the casing and to introduce a pipe furnished with a cock, into the bottom of the cylinder, by which water was supplied from a reservoir. Newcomen's engine required the constant attendance of some person to open and shut the regulating and condensing valves, a duty which was usually entrusted to boys, called *cock-boys*. It is said that one of these boys, named Humphrey Potter, wishing to join his comrades at play, without exposing himself to the consequences of suspending the performance of the engine, contrived by attaching strings of proper length to the levers which governed the two cocks, to connect them with the beam, so that it should open and close the cocks as it moved up and down, with the most perfect regularity. By this simple contrivance the steam-engine for the first time became an automaton.

It was in repairing a working model of a steam-engine on Newcomen's principle for the lectures of the professor of natural philosophy at the University of Glasgow, that James Watt directed his mind to the prosecution of those inventions and beautiful contrivances, by which he gave to senseless matter an almost instinctive power of self-adjustment, with precision of action more than belongs to any animated being, and which have rendered his name celebrated over the world.

At the time of which we speak, Newcomen's engine was of the last and most approved construction. The moving power was the weight of the air pressing on the upper surface of a piston

working in a cylinder; steam being employed at the termination of each downward stroke to raise the piston with its load of air up again, and then to form a vacuum by its condensation when cooled by a jet of cold water, which was thrown into the cylinder when the admission of steam was stopped. Upon repairing the model, Watt was struck by the incapability of the boiler to produce a sufficient supply of steam, though it was larger in proportion to the cylinder than was usual in working engines. This arose from the nature of the cylinder, which being made of brass, a better conductor of heat than cast-iron, and presenting, in consequence of its small size, a much larger surface in proportion to its solid content than the cylinders of working engines, necessarily cooled faster between the strokes, and therefore at every fresh admission consumed a greater proportionate quantity of steam. But being made aware of a much greater consumption of steam than he had imagined, he was not satisfied without a thorough inquiry into the cause. With this view he made experiments upon the merits of boilers of different constructions; on the effect of substituting a less perfect conductor, as wood, for the material of the cylinder; on the quantity of coal required to evaporate a given quantity of water; on the degree of expansion of water in the form of steam: and he constructed a boiler which showed the quantity of water evaporated in a given time, and thus enabled him to calculate the quantity of steam consumed at each stroke of the engine. This proved to be several times the content of the cylinder. He soon discovered that, whatever the

size and construction of the cylinder, an admission of hot steam into it must necessarily be attended with very great waste, if in condensing the steam previously admitted, that vessel had been cooled down sufficiently to produce a vacuum at all approaching to a perfect one. If, on the other hand, to prevent this waste, he cooled it less thoroughly, a considerable quantity of steam remained uncondensed within, and by its resistance weakened the power of the descending stroke. These considerations pointed out a vital defect in Newcomen's engine; involving either a loss of steam, and consequent waste of fuel; or a loss of power from the piston's descending at every stroke through a very imperfect vacuum.

It soon occurred to Watt, that if the condensation were performed in a separate vessel, one great evil, the cooling of the cylinder, and the consequent waste of steam, would be avoided. The idea once started, he soon verified it by experiment. By means of an arrangement of cocks, a communication was opened between the cylinder, and a distinct vessel exhausted of its air, at the moment when the former was filled with steam. The vapour of course rushed to fill up the vacuum, and was there condensed by the application of external cold, or by a jet of water; so that fresh steam being continually drawn off from the cylinder to supply the vacuum continually created, the density of that which remained might be reduced within any assignable limits. This was the great and fundamental improvement.

Still, however, there was a radical defect in the atmospheric

engine, inasmuch as the air being admitted into the cylinder at every stroke, a great deal of heat was abstracted, and a proportionate quantity of steam wasted. To remedy this, Watt excluded the air from the cylinder altogether; and recurred to the original plan of making steam the moving power of the engine, not a mere agent to produce a vacuum. In removing the difficulties of construction which beset this new plan, he displayed great ingenuity and powers of resource. On the old plan, if the cylinder was not bored quite true, or the piston not accurately fitted, a little water poured upon the top rendered it perfectly air-tight, and the leakage into the cylinder was of little consequence, so long as the injection water was thrown into that vessel. But on the new plan, no water could possibly be admitted within the cylinder; and it was necessary, not merely that the piston should be air-tight, but that it should work through an air-tight collar, that no portion of the steam admitted above it might escape. This he accomplished by packing the piston and the stuffing-box, as it is called, through which the piston-rod works, with hemp. A further improvement consisted in equalising the motion of the engine by admitting the steam alternately above and below the piston, by which the power is doubled in the same space, and with the same strength of material. The vacuum of the condenser was perfected by adding a powerful pump, which at once drew off the condensed and injected water, and with it any portion of air which might find admission; as this would interfere with the action of the engine if allowed to accumulate.

His last great change was to cut off the communication between the cylinder and the boiler, when a portion only, as one-third or one-half, of the stroke was performed; leaving it to the expansive power of the steam to complete it. By this, œconomy of steam was obtained, together with the power of varying the effort of the engine according to the work which it has to do, by admitting the steam through a greater or smaller portion of the stroke.

These are the chief improvements which Watt effected at different periods of his life. He was born June 19, 1736, at Greenock, where he received the rudiments of his education. Having at an early age manifested a partiality for the practical part of mechanics, he went in his eighteenth year to London to obtain instruction in the profession of a mathematical instrument-maker, but remained there little more than a year, being compelled to return home on account of his health. In 1757, shortly after his return home, he was appointed instrument-maker to the University of Glasgow, and accommodated with premises within the precincts of that learned body. In 1763 he removed into the town of Glasgow, intending to practise as a civil engineer. His first patent is dated June 5, 1769, which parliament extended in 1775 for twenty-five years in consideration of the national importance of the inventions, and the difficulty and expense of introducing them to public notice. He died at his house at Heathfield in the county of Stafford, on the 25th of August, 1819, at the advanced age of eighty-four, after having realized an ample fortune, the well-

earned reward of his industry and ability.

To enter into the history of the various applications of the steam-engine to the different branches of industry would carry us beyond the bounds of this work. "To enumerate its present effects," says a well-known writer on the steam-engine[1], "would be to count almost every comfort and every luxury of life. It has increased the sum of human happiness, not only by calling new pleasures into existence, but by so cheapening former enjoyments as to render them attainable by those who before could never have hoped to share them: the surface of the land, and the face of the waters are traversed with equal facility by its power; and by thus stimulating and facilitating the intercourse of nation with nation, and the commerce of people with people, it has knit together remote countries by bonds of amity not likely to be broken. Streams of knowledge and information are kept flowing between distant centres of population, those more advanced diffusing civilization and improvement among those that are more backward. The press itself, to which mankind owes in so large a degree the rapidity of their improvement in modern times, has had its power and influence increased in a manifold ratio by its union with the steam-engine. It is thus that literature is cheapened, and by being cheapened, diffused; it is thus that reason has taken the place of force, and the pen has superseded the sword; it is thus that war has almost ceased upon the earth, and that the differences which inevitably arise between

[1] Dr. Lardner.

people and people are for the most part adjusted by peaceful negotiation."

# LENDING AND PAWNBROKING

It appears singular to us at present that it should have been once considered unlawful to receive interest for lent money; but this circumstance will excite no wonder when the reason of it is fully explained. The different occupations by which one can maintain a family without robbery and without war, were at early periods neither so numerous nor so productive as in modern times; those who borrowed money required it only for immediate use, to relieve their necessities or to procure the conveniences of life; and those who advanced it to such indigent persons did so either through benevolence or friendship. The case now is widely different. With the assistance of borrowed money people enter into business, and carry on trades, from which by their abilities, diligence, or good fortune, so much profit arises that they soon acquire more than is requisite for their daily support; and under these circumstances the lender may undoubtedly receive for the beneficial use of his money a certain remuneration, especially as he himself might have employed it to advantage; and as by lending it he runs the risk of losing either the whole or a part of his capital, or at least of not receiving it again so soon as he may have occasion for it.

Lending on interest, therefore, must have become more usual in proportion as trade, manufactures, and the arts were extended; or as the art of acquiring money by money became more

common: but it long continued to be detested, because the ancient abhorrence against it was by an improper construction of the Mosaic law converted into a religious prejudice[2], which, like many other prejudices more pernicious, was strengthened and confirmed by severe papal laws. The people, however, who often devise means to render the faults of their legislators less hurtful, concealed this practice by various inventions, so that neither the borrower nor lender could be punished, nor the giving and receiving of interest be prevented. As it was of more benefit than prejudice to trade, the impolicy of the prohibition became always more apparent; it was known that the new-invented usurious arts under which it was privately followed would occasion greater evils than those which had been apprehended from lending on interest publicly; it was perceived also that the Jews, who were not affected by papal maledictions, foreigners, and a few natives who had neither religion nor conscience, and whom the church wished least of all to favour, were those principally enriched by it.

In no place was this inconvenience more felt than at the Romish court, even at a time when it boasted of divine infallibility; and nowhere was more care employed to remove it. A plan, therefore, was at length devised, by which the evil, as was supposed, would be banished. A capital was collected from which money was to be lent to the poor for a certain period on pledges without interest. This idea was indeed not new; for such

[2] J. D. Michaelis, in Syntagma Commentationum, ii. p. 9; and his Mosaisches Recht. iii. p. 86.

establishments had long before been formed and supported by humane princes. The emperor Augustus, we are told, converted into a fund the surplus of the money which arose to the State from the confiscated property of criminals, and lent sums from it, without interest, to those who could pledge effects equal to double the amount[3]. Tiberius also advanced a large capital, from which those were supplied with money for three years, who could give security on lands equivalent to twice the value[4]. Alexander Severus reduced the interest of money by lending it at a low rate, and advancing sums to the poor without interest to purchase lands, and agreeing to receive payment from the produce of them[5].

These examples of the ancients were followed in modern Italy. In order to collect money, the popes conferred upon those who would contribute towards that object a great many fictitious advantages, which at any rate cost them nothing. By bulls and holy water they dispensed indulgences and eternal salvation; they permitted burthensome vows to be converted into donations to lending-houses; and authorised the rich who advanced them considerable sums to legitimate such of their children as were not born in wedlock. As an establishment of this kind required a great many servants, they endeavoured to procure these also on the same conditions; and they offered, besides the above-

[3] Sueton. Vita Augusti, cap. 41.

[4] Taciti Annal. vi. 17. – Sueton. Vita Tiberii, cap. 48. – Dio Cassius, lviii. 21.

[5] Ælius Lamprid. Vita Alex. Severi, cap. 21.

mentioned benefits, a great many others not worth notice, to those who would engage to discharge gratis the business of their new undertaking; but in cases of necessity they were to receive a moderate salary from the funds. This money was lent without interest for a certain time to the poor only, provided they could deposit proper pledges of sufficient value.

It was, however, soon observed that an establishment of this kind could neither be of extensive use nor of long duration. In order to prevent the secret lending of money, by the usurious arts which had begun to be practised, it was necessary that it should advance sums not only to those who were poor in the strictest sense of the word, but to those also who, to secure themselves from poverty, wished to undertake and carry on useful employments, and who for that purpose had need of capitals. However powerful the attractions might be, which, on account of the religious folly that then prevailed, induced people to make large contributions, they gradually lost their force, and the latter were lessened in proportion, especially as a spirit of reformation began soon after to break out in Germany, and to spread more and more into other countries. Even if a lending-house should not be exhausted by the maintenance of its servants, and various accidents that could not be guarded against, it was still necessary, at any rate, to borrow as much money at interest as might be sufficient to support the establishment. As it was impossible that it could relieve all the poor, the only method to be pursued was to prevent their increase, by encouraging trade, and

by supplying those with money who wanted only a little to enable them to gain more, and who were in a condition and willing to pay a moderate interest. The pontiffs, therefore, at length resolved to allow the lending-houses to receive interest, not for the whole capitals which they lent, but only for a part, merely that they might raise as much money as might be sufficient to defray their expenses; and they now, for the first time, adopted the long-established maxim, that those who enjoy the benefits should assist to bear the burthen – a maxim which very clearly proves the legality of interest. When this opening was once made, one step more only was necessary to place the lending-houses on that judicious footing on which they would in all probability have been put by the inventor himself, had he not been under the influence of prejudice. In order that they might have sufficient stock in hand, it was thought proper to give to those who should advance them money a moderate interest, which they prudently concealed by blending it with the unavoidable expenses of the establishment, to which it indeed belonged, and which their debtors, by the practice a little before introduced, were obliged to make good. The lending-houses, therefore, gave and received interest. But that the odious name might be avoided, whatever interest was received, was said to be *pro indemnitate*; and this is the expression made use of in the papal bull.

All this, it must be confessed, was devised with much ingenuity: but persons of acuteness still discovered the concealed interest; and a violent contest soon arose respecting the legality

of lending-houses, in which the greatest divines and jurists of the age took a part; and by which the old question, whether one might do anything wicked, or establish interest, in order to effect good, was again revived and examined. Fortunately for the pontifical court, the folly of mankind was still so great that a bull was sufficient to suppress, or at least to silence, the spirit of inquiry. The pope declared the holy mountains of piety, "sacri monti de pietà," to be legal; and threatened those with his vengeance who dared to entertain any further doubts on the subject. All the cities now hastened to establish lending-houses; and their example was at length followed in other countries. Such, in a general view, is the history of these establishments: I shall now confirm it by the necessary proofs.

When under the appellation of *lending-house* we understand a public establishment where any person can borrow money upon pledges, either for or without interest, we must not compare it to the *tabernæ argentariæ* or *mensæ nummulariæ* of the Romans. These were banking-houses, at which the state and rich people caused their revenues to be paid, and on which they gave their creditors orders either to receive their debts in money, or to have the sums transferred in their own name, and to receive security for them. To assign over money and to pay money by a bill were called *perscribere* and *rescribere*; and an assignment or draft was called *attributio*. These *argentarii*, *mensarii*, *nummularii*, *collybistæ* and *trapezitæ* followed the same employment, therefore, as our cashiers or bankers. The former,

like the latter, dealt in exchanges and discount; and in the same manner also they lent from their capital on interest, and gave interest themselves, in order that they might receive a greater. Those who among the ancients were enemies to the lending of money on interest brought these people into some disrepute; and the contempt entertained for them was probably increased by prejudice, though those *nummarii* who were established by government as public cashiers held so exalted a rank that some of them became consuls. Such banking-houses existed in the Italian States in the middle ages, about the year 1377. They were called *apothecæ seu casanæ feneris*[6], and in Germany *Wechselbanke*, banks of exchange; but they were not lending-houses in the sense in which I here understand them.

Equally distinct also from lending-houses were those banks established in the fourteenth century, in many cities of Italy, such, for example, as Florence, in order to raise public loans. Those who advanced money on that account received an obligation and monthly interest, which on no pretext could be refused, even if the creditor had been guilty of any crime. These obligations were soon sold with advantage, but oftener with loss; and the price of them rose and fell like that of the English stocks, but not so rapidly; and theologists disputed whether one could with a safe conscience purchase an obligation at less than the

[6] M. Manni circa i sigilli antichi dei secoli bassi, vol. xxvii. p. 86. The author here quotes from an ancient city-book the following passage: – "Franciscus fenerator pro se et *apotheca seu casana fenoris*, quam tenebat in via Quattro Pagoni," &c.

stated value, from a proprietor who was obliged to dispose of it for ready specie. If the State was desirous or under the necessity of repaying the money, it availed itself of that regale called by Leyser *regale falsæ monetæ*, and returned the capital in money of an inferior value. This establishment was confirmed, at least at Florence, by the pontiff, who subjected those who should commit any fraud in it to ecclesiastical punishment and a fine, which was to be carried to the papal treasury: but long before that period the republic of Genoa had raised a loan by mortgaging the public revenues. I have been more particular on this subject, because Le Bret[7] calls these banks, very improperly, lending-houses; and in order to show to what a degree of perfection the princely art of contracting and paying debts was brought so early as the fourteenth century.

Those who have as yet determined the origin of lending-houses with the greatest exactness, place it, as Dorotheus Ascanius, that is Matthias Zimmermann[8], does, in the time of Pope Pius II. or Paul II., who filled the papal chair from 1464

[7] Algemeine Welthistorie, xlv. p. 10.

[8] This theologian, born at Eperies in Hungary in 1625, was driven from his native country on account of his religion, and died superintendant at Meisse in 1689. He wrote, besides other works, Dorothei Asciani Montes Pietatis Romanenses, historice, canonice, et theologice detecti. Lipsiæ, 1670, 4to. This book is at present very scarce. I shall take this opportunity of mentioning also the following, because many who have written on lending-houses have quoted it, though they never saw it: – Montes Pietatis Romanenses, das ist, die Berg der Fromheit oder Gottesforcht in der Stadt Rom. Durch Elychnium Gottlieb. Strasburg, 1608, 8vo. It contains nothing of importance that may not be found in Ascianus.

to 1471; and the reason for supposing it to have been under the pontificate of the latter is, because Leo X. in his bull, which I shall quote hereafter, mentions that pope as the first who confirmed an establishment of this kind. As the above account did not appear to me satisfactory, and as I knew before that the oldest lending-houses in Italy were under the inspection of the Franciscans, I consulted the Annals of the Seraphic Order, with full expectation that this service would not be omitted in that work; and I indeed found in it more materials towards the history of lending-houses than has ever been collected, as far as I know, by any other person.

As complaints against usury, which was practised by many Christians, but particularly by the Jews, became louder and more public in Italy in the fifteenth century, Barnabas Interamnensis, probably of Terni, first conceived the idea of establishing a lending-house. This man was originally a physician; had been admitted to the degree of doctor; was held in great respect on account of his learning; became a Minorite, or Franciscan; acquired in that situation every rank of honour, and died, in the first monastery of this order at Assisi (*in monte Subasio*[9]),

[9] Of this Barnabas I know nothing more than what I have here extracted from Waddingii Annales Minorum, tom. xiv. p. 93. Wadding refers to Marian. lib. v. c. 40. § 17; and Marc. 3. p. lib. 5. cap. 58. The former is Marianus Florentinus, whose Fasciculus Chronicoram Ordinis Minorum, which consists of five books, was used in manuscript by Wadding, in composing his large work, and in my opinion has never been printed. Marc. is Marcus Ulyssoponensis, whose Chronica Ordinis Minorum I have not been able to procure, though it is translated into several languages. See Waddingii Scriptores Ordinis Minorum. Romæ 1650, fol. pp. 248, 249.

in the year 1474. While he was employed in preaching under Pope Pius II. at Perugia, in the territories of the Church, and observed how much the poor were oppressed by the usurious dealings of the Jews, he made a proposal for raising a capital by collections, in order to lend from it on pledges to the indigent, who should give monthly, for the use of the money borrowed, as much interest as might be necessary to pay the servants employed in this establishment, and to support it. Fortunatus de Copolis, an able jurist of Perugia, who after the death of his wife became also a Franciscan, approved of this plan, and offered to assist in putting it into execution. To be assured in regard to an undertaking which seemed to approach so near to the lending on interest, both these persons laid their plan before the university of that place, and requested to know whether such an establishment could be allowed; and an answer being given in the affirmative, a considerable sum was soon collected by preaching, so that there was a sufficiency to open a lending-house. Notwithstanding this sanction, many were displeased with the design, and considered the receiving of interest, however small it might be, as a species of usury. Those who exclaimed most against it were the Dominicans (*ex ordine Prædicatorum*): and they seem to have continued to preach in opposition to it, till they were compelled by Leo X. to be silent; while the Franciscans, on the other hand, defended it, and endeavoured to make it be generally adopted. The dispute became more violent when, at the end of a year, after all expenses were paid, a

considerable surplus was found remaining; and as the managers did not know how to dispose of it, they at length thought proper to divide it amongst the servants, because no fixed salaries had been appointed for them. Such was the method first pursued at Perugia; but in other places the annual overplus was employed in a different manner. The particular year when this establishment began to be formed I have nowhere found marked; but as it was in the time of Pius II., it must have been in 1464, or before that period[10]. It is very remarkable that this pontiff confirmed the lending-house at Orvieto (*Urbs Vetus*) so early as the above year; whereas that at Perugia was sanctioned, for the first time, by Pope Paul II. in 1467. It is singular also that Leo X., in his confirmation of this establishment, mentions Paul II., Sixtus IV., Innocent VIII., Alexander VI. and Julius II.; but not Pius II. Pope Sixtus IV., as Wadding says, confirmed in 1472 the lending-house at Viterbo, which had, however, been begun so early as 1469, by Franciscus de Viterbo, a Minorite[11].

In the year 1479 Sixtus IV. confirmed the lending-house which had been established at Savona, the place of his birth,

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[10] This is confirmed by M. B. Salon, in t. 2. Contr. de Justit. et Jure, in ii. 2 Thom. Aquin. qu. 88. art. 2. controv. 27: "Hujus modi mons non erat in usu apud antiquos. Cœpit fere a 150 annis, tempore Pii II." In C. L. Richard's Analysis Conciliorum Generalium et Particularium, Venetiis, 1776, 4 vol. fol. iv. p. 98, I find that the first lending-house at Perugia was established in the year 1450; but Pius II., under whose pontificate it appears by various testimonies to have been founded, was not chosen pope till the year 1458.

[11] Bussi, Istoria della città di Viterbo. In Roma, 1742, fol. p. 271.

upon the same plan as that at Perugia. The bull issued for this purpose is the first pontifical confirmation ever printed[12]; for that obtained for Perugia was not, as we are told by the editor, to be found in the archives there in 1618, the time when the other was printed. I have never found the confirmation of those at Orvieto and Viterbo. Ascianus sought for them, but without success, in Bullarium Magnum Cherubini, and they are not mentioned by Sixtus. This pontiff, in his bull, laments that the great expenses to which he was subjected did not permit him to relieve his countrymen with money, but that he would grant to the lending-house so many spiritual advantages, as should induce the faithful to contribute towards its support; and that it was his desire that money should be lent from it to those who would assist gratis during a year in the business which it required. If none could be found to serve on these conditions, a moderate salary was to be given. He added a clause also respecting pledges; but passed over in silence that the debtors were to contribute anything for the support of the institution by paying interest, which Barnabas, whose name does not occur in the bull, introduced however at Perugia, and which the pope tacitly approved.

The greater part of the lending-houses in Italy were established in the fifteenth and following centuries by

[12] It may be found in Bolle et Privilegi del Sacro Monte della Pietà di Roma. In Roma, 1618: ristampati l'anno 1658. This collection is commonly bound up with the following work, which was printed in the same year and again reprinted: Statuti del Sacro Monte della Pietà di Roma. This bull is inserted entire by Ascianus, p. 719, but in the Collection of the pontifical bulls it is omitted.

the Minorites Marcus Bononiensis, Michael a Carcano[13], Cherubinus Spoletanus, Jacobus de Marchia, Antonius Vercellensis, Angelus a Clavasio, and above all, Bernardinus Tomitano, named also *Feltrensis* and *Parvulus*. This man was born at Feltri, in the country of Treviso, in the year 1439. His father was called Donato Tomitano, and his mother Corona Rambaldoni; they were both of distinguished families, though some assert that he was of low extraction, and a native of Tomi, a small place near Feltri, on which account he got the name of Tomitano. The name of *Parvulus* arose from his diminutive stature, which he sometimes made a subject of pleasantry[14]. This much at any rate is certain, that he had received a good education. In 1456, when seventeen years of age, he suffered his instructors, contrary to the inclination of his father, to carry him to Padua, to be entered in the order of the Minorites; and on this occasion he changed his christian-name Martin into Bernardinus. As he was a good speaker, he was employed by his order in travelling through Italy and preaching. He was heard with applause, and in many parts the people almost paid him divine honours. The chief object of his sermons was to banish gaming, intemperance, and extravagance of dress; but he above all attacked the Jews, and excited such a hatred against them, that the governments

[13] This Michael travelled and preached much in company with Bernardinus, and died at Como in 1485. – Wadding, xiv. p. 396.

[14] The Piccolimini, nephews of the pope, having once paid their respects to him at Siena, he told them he was their namesake. – Wadding, xiv. p. 447.

in many places were obliged to entreat or to compel him either to quit their territories or not to preach in opposition to these unfortunate people, whom the crowds he collected threatened to massacre; and sometimes when he visited cities where there were rich Jews and persons who were connected with them in trade, he was in danger of losing even his own life. Taking advantage of this general antipathy to the Jews, he exerted himself, after the example of Barnabas, his brother Minorite, to get lending-houses established, and died at Pavia in the year 1494. The Minorites played a number of juggling tricks with his body, pretending that it performed miracles, by which means they procured him a place in the catalogue of the saints; and to render his name still more lasting, some of his sermons have been printed among the works of the writers of the Franciscan order[15].

The lending-houses in Italy, with the origin of which I am acquainted, are as follows: – The lending-house at Perugia was inspected in 1485 by Bernardinus, who enlarged its capital.

The same year he established one at Assisi, which was confirmed by Pope Innocent, and which was visited and improved by its founder in 1487[16].

In the year 1486, after much opposition, he established a lending-house at Mantua, and procured for it also the pope's

[15] Waddingii Scriptores Ordinis Minorum, p. 58. Fabricii Biblioth. Mediæ et Infimæ Æt. i. p. 586.

[16] Wadding, xiv. pp. 398, 433.

sanction[17]. Four years after, however, it had declined so much, that he was obliged to preach in order to obtain new donations to support it.

At Florence he met with still more opposition; for the rich Jews bribed the members of the government, who wished in appearance to favour the establishment of the lending-house, to which they had consented eighteen years before, while they secretly thwarted it; and some boys having once proceeded, after hearing a sermon, to attack the houses of the Jews, the Minorites were ordered to abstain from preaching and to quit the city[18]. It was however completely established; but by the Dominican Hieronymus Savonarola[19].

In the year 1488 Bernardinus established a lending-house at Parma, and procured for it the pope's sanction, as well as for one at Cesena, where the interest was defined to be "pro salariis officialium et aliis montis oneribus perferendis." About the conclusion of this year he was at the other end of Italy, where he re-established the lending-house at Aquila in the kingdom of Naples[20].

In the year following he established one at Chieti (*Theate*)

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[17] It may be found entire in Wadding, xiv. p. 411. It was ordered that the pledges should be worth double the sum lent, and that they should be sold if not redeemed within a year.

[18] Wadding, xiv. p. 446.

[19] D. Manni circa i Sigilli Antichi, tom. xxvii. p. 92, where much information respecting this subject may be found.

[20] Wadding, xiv. p. 451.

in the same kingdom, another at Rieti (*Reate*) in the territories of the Church, a third at Narni (*Narnia*)[21]; and a fourth at Lucca, which was confirmed by the bishop, notwithstanding the opposition of the Jews, who did every thing in their power to prevent it.

In the year 1490 a lending-house was established at Piacenza (*Placentia*) by Bernardinus, who at the same time found one at Genoa which had been established by the before-mentioned Angelus a Clavasio[22]. At this period also a lending-house was established at Verona[23], and another at Milan by the Minorite Michael de Aquis.

In 1491 a lending-house was established at Padua, which was confirmed by Pope Alexander VI. in 1493[24]; and another was established at Ravenna[25].

In 1492 Bernardinus reformed the lending-house at Vicenza, where, in order to avoid the reproach of usury, the artifice was employed of not demanding any interest, but admonishing the borrowers that they should give a remuneration according to their piety and ability. As people were by these means induced to pay more interest than what was legally required at other lending-

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[21] Ibid. pp. 462, 465.

[22] Ibid. xiv. pp. 480, 481.

[23] Ibid. p. 517.

[24] Ibid. xiv. pp. 93, 482.

[25] Ibid. p. 514.

houses, Bernardinus caused this method to be abolished[26]. He established a lending-house also the same year in the small town of Campo S. Pietro, not far from Padua, and expelled the Jews who had lent upon pledges. At this period there were lending-houses at Bassano, a village in the county of Trevisi, and also at Feltri, which he inspected and improved[27].

In the year 1493 Bernardinus caused a lending-house to be established at Crema, in the Venetian dominions; another at Pavia, where he requested the opinion of the jurists, whom he was happy to find favourable to his design; and likewise a third at Gubbio, in the territories of the Church. At the same time another Franciscan established at Cremona a *mons frumenti pietatis*, from which corn was lent out on interest to necessitous persons; and it appears that there had been an institution of the like kind before at Parma[28].

In the year 1494, Bernardinus, a short time before his death, assisted to establish a lending-house at Montagnana, in the Venetian territories[29], and to improve that at Brescia, which was likely to decay, because the servants had not fixed salaries[30]. The same year another Franciscan established the lending-house at Modena.

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[26] Ibid. xv. pp. 6, 65.

[27] Wadding, xv. pp. 7, 9, 12.

[28] Ibid. xv. pp. 37, 45, 46.

[29] Ibid. xv. 67.

[30] Ibid. xv. p. 68. Bernardinus considered the giving of wages as a necessary evil.

In the year 1506 Pope Julius II. confirmed the lending-house at Bologna. That of Trivigi was established in 1509; and in 1512, Elizabeth of the family of Gonzaga, as widow of duke Guido Ubaldus, established the first lending-house in the duchy of Urbino at Gubbio, and procured permission for it to coin money[31].

The historical account I have here given, displays in the strongest light the great force of prejudice, and particularly of the prejudice of ecclesiastics. Notwithstanding the manifest advantages with which lending-houses were attended, and though a great part of them had been already sanctioned by the infallible court of Rome, many, but chiefly Dominicans, exclaimed against these institutions, which they did not call *montes pietatis*, but *impietatis*. No opposition gave the Minorites so much uneasiness as that of the Dominican Thomas de Vio, who afterwards became celebrated as a cardinal under the name of Cajetanus. This monk, while he taught at Pavia in 1498, wrote a treatise De Monte Pietatis[32], in which he inveighed bitterly against taking pledges and interest, even though the latter was destined for the maintenance of the servants. The popes, he said, had confirmed lending-houses in general, but not every regulation that might be introduced into them, and had only given their express

[31] Della Zecca di Gubbio, e delle Geste de' Conti e Duchi di Urbino; opera di Rinaldo Reposati. Bologna, 1772, 4to.

[32] It is to be found in the well-known large collection of juridical writings quoted commonly under the title Tractatus Tractatuum. Venetiis, 1584, fol. p. 419, vol. vi. part 1. It has also been printed separately.

approbation of them so far as they were consistent with the laws of the church. These words, he added, had been wickedly left out in the bulls which had been printed; but he had heard them, and read them, in the confirmation of the lending-house at Mantua. I indeed find that these words are not in the copy of that bull given in Wadding, which is said to have been taken from the original; nor in the still older confirmation of the lending-house at Savona. But even were they to be found there, this would not justify Cajetan's opposition, as the pope in both these bulls recommended the plan of the lending-house at Perugia to be adopted, of which receiving interest formed a part. Bernardinus de Bustis[33], a Minorite, took up the cause in opposition to Cajetan, and, according to Wadding's account, with rather too much vehemence. Among his antagonists were Barrianus and Franc. Papafava, a jurist of Padua[34]. As this dispute was revived with a great deal of warmth in the beginning of the sixteenth century, it was at length terminated by Pope Leo X., who in the tenth sitting of the council of the Lateran declared by a particular bull that lending-houses were legal and useful; that all doubts to the contrary were sinful, and that those who wrote against them should be placed in a state of excommunication[35]. The

[33] His works were printed together, in folio, at Brescia in 1588.

[34] The work of the former appeared in 1496. The writings of both are printed in the work of Ascianus, or Zimmermann, which has been often quoted already.

[35] This bull, which forms an epoch in the history of lending-houses, may be found in S. Lateranen. Concilium Novissimum. Romæ, 1521, fol. This scarce work, which I have now before me, is inserted entire in Harduini Acta Conciliorum, tom. ix. Parisiis,

whole assembly, except one archbishop, voted in favour of this determination; and it appears from a decree of the council of Trent, that it also acknowledged their legality, and confirmed them[36]. Notwithstanding this decision, there were still writers who sometimes condemned them; and who did not consider all the decrees, at least the above one of the Lateran council, as agreeable to justice. Among these was Dominicus de Soto, a Dominican. All opposition, however, in the course of time subsided, and in the year 1565, Charles Borromeo, the pope's legate at the council of Milan, ordered all governments and ecclesiastics to assist in establishing lending-houses[37].

Of the lending-houses established after this period in Italy, I shall mention those only of Rome and Naples. It is very remarkable that the pope's capital should have been without an institution of this kind till the year 1539, and that it should have been formed by the exertions of Giovanni Calvo, a Franciscan. Paul III., in his bull of confirmation, ordered that Calvo's successors in rank and employment should always have the inspection of it, because the Franciscans had taken the greatest

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1714, fol. The bull may be found p. 1773. It may be found also in Bullarium Magnum Cherubini, i. p. 560; Waddingii Annal. Minor. xv. p. 470; Ascianus, p. 738; and Beyerlinck's Theatrum Vitæ Hum. v. p. 603.

[36] This is the conclusion formed by Richard, in Analysis Conciliorum, because in sess. 22, cap. 8, lending-houses are reckoned among the *pia loca*, and the inspection of them assigned to the bishops.

[37] Waddingii Annal. Minor. xv. p. 471.

pains to endeavour to root out usury[38].

The lending-house at Naples was first established in 1539 or 1540. Two rich citizens, Aurelio Paparo, and Leonardo or Nardo di Palma, redeemed all the pledges which were at that time in the hands of the Jews, and offered to deliver them to the owners without interest, provided they would return the money which had been advanced on them. More opulent persons soon followed their example; many bequeathed large sums for this benevolent purpose; and Toledo, the viceroy, who drove the Jews from the kingdom, supported it by every method possible. This lending-house, which has indeed undergone many variations, is the largest in Europe; and it contains such an immense number of different articles, many of them exceedingly valuable, that it may be considered as a repository of the most important part of the moveables of the whole nation. About the year 1563, another establishment of the like kind was formed under the title of *banco de' poveri*. At first this bank advanced money without interest, only to relieve confined debtors; afterwards, as its capital increased, it lent upon pledges, but not above the sum of five ducats without interest. For larger sums the usual interest was demanded[39].

At what time the first lending-house was established at Venice

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[38] Ibid. xvi. p. 444; Ascianus, p. 766.

[39] (Summonte) Historia de Napoli, 1749, 4to, vol. iv. p. 179. – Giannone, vol. iv. – De' Banchi di Napoli, da Michele Rocco. Neap. 1785, 3 vols. 8vo, i. p. 151.

I have not been able to learn[40]. This State seems to have long tolerated the Jews; it endeavoured to moderate the hatred conceived against these people, and gave orders to Bernardinus to forbear preaching against them[41]. It appears to me in general, that the principal commercial cities of Italy were the latest to avail themselves of this invention; because they knew that to regulate interest by law, where trade was flourishing, would be ineffectual or useless; or because the rich Jew merchants found means to prevent it.

The name *mons pietatis*, of which no satisfactory explanation has been as yet given, came with the invention from Italy, and is equally old, if not older. Funds of money formed by the contributions of different persons, for some end specified, were long before called *montes*. In the first centuries of the Christian æra, free gifts were collected and preserved in churches by ecclesiastics, partly for the purpose of defraying the expense of divine service, and partly to relieve the poor. Such capitals, which were considered as ecclesiastical funds, were by Prudentius, in the beginning of the fifth century, called *montes annonæ* and *arca numinis*[42]. Tertullian calls them *deposita pietatis*[43]; and hence

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[40] Vettor Sandi, in Principi di Storia civile della Republica di Venezia. In Venezia 1771, 4to, vol. ii. p. 436. The author treats expressly of the institution of this bank, but the year when it commenced is not mentioned.

[41] Waddingii Annal. Minor. xv. p. 67.

[42] Hymnus ii. honorem Laurentii. The poet relates, that in the third century the pagan governor of the city demanded the church treasure from Laurentius the deacon.

[43] This passage, with which Senkenberg was not acquainted, may be found in

has been formed *montes pietatis*. At any rate I am of opinion that the inventor chose and adopted this name in order to give his institution a sacred or religious appearance, and to procure it more approbation and support.

I find however that those banks employed in Italy, during the thirteenth and fourteenth centuries, to borrow money in the name of States, for which the public revenues were mortgaged and interest paid, were also called *montes*[44]. In this sense the word is used by Italian historians of much later times; and those are greatly mistaken, who, with Ascian and many others, consider all these *montes* as real lending-houses. These loan-banks or *montes* received various names, sometimes from the princes who established them, sometimes from the use to which the money borrowed was applied, and sometimes from the objects which were mortgaged. Of this kind were the *mons fidei*, or loan opened by Pope Clement VII. in the year 1526, for defending his capital[45]; the *mons aluminarius*, under Pope Pius IV., for which the pontifical alum-works were pledged; the *mons religionis*, under Pius V., for carrying on the war against the Turks; and the *montes farinæ*, *carnium*, *vini*, &c., when the duties upon these articles were pledged as a security. To facilitate these loans, every condition that could induce people to advance money was thought of. Sometimes high interest was given, if the subscribers

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Tertullian's Apolog. cap. 39, edition of De la Cerda, p. 187.

[44] This word however is not to be found in the Glossarium Manuale.

[45] See the bull in Bullarium Magnum, n. 17.

agreed that it should cease, and the capital fall to the bank after their death; and sometimes low interest was given, but the security was heritable and could be transferred at pleasure. The former were called *montes vacabiles*, and the latter *montes non vacabiles*. Sometimes the State engaged to pay back the capital at the end of a certain period, such for example as nine years, as was the case in regard to the *mons novennalis*, under Paul IV.; or it reserved to itself the option of returning the money at such a period as it might think proper, and sometimes the capital was sunk and the interest made perpetual. The first kind were called *montes redimibiles*, and the second *irredimibiles*[46]. One can here clearly discover the origin of life-rents, annuities, tontines, and government securities; but the further illustration of this subject I shall leave to those who may wish to employ their talents on a history of national debts. I have introduced these remarks, merely to rectify a mistake which has become almost general, and which occasioned some difficulties to me in this research; and I shall only observe further, that the popes gave to their loans, in order to raise their sinking credit, many of those spiritual advantages which they conferred on the *montes pietatis*. This error therefore was more easily propagated, as both were called *montes*; and hence it has happened that Ascianus and others assert that many lending-houses were misapplied by the popes in order to raise public loans.

[46] See Petr. Gregorius Tholosanus de Republica. Francof. 1609, 4to, lib. xiii. c. 16, p. 566; and Ascianus, p. 753.

From the instances here adduced, one may see that the first lending-houses were sanctioned by the pontiffs, because they only could determine to the Catholics in what cases it was lawful for them to receive interest. This circumstance seems to have rendered the establishment of them out of Italy difficult. At any rate the Protestants were at first averse to imitate an institution which originated at the court of Rome, and which, according to the prevailing prejudice of the times, it alone could approve; and from the same consideration they would not adopt the reformation which had been made in the calendar.

The first mention of a lending-house in Germany, which I have as yet met with, is to be found in the permission granted by the emperor Maximilian I. to the citizens of Nuremberg, in the year 1498, to drive the Jews from the city, and to establish an exchange-bank. The permission further stated, "That they should provide for their bank proper managers, clerks, and other persons to conduct it according to their pleasure, or as necessity might require; that such of their fellow-citizens as were not able to carry on their trades, callings, and occupations without borrowing and without pledging their effects, should, on demand, according to their trade and circumstances, receive money, for which pledges, caution and security should be taken; that at the time of payment a certain sum should be exacted by way of interest; that the clerks and conductors of the bank should receive salaries for their service from the interest; and that if any surplus remained it should be employed for the common use of the city

of Nuremberg, like any other public fund."

It here appears that the lending-houses in Germany were first known under the name of exchange-banks, by which was before understood any bank where money was lent and exchanged; but it does not thence follow, as Professor Fischer thinks[47], that they were an Italian invention. The citizens of Nuremberg had not then a lending-house, nor was one established there till the year 1618. At that period they procured from Italy copies of the regulations drawn up for various houses of this kind, in order to select the best. Those of the city of Augsburg however were the grounds on which they built, and they sent thither the persons chosen to manage their lending-house, that they might make themselves fully acquainted with the nature of the establishment at that place[48]. In the year 1591, the magistrates of Augsburg had prohibited the Jews to lend money, or to take pledges; at the same time they granted 30,000 florins as a fund to establish a lending-house, and the regulations of it were published in 1607[49].

In the Netherlands, France and England, lending-houses were first known under the name of *Lombards*, the origin of which is evident. It is well known that in the thirteenth and following centuries many opulent merchants of Italy, which at those

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[47] Geschichte des Teutschen Handels, ii. p. 454.

[48] Gokink's Journal für Teutschland, 1784, i. p. 504, where may be found the first and the newest regulations respecting the lending-house at Nuremberg.

[49] Stettens Geschichte der Stadt Augsburg. Frankf. 1742, 2 vols. 4to, i. p. 720, 789, 833.

periods was almost the only part of Europe that carried on an extensive trade, were invited to these countries, where there were few mercantile people able to engage deeply in commerce. For this reason they were favoured by governments in most of the large cities; but in the course of time they became objects of universal hatred, because they exercised the most oppressive usury, by lending at interest and on pledges. They were called *Longobardi* or *Lombardi*, as whole nations are often named after a part of their country, in the same manner as all the Helvetians are called Swiss, and the Russians sometimes Moscovites. They were, however, called frequently also Caorcini, Caturcini, Caursini, Cawarsini, Cawartini, Bardi, and Amanati; names, which in all probability arose from some of their greatest houses or banks. We know, at any rate, that about those periods the family of the Corsini were in great consideration at Florence. They had banks in the principal towns for lending money; they demanded exorbitant interest; and they received pledges at a low value, and retained them as their own property if not redeemed at the stated time. They eluded the prohibition of the church against interest when they found it necessary, by causing the interest to be previously paid as a present or a premium; and it appears that some sovereigns borrowed money from them on these conditions. In this manner did Edward III. king of England, when travelling through France in the year 1329, receive 5000 marks from the bank of the Bardi, and give then in return, by way of

acknowledgement, a bond for 7000[50]. When complaints against the usurious practices of these Christian Jews became too loud to be disregarded, they were threatened with expulsion from the country, and those who had rendered themselves most obnoxious on that account, were often banished, so that those who remained were obliged to conduct themselves in their business with more prudence and moderation. It is probable that the commerce of these countries was then in too infant a state to dispense altogether with the assistance of these foreigners. In this manner were they treated by Louis IX. in 1268, and likewise by Philip the Bold; and sometimes the popes, who would not authorise interest, lent their assistance by prohibitions, as was the case in regard to Henry III. of England in 1240.

In the fourteenth century, the Lombards in the Netherlands paid to government rent for the houses in which they carried on their money transactions, and something besides for a permission. Of this we have instances at Delft in 1313, and at Dordrecht in 1342[51]. As in the course of time the original Lombards became extinct, these houses were let, with the same permission, for the like employment[52]; but governments at length fixed the rate of interest which they ought to receive, and established regulations for them, by which usurious practices were restrained. Of leases granted on such conditions, an

[50] Fœdera, vol. iv. p. 387.

[51] Beschryving der Stadt Delft. 1729, fol. p. 553.

[52] Salmasius de Fœnore trapezitico. Lugd. 1640, 8vo, p. 744.

instance occurs at Delft in the year 1655. In 1578, William prince of Orange recommended to the magistrates of Amsterdam Francis Masasia, one of the Lombards, as they were then called, in order that he might obtain for him permission to establish a lending-house[53], as many obtained permission to keep billiard-tables, and Jews letters of protection. In the year 1611, the proprietor of such a house at Amsterdam, who during the latter part of his lease had gained by his capital at least thirty-three and a half per cent., offered a very large sum for a renewal of his permission; but in 1614, the city resolved to take the lombard or lending-house into their own hands, or to establish one of the same kind. However odious this plan might be, a dispute arose respecting the legality of it, which Marets[54] and Claude Saumaise endeavoured to support. The public lending-house or lombard at Brussels was established in 1619; that at Antwerp in 1620, and that at Ghent in 1622. All these were established by the archduke Albert, when he entered on the governorship, with the advice of the archbishop of Mechlin; and on this occasion the architect Wenceslaus Coberger was employed, and appointed inspector-general of all the lending-houses in the Spanish Netherlands[55]. Some Italians assert that the Flemings were the first people who borrowed money on interest for their lending-houses; and they

[53] De Koophandel van Amsterdam. Rott. 1780, 8vo, i. p. 221.

[54] S. de Marets Diss. de trapezitis.

[55] Beyerlinck, Magnum Theatrum Vitæ, tom. v. p. 602.

tell us that this practice began in the year 1619[56]. We are assured also, that after a long deliberation at Brussels, it was at length resolved to receive money on interest at the lending-houses. It however appears certain that in Italy this was never done, or at least not till a late period, and that the capitals of the lending-houses there were amassed without giving interest.

This beneficial institution was always opposed in France; chiefly because the doctors of the Sorbonne could not divest themselves of the prejudice against interest; and some in modern times who undertook there to accommodate people with money on the like terms, were punished by government[57]. A lending-house however was established at Paris under Louis XIII., in 1626; but the managers next year were obliged to abandon it[58]. In 1695, some persons formed a capital at Marseilles for the purpose of establishing one there according to the plan of those in Italy[59]. The present *mont de piété* at Paris, which has sometimes in its possession forty casks filled with gold watches that have been pledged, was, by royal command, first established in 1777[60].

[The following is the rate of profit or interest which pawnbrokers in this country are entitled to charge per calendar month. For 2*s.* 6*d.* one halfpenny; 5*s.* one penny; 7*s.* 6*d.* three

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[56] Richard, Analysis Concilior. iv. p. 98.

[57] Turgot, Mem. sur le prêt à intérest, &c. Par. 1789, 8vo.

[58] Sauval, Hist. de la Ville de Paris.

[59] Rufel, Hist. de la Ville de Marseille; 1696. fol. ii. p. 99.

[60] Tableau de Paris. Hamb. 1781. 8vo, i. p. 78.

halfpence; 10*s.* twopence; 12*s.* 6*d.* twopence halfpenny; 15*s.* threepence; 17*s.* 6*d.* threepence halfpenny; £1 fourpence; and so on progressively and in proportion for any sum not exceeding 40*s.* For every sum exceeding 40*s.* and not exceeding 42*s.* eightpence; and for every sum exceeding 42*s.* and not exceeding £10, threepence to every pound, and so on in proportion for any fractional sum. Where any intermediate sum lent on a pledge exceeds 2*s.* 6*d.* and does not exceed 40*s.*, a sum of fourpence may be charged in proportion to each £1. Goods pawned are forfeited on the expiration of a year, exclusive of the date of pawning. But it has been held that the property is not transferred, but that the pawnbroker merely has a right to sell the article; and consequently that, on a claim after this period, with tender of principal and interest, the property must be restored if unsold (Walker *v.* Smith, 5 *Barn.* and *Ald.* 439). Pledges must not be taken from persons intoxicated or under twelve years of age. In Great Britain pawnbrokers must take out a license, which costs £15 within the limits of the old twopenny-post, and £7 10*s.* in other parts. No license is required in Ireland. A second license, which costs £5 15*s.*, is required to take in pledge articles of gold and silver.

From 1833 to 1838 the number of pawnbrokers in the metropolitan district increased from 368 to 386; in the rest of England and Wales, from 1083 to 1194; and in Scotland, from 52 to 88; making a total of 1668 establishments, paying £15,419 for their licenses, besides the licenses which many of

them take out as dealers in gold and silver. The business of a pawnbroker was not known in Glasgow until August 1806, when an itinerant English pawnbroker commenced business in a single room, but decamped at the end of six months; and his place was not supplied until June 1813, when the first regular office was established in the west of Scotland for receiving goods in pawn. Other individuals soon entered the business, and the practice of pawning had become so common, that in 1820, in a season of distress, 2043 heads of families pawned 7380 articles, on which they raised £739 5*s.* 6*d.* Of these heads of families 1375 had never applied for or received charity of any description; 474 received occasional aid from the relief committee, and 194 were paupers. The capital invested in this business in 1840 was about £26,000. Nine-tenths of the articles pledged are redeemed within the legal period. There are no means of ascertaining the exact number of pawnbrokers' establishments in the large towns of England. In 1831, the number of males above the age of twenty employed in those at Manchester was 107; at Liverpool, 91; Birmingham, 54; Bristol, 33; Sheffield, 31.

The following curious return was made by a large pawnbroking establishment at Glasgow to Dr. Cleland, who read it before the British Association in 1836. The list comprised the following articles: – 539 men's coats, 355 vests, 288 pairs of trowsers, 84 pairs of stockings, 1980 women's gowns, 540 petticoats, 132 wrappers, 123 duffies, 90 pelisses, 240 silk handkerchiefs, 294 shirts and shifts, 60 hats, 84 bed-ticks, 108

pillows, 262 pairs of blankets, 300 pairs of sheets, 162 bed-covers, 36 tablecloths, 48 umbrellas, 102 *bibles*, 204 watches, 216 rings, and 48 *Waterloo medals*. There were about thirty pawnbrokers in Glasgow in 1840. In the manufacturing districts, during the prevalence of strikes, or in seasons of commercial embarrassment, many hundreds of families pawn the greater part of their wearing apparel and household furniture. The practice of having recourse to the pawnbrokers on such occasions is quite of a different character from the habits of dependence into which many of the working classes suffer themselves to fall, and who, "on being paid their wages on the Saturday, are in the habit of taking their holiday clothes out of the hands of the pawnbroker to enable them to appear respectably on the Sabbath, and on the Monday following they are again pawned and a fresh loan obtained to meet the exigencies of their families for the remainder of the week." It is on these transactions and on such as arise out of the desire of obtaining some momentary gratification that the pawnbrokers make their large profits. It is stated in one of the reports on the poor laws that a loan of threepence, if redeemed the same day, pays annual interest at the rate of 5200 per cent.; weekly, 866 per cent.;

> 4*d.*, annual interest 3900 per cent., or 650 p. c. weekly;
> 12*d.*, annual interest 1300 per cent., or 216 p. c. weekly.

It is stated that on a capital of sixpence thus employed (in weekly loans), pawnbrokers make in twelve months 2*s.* 2*d.*; on five shillings they gain 10*s.* 4*d.*; on ten shillings, 22*s.* 3¼*d.*;

and on twenty shillings lent in weekly loans of sixpence, they more than double their capital in twenty-seven weeks, and should the goods pawned remain in their hands for the term of twelve months (which seldom occurs), they then frequently derive 100 per cent.[61]]

[61] Waterston's Cyclopædia of Commerce.

# CHEMICAL NAMES OF METALS

As those metals earliest known, viz. copper, iron, gold, silver, lead, quicksilver and tin, received the same names as the nearest heavenly bodies, which appear to us largest, and have been distinguished by the like characters, two questions arise: Whether these names and characters were given first to the planets or to the metals? When, where, and on what account were they made choice of; and why were the metals named after the planets, or the planets after the metals? The latter of these questions, in my opinion, cannot be answered with any degree of certainty; but something may be said on the subject, which will not, perhaps, be disagreeable to those fond of such researches, and who have not had an opportunity of examining it.

That the present usual names were first given to the heavenly bodies, and at a later period to the metals, is beyond all doubt; and it is equally certain that they came from the Greeks to the Romans, and from the Romans to us. It can be proved also that older nations gave other names to these heavenly bodies at much earlier periods. The oldest appellations, if we may judge from some examples still preserved, seem to have originated from certain emotions which these bodies excited in the minds of men; and it is not improbable that the planets were by the ancient Egyptians and Persians named after their gods, and that the Greeks only adopted or translated into their

own language the names which those nations had given them[62]. The idea that each planet was the residence of a god, or that they were gods themselves, has arisen, according to the most probable conjecture, from rude nations worshiping the sun, which, on account of his beneficent and necessary influence over all terrestrial bodies, they considered either as the deity himself, or his abode, or, at any rate, as a symbol of him. In the course of time, when heroes and persons who by extraordinary services had rendered their names respected and immortal, received divine honours, particular heavenly bodies, of which the sun, moon and planets seemed the fittest, were also assigned to these divinities[63]. By what laws this distribution was made, and why one planet was dedicated to Saturn and not to another, Pluche did not venture to determine: and on this point the ancients themselves are not all agreed[64]. When the planets were once dedicated to the gods, folly, which never stops where it begins, proceeded still further, and ascribed to them the attributes and powers for which the deities, after whom they were named, had been celebrated in the fictions of their mythologists. This in time laid the foundation of astrology; and hence the planet Mars, like the deity of that name, was said to cause and to be fond of war; and Venus to preside over love and its pleasures.

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[62] See Goguet, Origines. Bailly, Hist. de l'Astron. Ancienne.

[63] Jablonski, Pantheon Ægypt. 1750, p. 49.

[64] These contradictions are pointed out by Goguet, in a note, p. 370. A better view of them may be found in Hygini Astronom. (ed. Van Staveren), xlii. p. 496.

The next question is, Why were the metals divided in the like manner among the gods, and named after them? Of all the conjectures that can be formed in answer to this question, the following appears to me the most probable. The number of the deified planets made the number seven so sacred to the Egyptians, Persians and other nations, that all those things which amounted to the same number, or which could be divided by it without a remainder, were supposed to have an affinity or a likeness to and connexion with each other[65]. The seven metals, therefore, were considered as having some relationship to the planets, and with them to the gods, and were accordingly named after them. To each god was assigned a metal, the origin and use of which was under his particular providence and government; and to each metal were ascribed the powers and properties of the planet and divinity of the like name; from which arose, in the course of time, many of the ridiculous conceits of the alchemists.

The oldest trace of the division of the metals among the gods is to be found, as far as I know, in the religious worship of the Persians. Origen, in his Refutation of Celsus, who asserted that the seven heavens of the Christians, as well as the ladder which Jacob saw in his dream, had been borrowed from the mysteries of Mithras, says, "Among the Persians the revolutions of the heavenly bodies were represented by seven stairs, which conducted to the same number of gates. The first gate was of

[65] Jablonski, Panth. p. 55. Vossius de Idololatria, ii. 34, p. 489. Bruckeri Histor. Philosoph. i. p. 1055.

lead; the second of tin; the third of copper; the fourth of iron; the fifth of a mixed metal; the sixth of silver, and the seventh of gold. The leaden gate had the slow tedious motion of Saturn; the tin gate the lustre and gentleness of Venus; the third was dedicated to Jupiter; the fourth to Mercury, on account of his strength and fitness for trade; the fifth to Mars; the sixth to the Moon, and the last to the Sun[66]." Here then is an evident trace of metallurgic astronomy, as Borrichius calls it, or of the astronomical or mythological nomination of metals, though it differs from that used at present. According to this arrangement, tin belonged to Jupiter, copper to Venus, iron to Mars, and the mixed metal to Mercury. The conjecture of Borrichius, that the transcribers of Origen have, either through ignorance or design, transposed the names of the gods, is highly probable: for if we reflect that in this nomination men at first differed as much as in the nomination of the planets, and that the names given them were only confirmed in the course of time, of which I shall soon produce proofs, it must be allowed that the causes assigned by Origen for his nomination do not well agree with the present reading, and that they appear much juster when the names are disposed in the same manner as that in which we now use them[67].

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[66] Origenes Contra Celsum, lib. vi. 22. I expected to have received some explanation of this passage from the editors of Origen, and in those authors who have treated expressly on the religious worship of the Persians; but I find that they are quoted neither by Hyde; Philip a Turre, whose Monumenta Veteris Antii is printed in Thesaurus Antiquitat. et Histor. Italiæ; nor by Banier in his Mythology.

[67] Borrichius arranges the words in the following manner: "Secundam portam

This astrological nomination of metals appears to have been conveyed to the Brahmans in India; for we are informed that a Brahman sent to Apollonius seven rings, distinguished by the names of the seven stars or planets, one of which he was to wear daily on his finger, according to the day of the week[68]. This can be no otherwise explained than by supposing that he was to wear the gold ring on Sunday; the silver one on Monday; the iron one on Tuesday, and so of the rest. Allusion to this nomination of the metals after the gods occurs here and there in the ancients. Didymus, in his Explanation of the Iliad, calls the planet Mars the iron star. Those who dream of having had anything to do with Mars are by Artemidorus threatened with a chirurgical operation,

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faciunt Jovis, comparantes ei stanni splendorem et mollitiem; tertiam Veneris æratam et solidam; quartam Martis, est enim laborum patiens, æque ac ferrum, celebratus hominibus; quintam Mercurii propter misturam inæqualem ac variam, et quia negotiator est; sextam Lunæ argenteam; septimam Solis auream." – Ol. Borrichius De Ortu et Progressu Chemiæ." Hafniæ, 1668, 4to, p. 29. Professor Eichhorn reminded me, as allusive to this subject, of the seven walls of Ecbatana, the capital of Media, the outermost of which was the lowest, and each of the rest progressively higher, so that they overtopped each other. Each was of a particular colour. The outermost was white; the second black; the third purple; the fourth blue; the fifth red, or rather of an orange colour; and the summit of the sixth was covered with silver, and that of the seventh, or innermost, with gold. Such is the account given by Herodotus, i. 98; and it appears to me not improbable that they may have had a relation to the seven planets, though nothing is hinted on that subject by the historian.

[68] Philostrat. Vita Apollonii, iii. 41, p. 130. How was the ring for Wednesday made? Perhaps it was hollow, and filled with quicksilver. Gesner, in Commentaria Societat. Scien. Gotting. 1753, iii. p. 78, thinks that these rings might have been made or cast under certain constellations.

for this reason, he adds, because Mars signifies iron[69]. Heraclides says also in his allegories, that Mars was very properly considered as iron; and we are told by Pindar that gold is dedicated to the sun[70].

Plato likewise, who studied in Egypt, seems to have admitted this nomination and meaning of the metals. We are at least assured so by Marsilius Ficinus[71]; but I have been able to find no proof of it, except where he says of the island Atlantis, that the exterior walls were covered with copper and the interior with tin, and that the walls of the citadel were of gold. It is not improbable that Plato adopted this Persian or Egyptian representation, as he assigned the planets to the demons; but perhaps it was first introduced into his system only by his disciples[72]. They seem, however, to have varied from the nomination used at present; as they dedicated to Venus copper, or brass, the principal component part of which is indeed copper; to Mercury tin; and to Jupiter electrum. The last-mentioned metal was a mixture of

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[69] Oneirocritica, v. 37.

[70] Isthm. Od. ver. 1. Of the like kind are many passages in Eustathius on Homer's Iliad, b. xi., and also the following passages of Constantinus Manasses, where he describes the creation of the stars, in his Annales (edit. Meursii, Lugd. 1616), p. 7, and p. 263: "Saturnus nigricabat, colore plumbeo; Jupiter ut argentum splendebat; Mars flammeus conspiciebatur; Sol instar auri puri lucebat; (Venus uti stannum;) Mercurius instar æris rubebat; Luna in morem glaciei pellucida suam et ipsa lucem emittebat," &c.

[71] In his Preface to Critias. Platonis Opera; Francof. 1602, fol. p. 1097.

[72] It is probable that Ficinus had in view a passage in Olympiodori Commentar. in Meteora Arist. Ven. 1551, fol. lib. iii. p. 59.

gold and silver; and on this account was probably considered to be a distinct metal, because in early periods mankind were unacquainted with the art of separating these noble metals[73].

The characters by which the planets and metals are generally expressed when one does not choose to write their names, afford a striking example how readily the mind may be induced to suppose a connexion between things which in reality have no affinity or relation to each other. Antiquaries and astrologers, according to whose opinion the planets were first distinguished by these characters, consider them as the attributes of the deities of the same name. The circle in the earliest periods among the Egyptians was the symbol of divinity and perfection; and seems with great propriety to have been chosen by them as the character of the sun, especially as, when surrounded by small strokes projecting from its circumference, it may form some representation of the emission of rays. The semicircle is in like manner the image of the moon, the only one of the heavenly bodies that appears under that form to the naked eye. The character ♄ is supposed to represent the sythe of Saturn; ♃ the thunderbolts of Jupiter; ♂ the lance of Mars, together with his shield; ♀ the looking-glass of Venus; and ☿ the caduceus or wand of Mercury.

The expression by characters adopted among the older chemists agrees with this mythological signification only in the

[73] This distribution, which is ascribed to the Platonists, may be found also in the scholiasts on Pindar, at the beginning of the fifth Isthmian Ode, p. 459.

character assigned to gold. Gold, according to the chemists, was the most perfect of metals, to which all others seemed to be inferior in different degrees. Silver approached nearest to it; but was distinguished only by a semicircle, which, for the more perspicuity, was drawn double, and thence had a greater resemblance to the most remarkable appearance of the moon; the name of which this metal had already obtained. All the other metals, as they seemed to have a greater or less affinity to gold or silver, were distinguished by marks composed of the characters assigned to these precious metals. In the character ☿ the adepts discover gold with a silver colour. The cross placed at the bottom, which among the Egyptian hieroglyphics had a mysterious signification[74], expresses, in their opinion, something I know not what, without which quicksilver would be silver or gold. This something is combined also with copper, the possible change of which into gold is expressed by the character ♀. The character ♂ declares the like honourable affinity also; though the half-cross is applied in a more concealed manner; for, according to the most proper mode of writing, the point is wanting at the top, or the upright line ought only to touch the horizontal, and not to intersect it. Philosophical gold is concealed in steel; and on this account it produces such valuable medicines. Of tin one-half is silver, and the other consists of the something unknown:

[74] Jablonski, Pantheon Ægypt. i. p. 282, 283, 287; and ii. p. 131. This author makes it the representation of something which cannot be well named. Kircheri Œdipus Ægypt. t. ii. pars ii. p. 399. Romæ, 1653, fol.

for this reason the cross with the half moon appears in ♄. In lead this something is predominant, and a similitude is observed in it to silver. Hence in its character ♄ the cross stands at the top, and the silver character is only suspended on the right-hand behind it.

The mythological signification of these characters cannot be older than the Grecian mythology; but the chemical may be traced to a much earlier period. Some, who consider them as remains of the Egyptian hieroglyphics[75], pretend that they may be discovered on the table of Isis, and employ them as a proof of the high antiquity, if not of the art of making gold, at least of chemistry. We are told also that they correspond with many other characters which the adepts have left us as emblems of their wisdom.

If we are desirous of deciding without prejudice respecting both these explanations, it will be found necessary to make ourselves acquainted with the oldest form of the characters, which in all probability, like those used in writing, were subjected to many changes before they acquired that form which they have at present. I can, however, mention only three learned men, Salmasius[76], Du Cange[77], and Huet[78], who took the trouble to collect these characters. As I am afraid that my readers

[75] Goguet, ii. pp. 370, 371, considers them as remains of the original hieroglyphics; but he is of opinion that we received them in their present form from the Arabians.

[76] Plinianæ Exercitat. in Solinum, p. 874.

[77] Gloss. ad Script. Med. et Infimæ Græcitatis.

[78] In his Annotations on Manilii Astronomicon (in usum Delphini). Par. 1679, 4to, p. 80.

might be disgusted were I here to insert them, I shall give a short abstract of the conclusion which they form from them; but I must first observe that the oldest manuscripts differ very much in their representation of these characters, either because they were not fully established at the periods when they were written, or because many supposed adepts endeavoured to render their information more enigmatical by wilfully confounding the characters; and it is probable also that many mistakes may have been committed by transcribers.

The character of Mars, according to the oldest mode of representing it, is evidently an abbreviation of the word Θοῦρος, under which the Greek mathematicians understood that deity; or, in other words, the first letter Θ, with the last letter ς placed above it. The character of Jupiter was originally the initial letter of Ζεύς; and in the oldest manuscripts of the mathematical and astrological works of Julius Firmicus the capital Z only is used, to which the last letter ς was afterwards added at the bottom, to render the abbreviation more distinct. The supposed looking-glass of Venus is nothing else than the initial letter, a little distorted, of the word Φωσφόρος, which was the name of that goddess. The imaginary sythe of Saturn has been gradually formed from the first two letters of his name Κρόνος, which transcribers, for the sake of dispatch, made always more convenient for use, but at the same time less perceptible. To discover in the pretended caduceus of Mercury the initial letter of his Greek name Στίλβων, one needs only look

at the abbreviations in the oldest manuscripts, where they will find that the Σ was once written as C; they will remark also that transcribers, to distinguish this abbreviation still more from the rest, placed the C thus, ◡; and added under it the next letter τ. If those to whom this deduction appears improbable will only take the trouble to look at other Greek abbreviations, they will find many that differ still further from the original letters they express than the present character ☿ from the C and τ united. It is possible that later transcribers, to whom the origin of this abbreviation was not known, may have endeavoured to give it a greater resemblance to the caduceus of Mercury. In short, it cannot be denied that many other astronomical characters are real symbols, or a kind of proper hieroglyphics, that represent certain attributes or circumstances, like the characters of Aries, Leo, and others quoted by Salmasius.

But how old is the present form of these characters? According to Scaliger[79], they are of great antiquity, because they are to be found on very old gems and rings. If the ring No. 104 in Goræus be old and accurately delineated, this must indeed be true; for some of these characters may be very plainly distinguished on the beazel[80]. We are told by Wallerius that

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[79] In his Annotations on Manilii Astron. Strasb. 1665, 4to, p. 460.

[80] In Gorii Thesaurus Gemmarum antiquarum astriferarum, Florent. 1750, 3 vols. fol., I found nothing on this subject. Characters of the moon and of the signs in the zodiac often occur; but no others are to be seen, except in tab. 33, where there is a ring, which has on it the present characters of Mars and Venus. In general the planets are represented by seven small asterisks, or by six and the character of the moon. Besides,

they were certainly used by the ancient Egyptians, because Democritus, who resided five years in Egypt, speaks of them in the plainest terms. I do not know whence Wallerius derived this information, but it proves nothing. He undoubtedly alludes to the laughing philosopher of Abdera, who lived about 450 years before our æra, but no authentic writings of his are now extant. Fabricius says that we have a Latin translation of a work of his, De Arte Sacra, Patavii, 1572, which, however, is certainly a production of much later times. I have it now before me from the library of our university; and I find that it is not the whole book, but only an abstract, and written in so extravagant a manner that the deception is not easily discovered. It contains chemical processes, but nothing of the characters of metals; which is the case also with the letters of Democritus, published by Lubbinus[81].

[By way of contrast to the seven metals with which the ancients were acquainted, we may enumerate those known at the present day. They are as follows: —

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the antiquity of this gem cannot be ascertained.

[81] See the collection of Greek letters of Eilh. Lubbinus. Commelin. 1601, 8vo.

| | | | |
|---|---|---|---|
| 1 | Gold | | 0 |
| 2 | Silver | | 2 |
| 3 | Iron | | 5 |
| 4 | Copper | | 9 |
| 5 | Mercury | | 8 |
| 6 | Lead | | b |
| 7 | Tin | | 7 |
| 8 | Antimony | Basil Valentine | 1490 |
| 9 | Bismuth | Agricola | 1530 |
| 10 | Zinc | (Paracelsus?) | 1530 |
| 11 | Arsenic | Brandt | 1733. |
| 12 | Cobalt | | |
| 13 | Platinum | Wood | 1741 |
| 14 | Nickel | Cronstedt | 1751 |
| 15 | Manganese | Gahn | 1774 |
| 16 | Tungsten | D'Elhujart | 1781 |
| 17 | Tellurium | Müller | 1782 |
| 18 | Molybdenum | Hjelm | 1782 |
| 19 | Uranium | Klaproth | 1789 |
| 20 | Titanium | Gregor | 1791 |
| 21 | Chromium | Vauquelin | 1797 |
| 22 | Columbium | Hatchett | 1802 |
| 23 | Palladium | Wollaston | 1803. |
| 24 | Rhodium | | |
| 25 | Iridium | Tennant | 1803. |
| 26 | Osmium | | |
| 27 | Cerium | Hisinger | 1804 |
| 28 | Potassium | Davy | 1807. |
| 29 | Sodium | | |
| 30 | Barium | | |
| 31 | Strontium | | |
| 32 | Calcium | | |
| 33 | Cadmium | Stromeyer | 1818 |
| 34 | Lithium | Arfivedson | 1818 |
| 35 | Silicium | | |

# ZINC

Zinc is one of those metals which were not known to the Greeks[82], Romans, or Arabians. This we have reason to conjecture, because it has not been distinguished by a chemical character like the rest; but it is fully proved, by our not finding in the works of the ancients any information that appears even to allude to it. I know but of one instance where it is supposed to have been found among remains of antiquity. Grignon pretends that something like it was discovered in the ruins of the ancient Roman city in Champagne[83]. Such an unexpected discovery deserved to have been investigated with the utmost minuteness; but it seems to have been examined only in a very superficial manner; and as that was the case, it is impossible to guess what kind of a metal or metallic mixture this author considered as zinc.

It is not surprising that this metal should have remained so long unknown, for it has never yet been found in the metallic state. Its ores are often and in a great degree mixed with foreign ingredients; and when they are melted, it sublimes in a metallic form, and is found adhering above to the cool sides of the

[82] [It has been observed by an anonymous reviewer (British and Foreign Medical Review, vol. viii. p. 361) that a passage in Strabo authorises the belief that the ancients were acquainted with this metal in its separate state, and that it is the *false silver*, ψευδάργυρον, of that ancient geographer.]

[83] Bulletin des fouilles d'une ville Romaine, p. 11.

furnace; but a particular apparatus is necessary, else the reduced metal partly evaporates, and is partly oxidized, by which means it appears like an earth, and exhibits to the eye no traces of metal.

That mixture of zinc and copper called at present brass, tomback, pinchbeck, princes-metal, &c., and which was first discovered by ores, abundant in zinc, yielding when melted not pure copper, but brass, was certainly known to the ancients. Mines that contained ores, from which this gold-coloured metal was produced, were held in the highest estimation; when exhausted, the loss of them was regretted; and it was supposed that the metal would never be again found. In the course of time it was remarked, no one knows by what accident, that an ore, which must have been calamine, when added to copper while melting, gave it a yellow colour. This ore was therefore used, though it was not known what metal it contained, in the same manner as oxide of cobalt was employed in colouring glass before mineralogists were acquainted with that metal itself. Aristotle and Strabo speak of an earth of that kind, the use of which in making brass has been retained through every century. Ambrosius, bishop of Milan, in the fourth century; Primasius, bishop of Adrumetum in Africa, in the sixth; and Isidore, bishop of Seville, in the seventh, mention an addition by which copper acquired a gold colour, and which undoubtedly must have been calamine. When in course of time more calamine was discovered, the ancient method of procuring brass from copper-ore that contained zinc was abandoned; and it was found more convenient first to extract

from it pure copper, and then to convert it into brass by the addition of calamine.

Those desirous of inquiring further into the knowledge which the ancients had of this metal must examine the meaning of the word *cadmia*, which seems to have had various significations. This task I have ventured to undertake; and though I cannot clear up everything that occurs respecting it, I shall lay before my readers what information I have been able to obtain on the subject, because perhaps it may amount to somewhat more than is to be found in the works of old commentators. *Cadmia* signified, then, in the first place, a mineral abounding in zinc, as well as any ore combined with it, and also that zinc-earth which we call calamine. Those who should understand under it only the latter, would not be able to explain the greater part of the passages in the ancients where it is mentioned. It is probable that ore containing zinc acquired this name, because it first produced brass[84]. When it was afterwards remarked that calamine gave to copper a yellow colour, the same name was conferred on it also. It appears, however, that it was seldom found by the ancients[85]; and we must consider *cadmia* in general as signifying ore that contained zinc. Gold-coloured copper or brass was long

[84] Plin. lib. xxxiv. sect. 22.

[85] Zinc-ore, besides being mentioned by Aristotle and Strabo, is mentioned by Galen, De Simplic. Medicam. Facultatibus, lib. ix. p. 142. As he found no furnace-calamine when he resided in Cyprus, he procured from the overseer of the mines some raw *cadmia*, which had been found in the mountains and rivulets, and which certainly must have been calamine.

preferred to pure or common copper, and thought to be more beautiful the nearer it approached to the best *aurichalcum*. Brass therefore was supposed to be a more valuable kind of copper; and on this account Pliny says that *cadmia* was necessary for procuring copper, that is brass. Copper, as well as brass, was for a great length of time called *æs*, and it was not till a late period that mineralogists, in order to distinguish them, gave the name of *cuprum* to the former[86]. Pliny says that it was good when a large quantity of *cadmia* had been added to it, because it not only rendered the colour more beautiful, but increased the weight. In the like manner a quintal of copper in Hungary produces a hundred and fifty pounds of brass. The same author

[86] At first it was called *æs cyprium*, but in the course of time only *cyprium*; from which was at length formed *cuprum*. It cannot however be ascertained at what periods these appellations were common. The epithet *cupreus* occurs in manuscripts of Pliny and Palladius; but one cannot say whether later transcribers may not have changed *cyprius* into *cupreus*, with which they were perhaps better acquainted. The oldest writer who uses the word *cuprum* is Spartian; who says, in the Life of Caracalla, "cancelli ex ære vel cupro." But may not the last word have been added to the text as a gloss? Pliny, book xxxvi. 26, says, "Addito cyprio et nitro;" which Isidore, xvi. 15, p. 393, expresses by the words *adjecto cupro et nitro*. The superiority of the Cyprian copper gave occasion to this appellation; as the best iron or steel was called *chalybs*, from the *Chalybes* (a people of Galatia) who prepared the finest, and carried on the greatest trade with it. But in what did the superiority of this Cyprian copper consist? In its purity, or in its colour, which approached near to that of gold? That island produced a great deal of ore which contained zinc, and abounded also with calamine. Pliny says, "in Cypro prima fuit æris inventio." Red copper however had been known there from the earliest periods, so that the honour of its invention must be allowed to that island without any contradiction; and Pliny must undoubtedly allude in the above passage to some particular kind.

remarks also that the *cadmia* (*fossilis*) was not used in medicine: this however is to be understood only of the raw ore, for some physicians prepared oxide of zinc from ore that contained zinc, as he afterwards tells us; and Galen extols the calamine found in Cyprus on account of its superior effects, because, perhaps, the oxide could be obtained from it much purer.

In the second place, *cadmia*, among the ancients, was what we call (*ofenbruch*) furnace-calamine, or what in melting ore that contains zinc, or in making brass, falls to the bottom of the furnace, and which consists of more or less calcined zinc. As this furnace-calamine assumes various appearances, according to the manner of melting, and according to many other circumstances that in part cannot be defined, and as the ancients comprehend all its varieties under the general name of *cadmia*, and give to each variety, according to its form, consistence and colour, a particular name also, a confusion of names has hence arisen which cannot now be cleared up, especially as it is not thought worth while to distinguish all its incidental variations. Our physicians esteem only the pure oxide of zinc; and as they know how to obtain it, they are not under the necessity of using impure furnace-calamine. In our melting-houses it is employed, without much nicety in the choice, for making zinc or brass[87].

[87] Dioscorides, book v. c. 84, first mentions some sorts of *cadmia*, βοτρυίτις, πλακωτὴ and ὀστρακῖτις. These, according to Galen and Pliny, are undoubtedly certain kinds of (*ofenbruch*) furnace-calamine; but Salmasius in his book De Homonymis, p. 230, and Sarracen in his Annotations, p. 113, are of opinion that Dioscorides considered them as native kinds of *cadmia*, or minerals abundant in zinc. I

What here appears to me most singular is, that the ancients should have given the same names to furnace-calamine as they gave to ores that contained zinc. The affinity of these substances they could conjecture only from their effects, or perhaps they were induced to do so from observing that furnace-calamine was not produced but when the different kinds of *cadmia*, as they were called, were melted; that is, when yellow and not red copper was obtained. *Ofenbruch* got the name of furnace-calamine at Rammelsberg, when it was observed that it could be employed instead of native calamine for making brass[88]. Were the ancients then in any measure acquainted with this use of it? Galen and Dioscorides speak only of its use in medicine, and say nothing of its being employed in the preparation of brass. The Arabian writers, particularly the translators of the Greek physicians,

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cannot however allow myself to believe that Dioscorides, who was so careful, and who immediately after describes the artificial preparation of *cadmia* clearly and properly, should have thus erred. Besides, every kind of *ofenbruch* (furnace-calamine) must have discovered its origin from fire to such a good judge of minerals as Dioscorides. I am convinced that he, as well as Galen and Pliny, considered the above kinds as furnace-calamine.Pompholyx was the name of the white flowers of zinc which Dioscorides, v. 85, p. 352, compares to wool, and which by chemists were formerly called *lana philosophica*. The ancients collected these flowers when produced by the melting of zinc-ore; but they obtained them also by an apparatus which is fully described by Dioscorides and Galen, and which approaches near to that used for collecting arsenic in the poison melting-houses, as they are usually called.

[88] This however I will not with certainty affirm. As *calmey* and *galmey* have probably taken their rise from *cadmia* or *calimia*, and as both these words signified proper calamine, as well as *ofenbruch*, the latter, perhaps, may at an earlier period have signified furnace-calamine.

speak in a much clearer manner of the preparation of brass; but the appellations which they employ are so indeterminate in their signification, that an answer to the above question cannot be deduced from them. *Climia*, which some pronounce *calimia* and from which the modern Greeks made *kelimia*, and the Latins *lapis calaminaris*, seems to have entirely the same meaning as *cadmia*. *Tutia*, which occurs first in the eleventh century, in Avicenna, and which the Greeks write *toutia*, or perhaps more properly *thouthia*, signifies sometimes *pompholyx*; but in common it seems to express also minerals that contain zinc, and likewise furnace-calamine[89]. Could it be proved that the *tutia* of the Arabs and later Greeks was furnace-calamine, or the *tutia* of our druggists, the oldest account with which I am acquainted of furnace-calamine, employed in making brass, would occur in Zosimus, who, according to every appearance, lived in the fifth century[90]. This author tells us, that in order to make brass, Cyprus copper must be melted, and pounded *tutia* must be strewed over it. Salmasius suspects that Zosimus here means only calamine: but however this may be, his receipt has been retained till the present time in books on the arts; for these recommend not calamine, but *tutia*[91].

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[89] Proofs respecting this subject may be found in Salmasius De Homonymis.

[90] It is not certainly known when this Zosimus Panopolitanus lived. His works, which must contain abundance of information respecting the history of chemistry, have never yet been printed. The greater part of them were preserved in the king's library at Paris. The receipt to which I allude has been inserted by Salmasius, p. 237.

[91] We read in Observations sur la Physique, vi. p. 255, that for many years *tutia* has

We can with more certainty affirm that this use of furnace-calamine, in making brass, was known to Albertus Magnus in the thirteenth century; for he says, first, that yellow copper was made by the addition of calamine, which he calls *lapis calaminaris*. He tells us afterwards, that Hermes taught how to give a gold colour to copper by throwing pounded *tutia* into the melted metal. *Tutia*, says he, which is used in the transmutation of metals, is not a native mineral, but an artificial mixture, produced in the furnace when copper-ore is melted; and he advises glass-gall to be strewed over the ore, otherwise calamine and *tutia* will lose their force in the fire[92]. It would appear that the last-mentioned name, in the thirteenth century, signified only furnace-calamine, and that its use for making brass was at that period known.

For many centuries, however, the *ofenbruch* (furnace-calamine), with which, as we are told, the furnaces at Rammelsberg overflowed, was thrown aside as useless, till at length, in the middle of the sixteenth century, Erasmus Ebener first showed that it might be used instead of native calamine for making brass. This Ebener, descended from the noble family

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been collected and sold in the bishopric of Liege. Lehmann endeavours to show that it was made by the Jews in Poland. Novi Comment. Acad. Petrop. xii. p. 381. As the use of tutia [which is an impure oxide of zinc found in the chimneys of the furnaces in which zinc-ores are roasted, or in which zinciferous lead-ores are smelted] has been almost abandoned, because physicians prefer pure flowers of zinc, and because those who make pinchbeck employ purified zinc, it is probable that this substance will soon be entirely neglected.

[92] De Mineralibus. Coloniæ, 1569, 12mo, p. 350, lib. iv. cap. 5; and lib. v. cap. 7, p. 388.

of that name at Nuremberg, was a man of great learning, and an able statesman. He was employed by his native city, and by foreign princes, on occasions of the highest importance. In 1569 he was privy-counsellor to Julius duke of Brunswick, and died in 1577, at Helmstadt, where he was buried. I regret much that I can give no further account of this important discovery; the time even when it was made is not known with certainty. Lœhneyss says that it was sixty years before the period when he wrote. But at what period did he write? The oldest edition, with which I am acquainted, of his treatise on mines, is of the year 1617, so that this discovery would fall about the year 1557[93]. Calvör caused to be printed an old account of the Rammelsberg mines, which was said to have been published in 1565. According to that work, Ebener made the above-mentioned observation at Nuremberg, about seventeen years before, that is, about the year 1548. Schluter assigns as the period about 1550, and Honemann about 1559. We may therefore very safely place it in the middle of the sixteenth century, and probably the discovery happened in 1553, at which time Ebener was sent to duke Henry, with whom he continued a long time, as we are expressly told by Doppelmayer. This use of calamine refuse induced the managers of the profitable brass-works in the Harz forest to pick up carefully that which before had been thrown aside. Duke Julius,

[93] The other edition was printed at Stockholm and Hamburg, by Liebezeit, and is the same as that mentioned by H. Gatterer, in Anleitung den Harz zu bereisen, i. p. 313, and ii. p. 13.

who endeavoured to improve every branch of manufacture, and particularly what related to metallurgy, and who, agreeably to the then prevailing mode of princes, suffered himself to be duped with the hopes of making gold, improved the brass-works at Buntheim, below Harzburg, and by these means brought a great revenue to the electoral treasury.

Another production of zinc, artificial white vitriol, was also long prepared, used and employed in commerce before it was known that it was procured from this metal. That it was not known before the middle of the sixteenth century, and that it was first made at Rammelsberg, may with confidence be affirmed. Schluter ascribes the invention of it to duke Julius, and places it in the year 1570: but it must be somewhat older than the above-quoted account of Rammelsberg; for the author, who wrote about 1565[94], relates, that in his time one citizen only, whom he calls Henni Balder, boiled white vitriol; and it appears that this person kept the process a secret. That the invention was not then new, is evident from his adding, that what its effects might be in

[94] "White vitriol also is made at Goslar, but by one citizen only, named Henni Balder. It is not procured by the evaporation of copper like other vitriol; but when large quantities of ore are roasted in the furnaces, a red substance is from time to time collected on the refuse of the ore, and found in some places half an ell thick. This substance, which is saltish, is formed into a lye, and boiled in small leaden pans. The rest of the process I do not know, but I observed that it crystallizes like saltpetre, but is stronger and whiter. It is also cast into small cakes about the thickness of one's hand. This vitriol is employed by the leather-dressers, and may be used for many things instead of alum; but it cannot be used in dressing white skins, because it makes them yellowish."

medicine had not been examined; but that its use in making eye-water had been known almost as early as the time when it was discovered. This agrees with another account, according to which the method of boiling white vitriol was found out at the time when Christopher Sander, whose service to the Harz is well-known, was tithe-gatherer. Honemann says that Sander was tithe-gatherer at the mines of the Upper Harz before the year 1564, but that in this year he was principal tithe-gatherer and director of the mines and melting-houses at Goslar. Sander himself, in a paper dated August 3, 1575, seems to ascribe the invention of white vitriol to duke Julius[95].

At first this salt was called *Erzalaun*, a name occasioned by its likeness to alum, but afterwards it was more frequently known by those of *Gallitzenstein*, *Golitzenstein*, and *Calitzenstein*. The latter names however appear to be older than white vitriol itself; as we find that green vitriol, even before the year 1565, was called green *Gallitzenstein*. May not the word be derived from *gallæ*; because it is probable that vitriol and galls were for a long time the principal articles used for making ink and in dyeing? I am of opinion that the white vitriol, which is produced in the mines of Rammelsberg in the form of icicles, gave rise to the discovery and manufacture of this salt. The former, so early as the year 1565, was called white native vitriol, or white *Gogkelgut*,

[95] Bruckmann, ii. p. 446. [Schwartze, in his Pharm. Tabell. 2nd edit. p. 779, states that white vitriol was known towards the end of the thirteenth or at the commencement of the fourteenth century.]

and was packed up in casks, and in that manner transported for sale[96]. I shall not here enter into the old conjectures respecting the origin and component parts of this vitriol; but it deserves to be remarked, that Henkel and Neumann[97] observed in it a mixture of zinc, by which Brandt, a member of the Swedish council of mines, was led to prove, that, when pure, it consists of vitriolic acid and oxide of zinc; and this was afterwards confirmed by Hellot[98].

I come now, in the last place, to the history of this metal, which, when furnace-calamine was used, could not remain long unobserved, as it is sometimes found amongst it uncalcined in metallic drops. It is worthy of remark, that Albertus Magnus, who first described the use of furnace-calamine in making brass, is the oldest author in whose works mention is made of zinc. He calls it *marchasita aurea*. This was properly a stone, the metallic particles of which were so entirely sublimated by fire, that nothing but useless ashes remained behind. It contained fixed quicksilver, communicated a colour to metals, on which account it was well known to the alchemists, burned in the fire, and was at

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[96] Calvor, Historische Nachricht, p. 199 and 200. Properly it is written and pronounced *jöckel*. It is very remarkable that in Iceland this word at present signifies icicles.

[97] Chemie, von Kessel, iv. 2, p. 832, where may be found the old opinions on this subject.

[98] Brandt, in Acta Upsaliens. 1735. Hellot, in Mémoires de l'Acad. des Sciences, Paris, 1735, p. 29. [Sulphate of zinc or white vitriol is at present manufactured in considerable quantity for pharmaceutical purposes, and for the calico-printer.]

length entirely consumed. It was found in various parts, but that at Goslar was the best, because the copper it contained seemed to have in it a mixture of gold. To give this copper however a still greater resemblance to gold, some tin was added to it, by which means it became more brittle. This marchasita also rendered copper white as silver. Thus far Albertus. It obtained without doubt the name of *marchasita aurea*, because zinc communicates a yellow colour to copper; and for the same reason the Greeks and the Arabians called *cadmia* golden or *aurea*. But how could Albertus say that marchasite made copper white? Did he commit a mistake, and mean tin? To me this appears not probable, as at one time he seems to call it *argentea*. I imagine that he knew that copper, when mixed with as much zinc as possible, that is, according to Scheffer, eighty-nine pounds to a hundred, became white; and it appears that by this he wished to establish its affinity with quicksilver.

The next author who gives an intelligible account of this metal is Theophrastus Paracelsus, who died in 1541. I do not however imagine that it was forgotten in this long interval, at least by those who were called alchemists. I am rather of opinion, that on account of the great hopes which it gave them by the colouring of copper, they described it purposely in an obscure manner, and concealed it under other names, so that it was not discovered in their works. There are few who would have patience to wade through these, and the few who could do so, turn their attention to objects of greater importance than those which

occupy mine. Gold and silver excepted, there is no metal which has had formerly so many and so wonderful names as zinc[99]. For this reason, chemists long believed that zinc was not a distinct metal, but only a variety of tin or bismuth; and with these perhaps it may hence have been often confounded.

The name zinc occurs first in Paracelsus. He expressly calls it a distinct metal, the nature of which was not sufficiently known; which could be cast, but was not malleable, and which was produced only in Carinthia. Was he then unacquainted with the zinc of Goslar, which was known at an earlier period to Albertus Magnus[100]? George Agricola, who wrote about the year 1550, speaks however of the Goslar zinc, but he calls it *liquor candidus*, and in German *conterfey*[101]. Mathesius, who published his sermons in 1562, says, "at Freyberg there is red and white zinc." Perhaps he did not mean the metal, but minerals that contained zinc. George Fabricius, who died in 1571, conjectures that *stibium* is what the miners call *cincum*, which can be melted,

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[99] A great many may be found collected in Fuchs, Geschichte des Zinks. Erfurt, 1778, 8vo.

[100] Paracelsi Opera. Strasb. 1616, fol. I shall here transcribe the principal passage. Of zinc: – There is another metal, zinc, which is in general unknown. It is a distinct metal of a different origin, though adulterated with many other metals. It can be melted, for it consists of three fluid principles, but it is not malleable. In its colour it is unlike all others, and does not grow in the same manner; but with its *ultima materia* I am as yet unacquainted, for it is almost as strange in its properties as *argentum vivum*. It admits of no mixture, will not bear the *fabricationes* of other metals, but keeps itself entirely to itself.

[101] De Re Metallica, lib. ix. p. 329.

but not hammered.

It is seen by these imperfect accounts that this metal must have been scarce, even in the middle of the sixteenth century, and that it was not in the collection of Agricola, which was considerable for that period. Libavius, who died in 1616, mentions it several times, but he regrets, in one of his letters, that he had not been able to procure any of it[102]. Was this owing to the prohibition of duke Julius, by which it was forbidden to be sold? This prohibition is quoted by Pott from Jungii Mineralogia, with which I am unacquainted; but as Pott has already, by his unintelligible quotations, made me spend many hours to no purpose, I shall not waste more in searching for it. The prohibition alluded to is mentioned neither by Rehtmeier nor by any other author. The foolish taste for alchemy, which prevailed then at the duke's court, makes it not altogether improbable that one was issued[103]; and if that was really the case, it was occasioned not so much by any dread of this metal being misused, as Pott thinks, but by the high hopes which were entertained of its utility in making gold. The first accurate and certain account of the method of procuring zinc at Goslar, is, as

[102] In J. Hornung's Cista Medica. Lipsiæ.

[103] How much duke Julius, who in other respects did great service to his country, suffered himself to be duped by the art of making gold, appears from an anecdote given by Rehtmeier, p. 1016. Of this anecdote I received from M. Ribbentrop an old account in manuscript, which one cannot read without astonishment. There is still shown, at the castle of Wolfenbuttle, an iron stool, on which the impostor, Anna Maria Zieglerinn, named Schluter Ilsche, was burnt, February 5, 1575.

far as I know, given by Lœhneyss, in 1617, though he considers it to be the same as bismuth[104]. Joh. Schrœder of Westphalia, who died in 1664, calls it *marcasita pallida*.

The first person who purposely procured this metal from calamine, by the addition of some inflammable substance, was undoubtedly Henkel, who gave an account of his success in the year 1741, though he concealed the whole process[105]. After him, Dr. Isaac Lawson, a Scotsman, seems to have made experiments which proved the possibility of obtaining zinc in this manner on a large scale; and in 1737 Henkel heard that it was then manufactured in England with great advantage. Of this Lawson I know nothing more than what is related by Dr. Watson[106].

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[104] Page 83: – "When the people at the melting-houses are employed in melting, there is formed under the furnace, in the crevices of the wall, among the stones where it is not well plastered, a metal which is called zinc or *conterfeht*; and when the wall is scraped, the metal falls down into a trough placed to receive it. This metal has a great resemblance to tin, but it is harder and less malleable, and rings like a small bell. It could be made also, if people would give themselves the trouble; but it is not much valued, and the servants and workmen only collect it when they are promised drink-money. They however scrape off more of it at one time than at another; for sometimes they collect two pounds, but at others not above two ounces. This metal, by itself, is of no use, as, like bismuth, it is not malleable; but when mixed with tin, it renders it harder and more beautiful, like the English tin. This zinc or bismuth is in great request among the alchemists."

[105] Kieshistorie, p. 571, and particularly p. 721.

[106] Pott refers to Lawson's Dissert. de Nihilo, and quotes some words from it; but I cannot find it; nor am I surprised at this, as it was not known to Dr. Watson. – See Chemical Essays, iv. p. 34. Pryce, in Mineral. Cornub., p. 49, says, "The late Dr. J. Lawson, observing that the flowers of *lapis calaminaris* were the same as those of zinc, and that its effects on copper were also the same with that semi-metal, never remitted

Anthony von Swab, member of the Swedish council of mines, procured this metal afterwards from calamine by distillation, in 1742; as did Marggraf in 1746, who appears however not to have been acquainted with the Swedish experiment. In the year 1743, one Champion established zinc works at Bristol, which were continued by his successor James Emerson, who established works of the like kind at Henham, in the neighbourhood. The manner in which the metal was procured, has been described by Dr. Watson in his Chemical Essays.

The greater part of this metal, used in Europe, was undoubtedly brought from the East Indies. The Commercial Company in the Netherlands, between the years 1775 and 1779, caused to be sold, on their account, above 943,081 pounds of it[107]. In the year 1780, the chamber of Rotterdam alone sold 28,000 pounds; and I find, by printed catalogues, that the other chambers, at that period, had not any of it in their possession. If the account given by Raynal be true, the Dutch East India Company purchased annually, at Palimbang, a million and a half of pounds[108]. In 1781, the Danish Company at Copenhagen

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his endeavours till he found the method of separating pure zinc from that ore." The same account is given in the supplement to Chambers's Dictionary, 1753, art. *calm.* and *zinc*; and in Campbell's Political Survey of Britain, ii. p. 35. The latter however adds, that Lawson died too early to derive any benefit from his discovery.

[107] Ricards Handbuch der Kaufleute, i. p. 57.

[108] Raynal says that the company purchase it at the rate of twenty-eight florins three-quarters per hundred weight, and that this price is moderate. At Amsterdam, however, the price was commonly from seventeen to eighteen florins banco. According to a catalogue which I have in my possession, the price, on the 9th of May, 1788, was

purchased 153,953 pounds of tutenage, which had been carried thither in two vessels, at the rate of from four and one-eighth to four and a quarter schillings Lubec per pound. It is probable that the English and Swedes import this article also. It would be of some consequence if one could learn in what part of India, when, and in what manner this metal was first procured, and in what year it was first carried thence to Europe. According to the scanty information which we have on the subject, it comes from China, Bengal, Malacca[109], and the Malabar coast, from which copper and tin are also imported. In the oldest bills of lading of ships belonging to the Netherlands I find no mention of zinc; but it is possible that it may be comprehended under the name of Indian tin; for so it was at first called. Savot, who died about the year 1640, relates, on the authority of a contemporary writer[110], that some years before the Dutch had taken from the Portuguese a ship laden with this metal, which was sold under the name of *speautre*. It is probable therefore that it was brought to Europe so early as the beginning of the seventeenth century. Indian tin is mentioned by Boyle.

It is probable that this metal was discovered in India before anything of the European zinc had been known in that country; but we are still less acquainted with the cause of the discovery

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seventeen florins, and on the 22nd of January, 1781, it was only sixteen.

[109] Linschoten, b. ii. c. 17. The author calls it *calaem*, the name used in the country. It is a kind of tin.

[110] De Nummis Antiquis; in Grævii Thes. Antiq. Rom. xi. p. 1195.

than with the method of procuring the metal. We are told that an Englishman, who, in the above century, went to India, in order to discover the process used there, returned with an account that it was obtained by distillation *ver descensum*.

Respecting the origin of the different names of this metal, I can offer very little. *Conterfey* signified formerly every kind of metal made in imitation of gold[111]. Frisch says it was called *zink*, from which was formed first *zinetum*, and afterwards *zincum*, because the furnace-calamine assumes the figure of (*zinken* or *zacken*) nails or spikes; but it is to be remarked that these names do not occur before the discovery of this metal, though *ofenbruch* was known long before. Fulda speaks of the Anglo-Saxon *sin*, *zink*, which he translates *obryzum*. *Spiauter*, *speauter*, and *spialter*, from which Boyle made *speltrum*, and also *tutaneg* or *tuttanego*, came to us from India with the commodity. Under the last-mentioned name is sometimes comprehended a mixture of tin and bismuth. *Calaem* is also an Indian appellation given to this metal, and has a considerable likeness to calamine; but I am of opinion with Salmasius that the latter is not derived from the former, as *lapis calaminaris* occurs in the thirteenth century, and

[111] Matthesius, Pred. v. p. 250. – "*Conterfeil* is a metal of little value, formed by additions and colouring substances, so that it resembles gold or silver, as an image, or anything counterfeited, does its archetype. Thus copper is coloured by calamine and other mixtures, in such a manner that it appears to be pure gold." In the police ordinance issued at Strasburg in 1628, young women are forbidden to wear gold or silver, or any *conterfaite*, and everything that might have the appearance of gold or silver.

*calaem* was first brought to us by the Portuguese from India.

[Most of the zinc works in this country are situated in the neighbourhood of Birmingham and Bristol; a few furnaces also exist in the neighbourhood of Sheffield, among the coal-pits surrounding that town; there is also one at Maestag in Glamorganshire. The ores worked at Bristol and Birmingham are principally obtained from the Mendip-hills and Flintshire; those at Sheffield from Alston Moor. The greater part however of the zinc used in this country is imported in ingots and plates from Silesia, by way of Hamburg, Antwerp, Dantzic, &c. We receive annually from 100,000 to 170,000 cwts. from Germany; of this quantity, about 80,000 cwt. are entered for home consumption, and the rest is exported for India.

From its moderate price and the ease with which it can be worked, zinc is now extensively used for making water-cisterns, baths, pipes, covering of roofs, and a great many architectural purposes. It has also of late been employed in the curious art of transferring printing, known under the name of *Zincography*, but owing to the ease with which this metal becomes coated with a film of oxide or carbonate, by exposure to the air, the plates cannot be preserved for any great length of time.]

# CARP

So obscure is the ichthyology of the ancients, or so little care has been taken to explain it, that the question whether our carp were known to Aristotle, Pliny, and their contemporaries, cannot with any great degree of probability be determined. Besides, that subject is attended with much greater difficulties than the natural history of quadrupeds. Among four-footed animals there is a greater variety in their bodily conformation, which at any rate strikes the eye more, and can be more easily described than that of fishes, which in general are so like in shape, that an experienced systematic naturalist finds it sometimes difficult to determine the characters of the genera and species. It is not surprising therefore that the simple descriptions of the ancients, or rather the short accounts which they give us of fish, do not afford information sufficient to enable us to distinguish with accuracy the different kinds. Quadrupeds may terrify us by their ferocity, or endeavour to avoid us by shyness and craft; but it is still possible to observe their sexes, their age, and their habits, and to remark many things that are common to one or only a few species. Fishes, on the other hand, live in an element in which we cannot approach them, and which for the most part conceals them from our observation. The chase, since the earliest periods, and in modern times more than formerly, has been the employment of idle persons, who bestow upon it greater

attention the fewer those objects are which can attract their curiosity or employ their minds: but fishing has almost always been the laborious occupation of poor people, who have no time to make observations, as they are obliged to follow it in order to find a subsistence; and mankind in general seldom see fish except on their tables or in collections of natural history. On this account those properties of fish by which their species could be determined, were less known. The descriptions of four-footed animals which have been handed down to us from the time of the Greek and Roman writers, give us, at any rate, some information; but from those of fishes, which are more uncommon, we can scarcely derive any; unless one were as acute or easy of belief as many collectors of petrefactions, who imagine that they can distinguish each species of fish in the impressions which they see in stones. More however might be done towards elucidating the ichthyology of the ancients than has hitherto been attempted. It would be necessary only to make a beginning by collecting the species and names which can with certainty be determined, together with the authorities, and separating them from the rest; and an abstract should be formed of what is said in the ancients respecting the unknown species, or whatever may in any measure serve to make us acquainted with them; but mere conjectures ought never to be given as proofs, nor ought the opinions of commentators, or the explanations of dictionaries to be adopted without sufficient grounds. If these are to be believed without further examination, the names *cyprini* and *lepidoti* must be

considered as those of carp; and the proposed question would be soon answered: but that opinion has scarcely probability in its favour when one searches after proofs.

I shall not here lay before the reader everything completely that the ancients have said respecting the *cyprini*, and which is in part so corrupted by transcribers, that no certain meaning can be drawn from it. Were I to treat of the ichthyology of the ancients, it might be necessary; but as that is not the case, I shall only quote such parts of it as have been employed by Rondelet and others to prove that they were our carp. Their principal grounds seem to be, that among all the fish of the ancients no others occur which can with any probability be considered as carp. If the *cyprini* therefore were not carp, these must not have been named by the ancients; and that undoubtedly will not readily be admitted. It is well known what a high value the ancients, particularly the Orientals, set upon fish, of which they had a great variety; and it appears that they preferred them to all dishes prepared from four-footed animals or fowls. Fish seem to have been the choicest delicacies of voluptuaries, and in that respect they are oftener mentioned by historians than fowls. Physicians also, to whom the most sumptuous tables have in all ages been of the greatest benefit, speak of fish oftener in their writings than of dishes made of the flesh of other animals. In the ancient cookery, the number of dishes prepared from fish is indeed great in comparison of those dressed from fowls. *Turdi* and *attagines* are much praised; but had pheasants, snipes, partridges,

and others, been as much esteemed then as they are now, these would not have been forgotten, or would have occurred oftener. Fish at present form the principal food in Greece, as well as at Constantinople, and a great abundance and variety of them may be found there in the markets; but fowls which have been caught or shot are seldom exposed for sale. When the Egyptian and Greek monks wished to distinguish themselves by abstinence and temperance, they denied themselves all kinds of fish, as the richest delicacies, in the same manner as pretended devotees among the Europeans deny themselves flesh. But though all this may be true, it does not prove that our carp must occur in the writings of the ancients. The Roman voluptuaries, indeed, left very little untried that was likely to gratify their appetite; but it was impossible for them to make a trial of everything. There may have been particular reasons which prevented them from meeting with carp; and who will venture to affirm that all the knowledge of the ancients must be contained in those few of their writings which have been preserved to us by accidents?

If one, freed from these prejudices, should now ask why the *cyprinus* must be our carp, the answer will be, because what we read of the tongue and scales of the *cyprini* cannot be applied with so much propriety to any species of fish as to the *Cyprinus carpio* of Linnæus. Aristotle informs us that the *cyprini* had properly no tongue, but that their soft fleshy palate might very readily be taken for one[112]. Athenæus affirms that they

[112] Histor. Animal. lib. iv. cap. 8.

had a tongue, but that it lay in the upper part of the mouth or palate; and in confirmation of this he refers to Aristotle[113]. This assertion of Athenæus however is very dubious; for these words are not to be found in the works of Aristotle which have been preserved, though the same meaning might be indeed forced, in case of necessity, from the passage first quoted. It is possible that Athenæus, as Casaubon[114] has already conjectured, may here, as well as in other parts, allude to some book of Aristotle not now extant. Besides, he calls the fish of which he speaks, not *cyprinus*, but *cyprianus*; and a question therefore arises, whether he may not have meant some other kind. This much at any rate appears certain from the passage of Aristotle, that the *cyprinus* had a thick fleshy palate; and that indeed is the case with our carp, so that the head, on account of the delicacy and agreeable taste of the palate, is reckoned the most relishing part. By that circumstance however nothing is proved; as it is not peculiar to carp alone, but common to every species of the same family, such as the bream, tench, &c. Fish of this kind, says Bloch, have properly no tongue; that which appears to be one is merely a cartilaginous substance which projects through those band-like parts that enclose it on each side. This proof would have more weight, did we find it related, that in the time of Aristotle, the tongue was considered as an exquisite morsel: but that is not mentioned; and H. Krunitz is mistaken, when he says that

[113] Lib. vii. p. 309.

[114] Animadvers. vii. 17, p. 540.

Heliogabalus, to satisfy his luxurious appetite, was induced to try a fricassee of the tongues of carp: it consisted only of the tongues of peacocks and nightingales[115]. Had the ancients really used carp on their tables, we must have ascribed to them the discovery of these delicious fish.

The other proof which is brought from the scales consists in what is said by Dorion, in Athenæus[116], that the *cyprianus* was called also by some *lepidotus*, or scaly. As nearly all fish have scales, the scales of this species must have been extremely large, as they got that name by way of eminence; and it must be indeed allowed, that the above epithet would suit our carp exceedingly well, as their scales are very large. But this circumstance alone proves nothing, as the *Mullus* and *Mugil* have still larger scales; and to the first genus belonged one of the fish most esteemed by the ancients[117]. Strabo mentions the *lepidotus* among the sacred fish of the Nile; but whether it be the same as that of which Dorion speaks, cannot be determined. It is certain that the Nile contains carp still; for Norden saw them caught at the waterfall

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[115] Lampridii Vita Heliogab. c. 20.

[116] Lib. vii. p. 309.

[117] This fish was a first-rate article of luxury among the Romans, and was purchased at a dear rate. Juvenal says, "Mullum sex millibus emit, æquantem sane paribus sestertia libris." See Plin. lib. ix. c. 17. The Italians have a proverb, "La triglia non mangia chi la piglia," which implies, that he who catches a mullet is a fool if he eats it and does not sell it. When this fish is dying, it changes its colours in a very singular manner till it is entirely lifeless. This spectacle was so gratifying to the Romans, that they used to show the fish dying in a glass vessel to their guests before dinner.

near Essuane, which is the ancient Syene. Did we know that the modern Greeks at present call carp *cyprini*, this would prove more; for it is an undoubted fact that the ancient names have for the most part been retained in Greece. We are assured by Massarius[118], that the Greeks still use the name *cyprinus*; but Gyllius says that it is employed only by a few: and this is confirmed by Bellon, who mentions all the names of carp which he heard in Greece, and which are entirely different from the ancient[119]; but he adds, that carp in Ætolia are still called *cyprini*. Both the before-mentioned circumstances respecting the *cyprini* agree extremely well with our carp; but as they will suit other kinds equally well, they afford no complete proof, but only a probability which amounts to this, that among the large-scaled fish, carp in particular have a fleshy palate; and it is readily admitted that the ancients were acquainted with all kinds, and chose names for them with more foundation than is done at present.

In opposition to this probability it may be said that Oppian and Pliny reckon the *cyprini* among the sea-fish, to which kind our carp do not belong. This reply however, which some have indeed made, is not of great weight. In the first place, both these writers seem to have been in an error; for what Pliny says of the

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[118] Fr. Massarii in ix. Plinii. libr. Castigat. Bas. 1537, 4to.

[119] A great service would be rendered to the natural history of the ancients, if some able systematic naturalist would collect all the Greek names used at present. Tournefort and others made a beginning.

*cyprini* is evidently taken from Aristotle, and the latter does not tell us that these fish live in the sea, but rather the contrary. The Roman author, as Dalechamp remarks, added the words *in mari*, if they were not added by some transcriber. Oppian as a poet does not always adhere strictly to truth; and he makes more of the freshwater fish of Aristotle to be inhabitants of the sea. In the second place, I consider the distinction made between sea-fish, freshwater fish and those kept in ponds, to be not always very certain or well founded. Who knows whether the greater part of the last may not have been originally sea-fish? This is the more probable in regard to carp, as Professor Foster says that carp are sometimes caught in the harbour at Dantzic[120].

In order to answer the question here proposed, another point may be considered. As all nations at present give these fish the same name, it is probable that it was brought with them from that country where they were first found, and from which they were procured. Cassiodorus, who lived in the sixth century, is the oldest author as yet known in whom that name has been observed[121]. In a passage where he speaks of the most delicate and costly fish, which at that time were sent to the tables of princes, he says, "Among these is the *carpa*, which is produced in the Danube." In the earliest Latin translation of Aristotle, the word *cyprinus*, as Camus says, is expressed by *carpra*. In the thirteenth century this fish was called by Vincentius de

[120] Philosophical Transact. vol. lxi. 1771, part i. 310.

[121] Variorum, p. 380.

Beauvais[122] *carpera*, and by Cæsarius *carpo*; and it is highly probable that both these names allude to our carp. By the above passage of Cassiodorus, the opinion that these fish were the *cyprini* of the ancients obtains a new, but at the same time a very feeble proof; for the *cyprinus* was found also in the Danube, as we learn from Ælian[123], who among the fish of the Ister, mentions black *cyprini*; and these, according to the conjecture of Professor Schneider, were the black fish of the Danube which Pliny considers as unhealthful or poisonous, and like which there were some in Armenia. Our carp indeed are not poisonous, but Pliny alludes to a particular variety, and what he says was only report, to which something must have given rise, as also to the idea of carp with a death's head, and the head of a pug-dog, as some have been represented by writers of the sixteenth century. The *carpo* of Cæsarius appears to have been our carp, because its scales had a very great resemblance to those of the latter; for we are told in the work already quoted, that the devil, once indulging in a frolic, appeared in a coat of mail, and had scales like the fish *carpo*. The *carpera* of Vincent de Beauvais is still less doubtful, as the same craft in avoiding rakes and nets is ascribed to that fish as is known to be employed by our carp. Sometimes they thrust their heads into the mud and suffer the net to pass over them; and sometimes they join the head and tail together, and separating them suddenly, throw themselves towards the surface

[122] Speculum Naturale.

[123] De Nat. Anim. xiv. – Plin. xxxi. sect. 19. – Antig. Car. c. 181.

of the water, and springing often four or five feet above the net, make their escape.

But whence did this name arise? The origin assigned by Vincentius, or the anonymous author of the lost books De Natura Rerum, like another mentioned in ridicule by Gesner, is too silly to be repeated. More learned at any rate is the derivation of Menage, who traces it from *cyprinus*, which was afterwards transformed into *cuprinus*, *cuprius*, *cuprus*, *cupra*, *curpa*, and lastly into *carpa*. For my part, I am more inclined to derive it from a dialect which was spoken on the banks of the Danube, and to believe that it was brought with the fish from the southern part of Europe; but I am too little acquainted with that dialect to be able to render my conjecture very probable; and the etymologists I consulted, such as Wachter, Ihre, Johnson, &c., afforded me no assistance. Fulda gave me some hopes, as he allows the word to be of German extraction; but I must confess that his derivation is too far-fetched, and like the chemistry of the adepts, to me not perfectly intelligible.

It may perhaps not be superfluous here to observe that one must not confound *carpa* and *carpo*, or our carp, with *carpio*. The latter belongs to the genus of the salmon and trout; and in the Linnæan system is called *Salmo carpio*. It is found chiefly in the Lago di Garda, the ancient Lacus Benacus, on the confines of Tyrol. The oldest account of this fish is to be found in works of the sixteenth century, such as the poems of Pierius Valerianus, and in Jovius de Piscibus. According to Linnæus, it is found in

the rivers of England; but that is false. This celebrated naturalist suffered himself to be misled by Artedi, who gives the char or chare, mentioned by Camden in his description of Lancashire, as the *Salmo carpio*. Pennant however, by whom it is not mentioned among the English fish, says expressly that the char is not the *carpio* of the Lago di Garda, but rather a variety of the *Salmo alpinus*[124].

That our carp were first found in the southern parts of Europe, and conveyed thence to other countries, is undoubtedly certain. Even at present they do not thrive in the northern regions, and the further north they are carried the smaller they become[125]. Some accounts of their transportation are still to be found. If it be true that the Latin poem on the expedition of Attila is as old as the fifth or sixth century, and if the fish which Walther gave to the boatman who ferried him over the Rhine, and which the latter carried to the kitchen of Gunther king of the Franks, were carp, this circumstance is a proof that these fish had not been before known in that part of France which bordered on the Rhine[126]. The examination of this conjecture I shall however leave to others. D'Aussy quotes a book never printed, of the thirteenth century, entitled Proverbes, and in which is given an account of the best articles produced at that time by the different parts of the kingdom, and assures us that a great many kinds of

[124] British Zoology, vol. iii. p. 259.

[125] Pontoppidan, Natürliche Historie von Norwegen, ii. p. 236.

[126] De Prima Expedit. Attilæ, ed. Fischer. Lips. 1780, 4to.

fish were mentioned in it, but no carp, though at present they are common all over France.

It appears also that there were no carp in England in the eleventh century, at least they do not occur in the Anglo-Saxon Dictionary of Ælfric, who in 1051 died archbishop of York[127]. We are assured likewise that they were first brought into the kingdom in the fifth year of the reign of Henry VIII., or in 1514, by Leonard Mascal of Plumsted in Sussex[128]. What we read in the Linnæan System, that these fish were first brought to England about the year 1600, is certainly erroneous. Where that celebrated naturalist, under whom I had the pleasure of studying, acquired this information, I do not know.

Denmark is indebted for these fish to that celebrated statesman Peter Oxe, who introduced them into the kingdom as well as cray-fish, and other objects for the table. He died in the year 1575.

We are told that these fish were brought from Italy to Prussia, where they are at present very abundant, by a nobleman whose name is not mentioned. This service however may be ascribed

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[127] Printed at the end of Somneri Dict. Saxonicum.

[128] See Anderson's Hist. of Commerce, and Pennant's Zoology, p. 300. Both these authors refer to Fuller's British Worthies. [The carp existed in England before the year 1486: for in Dame Juliana Berners' work on Angling, which was published at St. Albans (hence called the Book of St. Albans) in 1486, we find the following passage: speaking of the carp, she says "That it is a deyntous fysshe, but there ben but few in Englonde. And therefore I wryte the lesse of hym. He is an euyll fysshe to take. For he is so stronge enarmyd in the mouthe, that there maye noo weke harnays hold him."]

with more probability to the upper burg-grave, Caspar von Nostiz, who died in 1588, and who in the middle of the sixteenth century first sent carp to Prussia from his estate in Silesia, and caused them to be put into the large pond at Arensberg not far from Creuzburg. As a memorial of this circumstance, the figure of a carp, cut in stone, was shown formerly over a door at the castle of Arensberg. This colony must have been very numerous in the year 1535, for at that period carp were sent from Königsberg to Wilda, where the archduke Albert then resided. At present (1798) a great many carp are transported from Dantzic and Königsberg to Russia, Sweden, and Denmark. It appears to me probable that these fish after that period became everywhere known and esteemed, as eating fish in Lent and on fast-days was among Christians considered to be a religious duty, and that on this account they endeavoured to have ponds stocked with them in every country, because no species can be so easily bred in these reservoirs.

I shall observe in the last place, that the *Spiegel-carpen*, mirror-carp, distinguished by yellow scales, which are much larger, though fewer in number, and which do not cover the whole body, are not mentioned but by modern writers. Bloch says that they were first described by Johnston under the name of royal carp. The passage where he does so I cannot find; but in plate xxix. there is a bad engraving, with the title *Spiegel-karpen*, which however have scales all over their bodies, and cannot be the kind alluded to. On the other hand, the *Spiegel-karpen* are mentioned

by Gesner, who, as it appears, never saw them. In my opinion, Balbinus, who wrote in the middle of the sixteenth century, was the first person who gave a true and complete description of them; and according to his account, they seem to have come originally from Bohemia. The first correct figure of them is to be found in Marsigli.

# CAMP-MILLS

Under this appellation are understood portable or moveable mills, which can be used, particularly in the time of war, when there are neither wind- nor water-mills in the neighbourhood, and which on that account formerly accompanied armies in the same manner as camp-ovens and camp-forges. Some of these mills have stones for grinding the corn, and others are constructed with a notched roller like those of our coffee-mills. Some of them also are so contrived that the machinery is put in motion by the revolution of the wheels of the carriage on which they are placed; and others, and perhaps the greater part of those used, are driven by horses or men, after the wheels of the carriage are sunk in the ground, or fastened in some other manner.

To the latter kind belongs that mill of which Zonca[129] has given a coarse engraving, but without any description. He says it was invented by Pompeo Targone, engineer to the well-known marquis Ambrose Spinola; and he seems to place the time of the invention about the end of the sixteenth century. This mill is the same as that described by Beyer in his Theatrum Machinarum Molarium, and represented in the twenty-seventh plate of that

[129] Novo Teatro di Machine ed Edificii, di Vittorio Zonca. Padoua, 1621, and reprinted in 1656, fol. The greater part of the machines delineated in this scarce book are engines for raising heavy bodies; but many of them are used in various trades and manufactures, and may serve in some measure to illustrate the history of them.

work[130]. Beyer remarks that it was employed by Spinola.

The inventor, as his name shows, was an Italian, who made himself known, in particular, at the celebrated siege of Rochelle, under Louis XIII., at which he was chosen to assist, because in the year 1603, when with Spinola, who was consulted respecting the operations at Rochelle, he had helped by means of a mole to shut the harbour of Ostend during the tedious siege of that place. He was likewise in the French service, as *intendant des machines du roi*; but his numerous and expensive undertakings did not succeed according to his expectations[131]. He invented also a particular kind of gun-carriages, and a variety of warlike machines[132].

Another old figure of such a mill was shown to me by Professor Meister, in Recueil de Plusieurs Machines Militaires, printed in 1620. This machine was driven by the wheels of the carriage; but whether it was ever used the author does not inform us.

Lancellotti[133] ascribes this invention to the Germans, about the year 1633.

Carriages for transporting camp-forges and mill-machinery

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[130] J. M. Beyer's Schauplatz der Mühlen-Bau-kunst. Leipzig, 1735, fol. Reprinted at Dresden, 1767.

[131] All those authors who have written expressly on the fate of the Huguenots, the History of Richelieu, Louis XIII., and the siege of Rochelle, make mention of Targone.

[132] Histoire de la Milice Françoise, par Daniel. Amst. 1724, i. p. 332.

[133] L'Hoggidi, overo gl'Ingegni non inferiori a' passati. Ven. 1636, 8vo.

are mentioned by Leonard Fronsperger[134], but he does not say whether complete mills were affixed to them.

[134] Kriegsbuch, Frankf. 1596, fol. p. 9.

# MIRRORS [135]

It is highly probable that a limpid brook was the first mirror[136], but we have reason to think that artificial mirrors were made as mankind began to exercise their art and ingenuity on metals and stones. Every solid body, capable of receiving a fine polish, would be sufficient for this purpose; and indeed the oldest mirrors mentioned in history were of metal. Those which occur

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[135] The works in which this subject has been already treated are the following: – Eberhartus de Weihe, de Speculi origine, usu et abusu. A compilation formed without taste, of which I gave some account in the Article on Chimneys. – Spanhemii Obs. in Callimachi hymn. lavacr. Palladis, p. 615. – Académie des Inscriptions, t. xxiii. p. 140. – Recherches sur les Miroirs des Anciens, par Menard. A short paper, barren of information. – Saggi di Dissertazioni Accad. dell' Accad. Etrusca dell' città di Cortona, vii. p. 19: Sopra gli Specchi degli Antichi, del Sig. Cari. A translation from the French, with the figures of some ancient mirrors. It contains an explanation of some passages in Pliny, where he seems to speak of a mirror formed of a ruby, and some conjectures respecting the mirror of Nero. An anonymous member of the Academy, in an appendix, confirms the former, and considers the latter, very properly, as improbable. – Caylus, Recueil d'Antiquités, iii. p. 331, and v. p. 173. A description and figures of ancient mirrors, with some chemical experiments on their composition. – Amusemens Philosophiques. Par le père Bonaventure Abat. Amst. 1763, 8vo, p. 433: Sur l'Antiquité des Mirroirs de Verre. A dissertation worthy of being read on account of the author's acquaintance with the ancient writers, and his knowledge of technology; but he roves beyond all proof, and employs too much verbosity to decorate his conjectures.

[136] Passages of the poets, where female deities and shepherdesses are represented as contemplating themselves in water instead of a mirror, may be found in the notes to Phædri Fab. i. 4, in the edition of Burmann.

in Job[137] are praised on account of their hardness and solidity; and Moses relates[138], that the brazen laver, or washing-basin, was made from the mirrors of the women who had assembled at the door of the tabernacle to present them, and which he caused them to deliver up. As the women appeared in full dress at divine worship, it was necessary for them to have looking-glasses after the Egyptian manner. With these the washing-basins, according to the conjecture of most interpretators, were only ornamented, covered, or perhaps hung round; and Michaelis[139] himself was

[137] Chap. xxxvii. ver. 18.

[138] Exodus, chap. xxxviii. ver. 8.

[139] Historia Vitri apud Judæos, in Comment. Societat. Scient. Gotting. iv. p. 330. Having requested Professor Tychsen's opinion on this subject, I received the following answer: – "You have conjectured very properly that the mirrors of the Israelitish women, mentioned Exod. xxxviii. 8, were not employed for ornamenting or covering the washing-basins, in order that the priests might behold themselves in them; but that they were melted and basins cast of them. The former was a conceit first advanced, if I am not mistaken, by Nicol. de Lyra, in the fourteenth century, and which Michaelis himself adopted in the year 1754; but he afterwards retracted his opinion when he made his translation of the Old Testament at a riper age. In the Hebrew expression there is no ground for it; and mirrors could hardly be placed very conveniently in a basin employed for washing the feet. I must at the same time confess that the word (תאראמ) which is here supposed to signify a mirror, occurs nowhere else in that sense. Another explanation therefore has been given, by which both the women and mirrors disappear from the passage. It is by a learned Fleming, Hermann Gid. Clement, and may be found in his Dissertatio de Labro Æneo, Groning. 1732, and also in Ugolini Thesaurus, tom. xix. p. 1505. He translates the passage thus: Fecit labrum æneum et operculum ejus æneum cum *figuris ornantibus*, quæ ornabant ostium tabernaculi. This explanation however is attended with very great difficulties; and as all the old translators and Jewish commentators have here understood mirrors; and as the common translation is perfectly agreeable to the language and circumstances, we ought to believe that Moses,

once of this opinion. But why should we not rather believe that the mirrors were melted and formed into washing-basins? As soon as mankind began to endeavour to make good mirrors of metal, they must have remarked that every kind of metal was not equally proper for that use, and that the best could be obtained only from a mixture of different metals. In the mirrors however which were collected by Moses, the artists had a sufficient stock of speculum metal, and were not under the necessity of making it themselves; and for this reason they could much more easily give to the whole basin a polished surface, in which the priests, when they washed, might survey themselves at full length. At any rate such a basin would not be the only one employed instead of a mirror. Artemidorus[140] says that he who dreams of viewing himself in a basin, will have a son born to him by his maid. Dreams indeed are generally as groundless as this interpretation; but one can hardly conjecture that Artemidorus would have thought of such a dream, had it not been very common for people to contemplate themselves in a basin. There were formerly a kind of fortune-tellers, who pretended to show in polished basins to the simple and ignorant, what they wished to know[141]. The ancients also had drinking-vessels, the inside of which was cut into mirrors, so disposed that the image of the person who drank

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not having copper, melted down the mirrors of his countrywomen and converted them into washing-basins for the priests."

[140] Oneirocrit. lib. iii. cap. 30. p. 176.

[141] Joh. Sarisberiensis, i. cap. 12.

from them was seen multiplied[142]. Vopiscus mentions, among the valuable presents of Valerian to the emperor Probus, when a tribune, a silver cup of great weight, which was covered on the inside with mirrors of this sort[143].

Menard and others conjecture that mirrors in the time of Homer were not much used, because he mentions them on no occasion, not even where he describes in so circumstantial a manner the toilet of Juno[144]. In answer to this, however, I have two things to observe. In the first place, it is not to be

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[142] Plin. lib. xxxiii. cap. 9. Seneca, Quæst. Nat. i. cap. 5.

[143] Vita Probi, cap. iv. p. 926: "Patinam argenteam librarum decem specillatam." Salmasius chooses rather to read *specellatam*. I am inclined to think that this word ought to be read in Suetonius instead of *speculatum*, where he speaks of an apartment which Horace seems to have been fond of. That historian, in his Life of Horace, says, "Ad res venereas intemperantior traditur: nam *speculato* cubiculo scorta dicitur habuisse disposita, ut quocunque respexisset, ibi ei imago coitus referretur." Lessing, who in his Miscellanies (Vermischten Schriften, Berlin 1784, 12mo, iii. p. 205) endeavours to vindicate the poet from this aspersion, considers the expression *speculatum cubiculum*, if translated *an apartment lined with mirrors*, as contrary to the Latin idiom, and thinks therefore that the whole passage is a forgery. Baxter also before said that this anecdote had been inserted by some malicious impostor. This I will not venture to contradict, but I am of opinion that *specillatum* or *specellatum cubiculum* is at any rate as much agreeable to the Roman idiom as *patina specillata*. This expression Salmasius and Casaubon have justified by similar phrases, such as *opera filicata*, *tesselata*, *hederata*, &c. The chamber in which Claudian makes Venus ornament herself, and be overcome by the persuasion of Cupid, was also covered over with mirrors, so that whichever way her eyes turned, she could see her own image. Did Claudian imagine that this goddess knew how to employ such an apartment, not only for dressing, but even after she was undressed, as well as Horace? I have seen at a certain court, a bed entirely covered in the inside with mirrors.

[144] Iliad. lib. xiv. ver. 166.

expected that Homer should have mentioned every article with which he was acquainted; and secondly, we are assured by Callimachus, where he evidently has imitated the passage of Homer before-quoted[145], that neither Juno nor Pallas employed a mirror when they dressed. Mythology therefore did not allow the poet to introduce a mirror upon the toilet of that deity. Polydore Vergilius, Boccace, Menard, and others have all fallen into the error of making Æsculapius the inventor of mirrors, though Cicero[146] seems to say the same thing; but the best commentators have long since observed very justly, that the Roman philosopher alludes not to a mirror but to a probe, the invention of which we may allow to the father of medicine, who was at first only a surgeon.

When one reflects upon the use made of metal mirrors, particularly at Rome, to add to magnificence and for other purposes, and how many artists, during many successive centuries, were employed in constructing them, and vied to excel each other in their art, one cannot help conjecturing that this branch of business must at those periods have been carried to a high degree of perfection. It is therefore to be regretted that

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[145] Hymnus in Lavacrum Palladis, v. 15, 21. It was however customary to ascribe a mirror to Juno, as Spanheim on this passage proves; and Athanasius, in Orat. contra Gentes, cap. xviii. p. 18, says that she was considered as the inventress of dress and all ornaments. Should not therefore the mirror, the principal instrument of dress, belong to her? May it not have been denied to her by Callimachus, because he did not find it mentioned in the description which Homer has given of her dressing-room?

[146] De Natur. Deorum, iii. 22.

they have not been particularly described by any writer, and that on this account the art was entirely lost after the invention of glass mirrors, which are much more convenient. No one at that time entertained the least suspicion that circumstances would afterwards occur which would render these metal mirrors again necessary, as has been the case in our days by the invention of the telescope. Our artists then were obliged to make new experiments in order to discover the best mixture for mirrors of metal; and this should be a warning to mankind, never to suffer arts which have been once invented and useful to become again unknown. A circumstantial description of them should at any rate be preserved for the use of posterity, in libraries, the archives of human knowledge.

When we compare metals in regard to their fitness for mirrors, we shall soon perceive that the hardest of a white colour possess in the highest degree the necessary lustre. For this reason platina is preferable to all others, as is proved from the experiments made by the Count von Sickengen. Steel approaches nearest to this new metal, and silver follows steel; but gold, copper, tin and lead, are much less endowed with the requisite property. I have however observed among the ancients no traces of steel mirrors; and it is probable they did not make any of that metal, as it is so liable to become tarnished, or to contract rust. An ancient steel-mirror is indeed said to have been once found, but as some marks of silvering were perceived on it, a question arises whether the

silvered side was not properly the face of the mirror[147]. Besides, every person knows that a steel mirror would not retain its lustre many centuries amidst ruins and rubbish.

The greater part of the ancient mirrors were made of silver, not on account of costliness and magnificence, as many think, but because silver, as has been said, was the fittest and the most durable of all the then known unmixed metals for that use. In the Roman code of laws, when silver plate is mentioned, under the heads of heirship and succession by propinquity, silver mirrors are rarely omitted; and Pliny[148], Seneca[149], and other writers, who inveigh against luxury, tell us, ridiculing the extravagance of the age, that every young woman in their time must have a silver mirror. These polished silver plates may however have been very slight, for all the ancient mirrors, preserved in collections, which I have ever seen, are only covered with a thin coat of that expensive metal; and in the like manner our artists have at length learned a method of making the cases of gold and silver watches so thin and light, that every footman and soldier can wear one. At first the finest silver only was employed for these mirrors, because it was imagined that they could not be made of that which was standard; but afterwards metal was used of an inferior quality. Pliny tells us so expressly, and I form the same conclusion from

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147 Licetus de Lucernis Antiq. lib. vi. cap. 92.

148 Lib. xxxiv. cap. 17, p. 669.

149 Quæst. Nat. at the end of the first book.

a passage of Plautus[150]. Philematium having taken up a mirror, the prudent Scapha gives her a towel, and desires her to wipe her fingers, lest her lover should suspect by the smell that she had been receiving money. Fine silver however communicates as little smell to the fingers as gold; but it is to be remembered that the ancients understood much better than the moderns how to discover the fineness of the noble metals by the smell, as many modes of proof which we use to find out the alloy, were to them unknown. Money-changers therefore employed their smell when they were desirous of trying the purity of coin[151]. The witty thought of Vespasian, who, when reproached on account of his tax upon urine, desired those who did so to smell the money it produced, and to tell him whether it had any smell of the article which was the object of it, alludes to this circumstance. In the like manner many savage nations at present can by their smell determine the purity of gold[152].

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[150] Mostell. act i. sc. 3. v. 101.

[151] Arrianus in Epictet. i. cap. 20, p. 79.

[152] Among the remaining passages of the ancients with which I am acquainted, in which mention is made of silver mirrors, the following deserves notice. Chrysostom, Serm. xvii. p. 224, who, in drawing a picture of the extravagance of the women, says, "The maid-servants must be continually importuning the silversmith to know whether their lady's mirror be yet ready." The best mirrors therefore were made by the silversmiths. It appears that the mirror-makers at Rome formed a particular company; at least Muratori, in Thesaur. Inscript. Clas. vii. p. 529, has made known an inscription in which *collegium specularium* is mentioned. They occur also in Codex Theodos. xiii. tit. 4, 2. p. 57, where Ritter has quoted more passages in which they may be found. But perhaps the same name was given to those who covered walls with polished stones,

We are informed by Pliny, that Praxiteles, in the time of Pompey the Great, made the first silver mirror, and that mirrors of that metal were preferred to all others. Silver mirrors however were known long before that period, as is proved by the passage of Plautus above-quoted. To reconcile this contradiction, Meursius remarks that Pliny speaks only of his countrymen, and not of the Greeks, who had such articles much earlier, and the scene in Plautus is at Athens. This therefore seems to justify the account of Pliny, but of what he says afterwards I can find no explanation. Hardouin is of opinion, that mirrors, according to the newest invention, at that period, were covered behind with a plate of gold, as our mirrors are with an amalgam. But as the ancient plates of silver were not transparent, how could the gold at the back part of them produce any effect in regard to the image? May not the meaning be, that a thin plate of gold was placed at some distance before the mirror in order to throw more light upon its surface? But whatever may have been the case, Pliny himself seems not to have had much confidence in the invention.

Mirrors of copper, brass and gold, I have found mentioned only by the poets, who perhaps employed the names of these metals because they best suited their measure, or because they wished to use uncommon expressions, and thought a golden mirror the noblest. By the brass ones perhaps are to be understood only such as were made of mixed copper. Did golden

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and in latter times to glaziers.

mirrors occur oftener, I should be inclined to refer the epithet rather to the frame or ornaments than to the mirror itself; for at present we say a gold watch, though the cases only may be of that metal.

Mirrors seem for a long time to have been made of a mixture of copper and tin, as is expressly said by Pliny[153], who adds, that the best were constructed at Brundisium. This mixture, which was known to Aristotle, produces a white metal, which, on account of its colour, may have been extremely proper for the purpose, and even at present the same mixture, according to the careful experiments made by Mr. Mudge, an Englishman[154], produces the best metal for specula. It appears that the ancients had not determined the proportion very accurately; for Pliny assures us twice that in his time mirrors of silver were preferred. It is indeed not easy to ascertain the quantity of each metal that ought to be taken, and the most advantageous degree of heat; upon which a great deal depends. One of the principal difficulties is to cast the metal without blisters or air-holes, and without causing any part of the tin to oxidize, which occasions knots and cracks, and prevents it from receiving a fine polish. A passage of Lucian[155], which no one as yet has been able to clear up, alludes

[153] Lib. xxxiii. c. 9. p. 627, and lib. xxxiv. c. 17, p. 669.

[154] Philosophical Transactions, vol. lxvii. p. 296.

[155] Quomodo Historia sit conscrib. cap. 51, Bipont edition, iv. p. 210, 535. Commentators have found no other way to explain κέντρον (a word which occurs in Lucian's description of the mirror), than by the word *centre*, to which, according to their own account, there can be here no allusion. In my opinion κέντρον signifies those

certainly, in my opinion, to these faults. A mixture of copper and tin is so brittle, that it is very liable to crack; and a mirror formed of it, if not preserved with great care, soon becomes so dim, that it cannot be used till it has been previously cleaned and polished. For this reason a sponge with pounded pumice-stone was generally suspended, from the ancient mirrors, and they were kept likewise in a case or box, as may be seen by the greater part of those still extant. Mirrors of silver were less subject to this inconvenience, and I am inclined to think that the latter on this account made the former be disused, as we are informed by Pliny.

As ancient mirrors of metal are still to be found in collections of antiquities, it might be of some importance to the arts if chemical experiments were made on their composition. Those who have hitherto given us any account of them have contented themselves with describing their external figure and shape. Count Caylus[156] is the only person, as far as I know, who caused any

faulty places which are not capable of a complete polish, on account of the knots or cracks which are found in them. Lucian therefore speaks of a faultless mirror which represents the image perfect, as he afterwards informs us.

[156] As the account of these experiments is given only in an expensive work, which may not often fall into the hands of those who are best able to examine it, I insert it here. "The ancient mirror, which I examined, was a metallic mixture, very tender and brittle, and of a whitish colour inclining to grey. When put into the fire, it remained a long time in a state of ignition before it melted. It was neither inflammable nor emitted any smell like garlic, which would have been the case had it contained arsenic. It did not either produce those flowers which are generally produced by all mixtures in which there is zinc. Besides, the basis of this mixture being copper, it would have been of a yellow colour had that semi-metal formed a part of it. I took two drams of it and

chemical experiments to be undertaken on this subject. They were made on a mirror found near Naples, by M. Roux, who asserts that the composition was a mixture of copper and regulus of antimony, with a little lead. Antimony however was not known to the ancients. If that metal was really a component part, the mirror must have been the work of more modern times, or it must be allowed that the artist had metal combined with antimony without knowing it; but the latter is not probable. The experiments made by Roux do not seem to me to have proved in a satisfactory manner the presence of regulus of antimony; moreover, no certain information can be derived from them, for the antiquity of the mirror was not ascertained; nor was it known whether it ought to be reckoned amongst the best or the worst of the period when it was made.

Those mirrors, which were so large that one could see one's self in them at full length, must, in all probability, have consisted of polished plates of silver; for to cast plates of such a size of copper and tin would have required more art than we can allow to those periods; and I do not know whether our artists even now would succeed in them[157].

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dissolved them in the nitrous acid. A solution was speedily formed, which assumed the same colour as solutions of copper. It precipitated a white powder, which I carefully edulcorated and dried. Having put it into a crucible with a reductive flux, I obtained lead very soft and malleable.

[157] Of such large mirrors Seneca speaks in his Quæst. Nat. lib. i. Of the like kind was the mirror of Demosthenes mentioned by Plutarch, Lucian, and Quintilian. – Institut. Orat. xi. 3, 68, p. 572."Having filtered the solution, I took a part of it, upon which I poured an infusion of gall-nuts, but it produced no change. A solution of

We read in various authors, that, besides metals, the ancients formed stones into mirrors, which were likewise in use. It is undoubtedly certain that many stones, particularly of the vitreous kind, which are opake and of a dark colour, would answer exceedingly well for that purpose; but let the choice have been

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gold, which I poured upon another part, made it assume a beautiful green colour; but no precipitate was formed: which is sufficient to prove that there was neither iron nor tin in the mixture."On the remaining part of the solution I poured a sufficient quantity of the volatile alkali to dissolve all the copper that might be contained in it. The solution became of a beautiful sapphire blue colour, and a white precipitate was formed. Having decanted the liquor, and carefully edulcorated the precipitate, I endeavoured to reduce it; but whether it was owing to the quantity being too small, or to my not giving it sufficient heat, I could not succeed. I had recourse therefore to another method."I took the weight of two drams of the mixture, which I brought to a high state of ignition in a cuppel. When it was of a whitish-red colour, I threw upon it gradually four drams of sulphur, and when the flame ceased, I strengthened the fire in order to bring it to complete fusion. By these means I obtained a tender brittle regulus, whiter than the mixture, in which I observed a few small needles. Being apprehensive that some copper might still remain, I sulphurated it a second time, and then obtained a small regulus which was almost pure antimony."It results from these experiments, that the metal of which the ancients made their mirrors was a composition of copper, regulus of antimony, and lead. Copper was the predominant, and lead the smallest part of the mixture; but it is very difficult, as is well known, to determine with any certainty the exact proportion of the substances contained in such compositions."[In the examination of an Etruscan mirror, which was placed in my hands for analysis by Professor Gerhardt of Berlin, it was found to consist, in 100 parts, of 67·12 copper, 24·93 tin, and 8·13 lead, approximating closely to an alloy of eight parts of copper to three of tin and one of lead. The oxide of tin obtained in the course of analysis was carefully examined, before the blowpipe, for antimony, but I did not succeed in detecting a trace of that metal. A similar mirror had been likewise analysed by Klaproth; he found 62 per cent. copper, 32 tin, and 6 per cent. lead, but no trace of antimony. – W. F.]

ever so good, they would not, in this respect, have been nearly equal to metals. These of all mineral bodies have the most perfect opacity; and for that reason the greatest lustre: both these properties are produced by their solidity; and hence they reflect more perfectly, and with more regularity, the rays of light that proceed from other bodies. Our glass mirrors, indeed, are properly metallic. Stones, on the other hand, have at any rate some, though often hardly perceptible, transparency; so that many of the rays of light are absorbed, or at least not reflected. Mention of stone mirrors occurs also so seldom in the ancients, that we may conclude they were made rather for ornament than real utility. In general, we find accounts only of polished plates or panels of stone, fixed in the walls of wainscoted apartments, which were celebrated on account of their property of reflection.

Pliny[158] praises in this respect the obsidian stone, or, as it is now called, the Icelandic agate. Everything that he says of it will be perfectly intelligible to those who are acquainted with this species of stone or vitrified lava. The image reflected from a box made of it, which I have in my possession, is like a shadow or silhouette; but with this difference, that one sees not only the contour, but also the whole figure distinctly, though the colours are darkened. To form it into images and utensils, which Pliny speaks of, must have been exceedingly difficult, on account of its brittleness. I saw at Copenhagen, among other things made of it, a drinking-cup and cover, on which the artist had been employed

[158] Lib. xxxvi. c. 26, p. 758.

four years.

Domitian, when he suspected that plots were formed against him, caused a gallery, in which he used to walk, to be lined with *phengites*, which by its reflection showed everything that was done behind his back[159]. Under that appellation we are undoubtedly to understand a calcareous or gypseous spar, or selenite, which is indeed capable of reflecting an image; but we cannot therefore pretend to say that the ancients formed mirrors of it; nor do I explain what Pliny says, where he speaks of the *phengites*, as if whole buildings had been once constructed of it[160]. That kind of stone, for various reasons, and particularly on account of its brittleness, is altogether unfit for such a purpose. At those periods, the windows of houses were open, and not filled up with any transparent substance, but only covered, sometimes by lattices or curtains. It is probable, therefore, that those openings of the walls of the building mentioned by Pliny, where the windows used to be, were filled up with *phengites*, which, by admitting a faint light, prevented the place from being dark even when the doors were shut; so that Pliny might say, "It appeared as if the light did not fall into the building, but as if it

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[159] Sueton. in Vita Domit. cap. xiv. p. 334.

[160] Lib. xxxvi. 22, p. 752. – "Cappadociæ lapis, duritia marmoris, candidus atque translucidus, ex quo quondam templum constructum est a quodam rege, foribus aureis, quibus clausis claritas diurna erat." – Isidor. Origin. 16, 4. Our spar is transparent, though clouds and veins occur in it, like the violet and isabella-coloured, for example, of that found at Andreasberg. Compare this explanation with what Salmasius says in Exercitat. Plin. p. 184.

were inclosed in it."

I might be accused of omission did I not here mention also a passage of Pliny[161], where he seems to speak of a mirror made of an emerald, which Nero used to assist him to see the combats of the gladiators. Cary asserts that Nero was short-sighted, and that his emerald was formed like a concave lens. The former is expressly said by Pliny[162], but the latter, though by Abat considered not improbable[163], I can scarcely allow myself to believe, because such an interpretation of Pliny's words is too forced, and because they can be explained much better in another manner. As no mention of such an excellent help to short-sighted people is to be found in any other ancient author, we must allow, if Cary's opinion be adopted, that this property of the concave emerald was casually remarked, and that no experiments were made to cut any other natural or artificial glass in the same form for the like use, because people imagined that this property was peculiar to the emerald alone, which was then commonly supposed to be endowed with the power of greatly strengthening the eye-sight. Much more probable to me is the explanation of an Italian, which Abat also does not entirely reject, that the emerald had a smooth polished surface, and served Nero as a

[161] Lib. xxxvii. cap. 5, p. 774.

[162] Lib. xi. cap. 37, p. 617.

[163] This dissertation of Abat may be found translated in Neuen Hamburg. Magazin. i. p. 568.

mirror[164]; and the passage of Pliny alluded to seems to have been thus understood by Isidore[165] and Marbodæus. It may here be objected, that real emeralds are too small to admit of being used as mirrors; but the ancients speak of some sufficiently large for that purpose, and also of artificial ones[166]; so that we may with certainty conclude, that they classed among the emeralds fluor-spar green vitrified lava, or the green Icelandic agate as it is called, green jasper, and also green glass. The piece of green glass in the monastery of Reichenau, which is seven inches in length, three inches in thickness, and weighs twenty-eight pounds three-quarters; and the large cup at Genoa, which is however full of flaws[167], have been given out to be emeralds even to the present time.

Mirrors were made also of rubies, as we are assured by Pliny[168], who refers to Theophrastus for his authority; but this precious stone is never found now of such a size as to render this use possible; and Gary and the anonymous Italian before-mentioned have proved very properly that Pliny has committed a gross mistake, which has not been observed by Hardouin. Theophrastus, in the passage alluded to[169], does not speak of a

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[164] Academia di Cortona, vii. p. 34.

[165] Origin. xvi. 7.

[166] Goguet, ii. p. 111. Fabricii Biblioth. Græca. vol. i. p. 70.

[167] Keyssler, i. pp. 17 and 441.

[168] Lib. xxxvii. cap. 7.

[169] De Lapid. § 61.

ruby, but of the well-known black marble of Chio, though he calls both *carbunculus*, a name given to the ruby on account of its likeness to a burning coal, and to the black marble on account of its likeness to a quenched coal or cinder; and the latter, as well as the obsidian stone, was used sometimes for mirrors.

The account how mirrors were formed by the native Americans, before they had the misfortune to become acquainted with the Europeans, is of considerable importance in the history of this art. These people had indeed mirrors which the Europeans could not help admiring. Some of them were made of black, somewhat transparent, vitrified lava, called by the Spaniards *gallinazo*, and which is of the same kind as the obsidian stone employed by the Romans for the like purpose. Of this substance the Americans had plane, concave, and convex mirrors. They had others also made of a mineral called the Inca's stone[170], which, as has been already said by Bomare, Sage, Wallerius, and other mineralogists, was a compact pyrites or marcasite, susceptible of a fine polish; and on that account often brought to Europe, and worn formerly in rings under the name of the stone of health. Ulloa says the Inca's stone is brittle, opake, and of a somewhat bluish colour; it has often veins which cannot be polished, and where these veins are it frequently breaks. The mirrors formed of it, which he saw, were from two to three inches in diameter; but he saw one which was a foot and a half.

[170] [This stone acquired its name from its being much used in ornaments by the Incas or Princes of Peru.]

The opinion which some have entertained, that these mirrors were cast, has no other foundation than the likeness of polished marcasite to cast brass. This mineral is very proper for reflecting images; and I am inclined to think that the Peruvians had better mirrors than the Greeks or the Romans, among whom we find no traces of marcasite being employed in that manner. It appears, however, that the Indians had mirrors also of silver, copper, and brass[171].

I come now to the question in what century were invented our glass mirrors, which consist of a glass plate covered at the back with a thin leaf of metal. This question has been answered by some with so much confidence, that one might almost consider the point to be determined; but instead of real proofs, we find only conjectures or probabilities; and I must here remark, that I cannot help thinking that they are older than has hitherto been supposed, however desirous I may be to separate historical truth from conjecture. When I have brought together everything which I know on the subject, I would say, that attempts were even made at Sidon to form mirrors of glass; but that they must have been inferior to those of metal, because they did not banish the use of the latter. The first glass mirrors appear to me to have been of black-coloured glass, or an imitation of the obsidian stone; and to have been formed afterwards of a glass plate with some black foil placed behind it[172]. At a much later period, blown glass, while

[171] De la Vega, ii. 28.

[172] Montamy in Abhandlung von den Farben zum Porzellan, Leipzig, 1767, 8vo, p.

hot, was covered in the inside with lead or some metallic mixture; and still later, and, as appears, first at Murano, artists began to cover plates of glass with an amalgam of tin and quicksilver. The newest improvements are, the casting of glass-plates, and the art of making plates equally large by blowing and stretching, without the expensive and uncertain process which is required for casting.

That glass mirrors were made at the celebrated glass-houses of Sidon, is mentioned so clearly by Pliny that it cannot be doubted[173]. When I read the passage, however, without prejudice, without taking into consideration what others have said on it, and compare it with what certain information the ancients, in my opinion, give on the same subject, I can understand it no otherwise than as if the author said, that the art of manufacturing glass various ways was invented, principally, at Sidon, where attempts had been made to form mirrors of it. He appears therefore to allude to experiments which had not completely succeeded; and to say that such attempts, at the time when he wrote, had been entirely abandoned and were almost forgotten. Had this circumstance formed an epoch in the art, Pliny, in another place, where he describes the various improvements of it so fully, would not have omitted it; but of those experiments he makes no further mention[174]. All the inventions which he speaks

222, asserts that he saw, in a collection of antiquities, glass mirrors which were covered behind only with a black foil.

[173] Lib. xxxvi. cap. 26, p. 758.

[174] Lib. xxxiii. cap. 9, p. 627.

of, evidently relate to metal mirrors only, of which the silver, at that time, were the newest. Had the Sidonian mirrors consisted of glass plates covered at the back, those of metal, the making of which was, at any rate, attended with no less trouble, which were more inconvenient for use on account of their aptness to break, their requiring to be frequently cleaned and preserved in a case, and which were more unpleasant on account of the faint, dull image which they reflected, could not possibly have continued so long in use as they really did; and circumstances and expressions relative to glass mirrors must certainly have occurred. Though glass continued long to be held in high estimation, particularly at Rome; and though many kinds of glass-ware are mentioned in ancient authors, among costly pieces of furniture, mirrors are mentioned only among articles of silver plate. I am acquainted with no certain trace of glass mirrors from the time of Pliny to the thirteenth century; but after that period, at which they are spoken of in the clearest manner, we find them often mentioned in every century; and mirrors of metal at length entirely disappear.

How the Sidonian mirrors were made, is not known; but if I may be allowed a conjecture, I am of opinion that they consisted of dark-coloured glass, which had a resemblance to the obsidian stone. Such is the usual progress of inventions. At those periods one had no other representation of glass mirrors than that afforded by natural glass or vitreous stones. When artists wished to make mirrors of glass, they would try to imitate the latter. After the invention of printing, people endeavoured to render

printed books as like as possible to manuscripts; because they imagined that this invention was to be approved only so far as it enabled them to imitate these, without observing that it could far excel the art of writing. But the Sidonian glass mirrors were so much surpassed by the silver or brass ones, which perhaps were invented about the same time, that on this account they were never brought into use. Glass mirrors, perhaps, would have been invented sooner, had mankind employed at an earlier period glass-windows, which often, when they are shut on the outside so that no light can pass through them, reflect images in a much better manner than the best mirrors of metal. This observation, which may be made daily, would then, in all probability, have been sooner turned to advantage.

No one has employed a greater profusion of words to maintain an opinion opposite to mine, than Abat; but when his proofs are divested of their ornaments, they appear so weak that one has very little inclination to agree with him. "The observation," says he, "that a plate of glass is the best mirror, when all other rays of light, except those reflected back from the glass, are prevented, by a metallic covering placed behind it, from falling on the eye, is so easy, that it must have been made immediately after the invention of glass." Who does not think here of Columbus and his egg? Instances occur in history of many having approached so near an invention, that we are astonished how they could have missed it; so that we may exclaim

with a certain emperor, "Taurum toties non ferire difficile est[175]." "The Sidonian invention," continues he, "would not have been worth mentioning, had it not produced better mirrors than those which the ancients had before of the obsidian stone. But these even are mentioned only once, in so short and abrupt a manner, and as it were out of ridicule, that one may easily perceive they were not much esteemed." "If the Sidonians," adds he, "were not the inventors, let some other inventor be mentioned;" and he assures us that he had sought information on this subject, in Neri, Kunkel, and Merret, but without success. That I believe; but Abat does not remark that by the same manner of reasoning we may ascribe to the Sidonians the invention of watches, and many other articles, the inventors of which are not to be found in books where they ought as much to be expected as the inventor of glass in Neri. The grounds on which many old commentators of the Bible, Nicholas de Lyra and others, have supposed that glass mirrors were known so early as the time of Moses, are still weaker. If quoting the names of writers who entertain a like opinion be of any weight, I could produce a much greater number of learned men, who, after an express examination of the question, deny altogether that glass mirrors were used by the ancients.

Dr. Watson[176] also has endeavoured to support the opinion of Abat, but with less confidence and with more critical

[175] Trebell. Pollio, Vita Gallien. cap. 12.

[176] Chemical Essays, vol. iv. p. 246.

acumen. His grounds, I think, I have weakened already; but one observation here deserves not to be overlooked, because it suggests an idea that may serve to illustrate a passage of Pliny, which, as I before remarked, has never yet been explained. "If we admit," says he, "that Pliny was acquainted with glass mirrors, we may thus understand what he says respecting an invention, which was then new, of applying gold behind a mirror." Instead of an amalgam of tin, some one had proposed to cover the back of the mirror with an amalgam of gold, with which the ancients were certainly acquainted, and which they employed in gilding[177]. He mentions, also, on this occasion, that a thought had once occurred to Buffon, that an amalgam of gold might be much better for mirrors than that used at present[178]. This conjecture appears, at any rate, to be ingenious; but when I read the passage again, without prejudice, I can hardly believe that Pliny alludes to a plate of glass in a place where he speaks only of metallic mirrors; and the overlaying with amalgam requires too much art to allow me to ascribe it to such a period without sufficient proof. I consider it more probable that some person had tried, by means of a polished plate of gold, to collect the rays of light, and to throw them either on the mirror or the object, in order to render the image brighter.

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[177] Plin. lib. xxxiii.: Æs inaurari argento vivo, aut certe hydrargyro, legitimum erat. The first name here seems to signify native quicksilver, and the second that separated from the ore by an artificial process.

[178] Hist. Nat. Supplem. i. p. 451.

Professor Heeren showed me a passage in the Ecloga of Stobæus, which, on the first view, seems to allude to a glass mirror[179]. It is there said, Philolaus the Pythagorean believed that the sun was a vitreous body, which only received the rays of the æthereal fire and reflected them to us like a mirror. When we compare, however, the words of Stobæus with those by which Plutarch[180], Achilles Tatius[181], Eusebius[182], and others, express the same thing, that meaning cannot be drawn from them. It appears, at first, as if Philolaus had considered the sun to be transparent, and supposed that the rays passed through it, and came condensed to our earth, in the same manner as they are brought to a focus by a glass globe. Some commentators have explained the passage in this manner; and on account of the affinity of the Greek words have thought also of a funnel. In that case, however, the comparison of the sun with a mirror would not have been just; and if it be admitted that Philolaus considered the sun as a bright body endowed with the property of reflection, what he says of rays passing or transmitted through it, and of the pores of the sun's body, will become unintelligible. But even if we adopt the last explanation, that Philolaus imagined the sun to be a mirror, it does not follow that he had any idea of a glass

[179] Stob. Eclog. Antv. 1575, fol. p. 56.

[180] De Placitis Philos. ii. cap. 20.

[181] In Aratum, cap. 19.

[182] Lib. i. cap. 8.

one[183]; and besides, he only speaks of a body capable of reflecting a strong light; and that glass, under certain circumstances, is fit for that purpose, may have been remarked as soon as it was invented, though men might not find out the art of forming it into proper mirrors by placing some opake substance behind it[184]. Empedocles also said, that the sun was a mirror, and that the light received by our earth was the reflection of the æthereal fire, which Eusebius compares to the reflection made by water[185].

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[183] It is undoubtedly certain, that ὕαλος, which is translated *vitreous* or *glassy*, means any smooth polished body capable of reflecting rays of light. Originally it signified a watery body; and because watery bodies have a lustre, it was at length used for glass. See Salmas. ad Solin. p. 771.

[184] More observations respecting the opinion of Philolaus may be found in the edition of Plutarch's work De Placitis Philosophorum by Ed. Corsinus, Flor. 1750, 4to, p. 61, and p. 23.

[185] Professor Heeren having given me his opinion on this passage of Stobæus, I shall here insert it for the satisfaction of the learned reader. The critics, says he, will hardly be persuaded that the words καὶ τὸ ἀπ' αὐτοῦ πυροειδὲς κατὰ τὸ ἐσοπτροειδὲς are correct, as they can be translated different ways. With regard to the explanation of the matter, I build only on the plain meaning of the words. The author tells us, that Philolaus thought the sun to be a mirror; but we must conclude that he speaks of a mirror such as were then in use; a smooth plate of metal, and not a globe. In this case the first explanation of a glass globe falls to the ground. This is confirmed by Eusebius, who calls it ὑαλοειδὴς δίσκος, though it is possible that the latter word may be a gloss added by some grammarian, or by Eusebius himself. If we enter further into the explanation, we must adopt the plain idea, that the rays of the sun fall upon this plate, and are reflected to us. I am however of opinion, that ὕαλος ought to be translated *glass*, ὑαλοειδὴς *glassy* or *vitreous*; for the intention of Philolaus evidently was to define the substance of the sun's body. The result of the whole is, Philolaus considered the sun as a plain plate of glass which reflected the rays or brightness of the æthereal fire. But that he was acquainted with a proper glass mirror does not thence

In the problems ascribed to Alexander of Aphrodisias, glass mirrors, covered on the back with tin, are clearly mentioned; but this information does not lead us one step further in the history of the art; as it is proved that the above Alexander, who lived in the beginning of the third century, could not have written that work. The author, who must have been a physician, maintains the immortality of the soul, which Alexander of Aphrodisias, with Aristotle, denies. Some therefore have ascribed these problems to Alexander Trallianus, who practised physic in the middle of the sixth century; but this is only a conjecture which no one has as yet rendered probable, especially as there have been many physicians of the name of Alexander. The problem to which I allude is not to be found in every manuscript and edition; so that it is doubtful whether it may not be the production of a later author than that of the rest of the book, particularly as it is certain that many who had it in their possession added problems of various kinds according to their pleasure. However this may be, it is evident that the author of this problem was acquainted with mirrors covered at the back; and the expression which he uses does not merely imply that a leaf of tin was placed behind the glass plate, but that the tin in a liquid state was rubbed over it. The old French translator thinks that the author speaks of windows; but that opinion is undoubtedly false[186].

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follow with certainty.

[186] Pourquoy reluient les fenestres de verre si fort? Pourtant que la nature de l'estain, duquel elles sont basties par dedans, fort clere, meslée avec le verre cler aussi de lui mesme reluyst d'avantage; et le quel estain outrepassant ses raïons par les petits pores

Of as little importance as the above passage of Alexander, is another of Isidore, often quoted in support of the antiquity of glass mirrors. On the first view it appears to be a testimony of great weight; but when closely examined it becomes reduced to very little. "Nothing," says he, "is so fit for mirrors as glass[187]." Abat and others, who have considered these words as decisive, make less hesitation to ascribe to the sixth century, in which Isidore lived, a knowledge of mirrors covered on the back with tin and quicksilver, as the same writer, in another place, observes, that quicksilver can be kept in no vessel but one of glass[188]. It is very true that a glass filled with that metal will form a very good mirror; but I am of opinion that this may have been long known, before people thought of making an amalgam of tin and quicksilver in order to cover the backs of mirrors. The first passage, which is properly the one of any consequence, loses its force when we see that it is taken from Pliny and copied incorrectly. The latter says, that one can give to glass every kind of shape and colour, and that no substance is more ductile, or fitter to be moulded into any form[189]. Isidore, as is usual, says the same thing, and in the same words, except, that instead of *sequacior* he substitutes *speculis aptior*; so that the mention of

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du verre, et augmentant doublement la face extérieure du dit verre, la rend grandement clere. – Problemes d'Alexandre Aphrod., traduit par M. Herret. Paris 1555, 8vo, p. 50.

[187] Origin. lib. xvi. 15, p. 394.

[188] Origin. lib. xvi. 18, p. 396.

[189] Lib. xxxvi. cap. 26, p. 759.

a mirror is altogether unexpected, and so little suited to what goes before and what follows, that one must believe that this alteration, occasioned perhaps by the similitude of the words, or by an abbreviation, was not made by Isidore, but by some transcriber. But even if we believe that Isidore himself spoke of glass being used at that period for mirrors, we are not able to comprehend, from what he says, how glass mirrors were made in the sixth century.

I have met with no information respecting this subject in the whole period between the age of Isidore and the eleventh century. About the year 1100, at least as is supposed not without probability, Alhazen the Arabian wrote his well-known treatise on Optics, in which I conjectured that I should find mention made of glass mirrors; but I searched that work in vain, though I must confess I did not read it through entirely. Where he begins his catoptrical lessons, he however often speaks of iron mirrors, by which we may understand mirrors of the best steel. In explaining a certain phænomenon, he says, that the cause of it cannot be in the darkness of the iron mirror, because if a mirror of silver be used, the same effects will be produced. Would he not on this occasion have introduced glass mirrors, had he been as well-acquainted with them as with those already mentioned? At first, he never speaks of mirrors without adding of iron, of silver; but he mentions them afterwards without any epithet of the kind.

All these mirrors I find also in the Optics of Vitello, who wrote in the middle of the thirteenth century, in Italy, a country which

was at that time almost the only one where the arts flourished[190]. That author has, indeed, borrowed a great deal from Alhazen, though there are many things of his own, and he gives an account of some experiments on the refracting power of glass; but he never, as far as I have observed, mentions glass mirrors. Whether Jordanus Nemorarius, or Nemoratius, who also wrote, in the thirteenth century, a book *De Speculorum Natura*, makes mention of them, I do not know, because I have never had an opportunity of seeing that work. I am of opinion it was never printed.

It is in the thirteenth century, that I find the first undoubted mention of glass mirrors covered at the back with tin or lead. Johannes Peckham, or Peccam, an English Franciscan monk, who taught at Oxford, Paris, and Rome, and who died in 1292, wrote about the year 1279 a treatise of optics, which was once printed, with the title of Johannis Pisani Perspectiva Communis[191]. In this work, besides mirrors made of iron, steel, and polished marble, the author not only speaks often of glass mirrors, but says also that they were covered on the back with lead, and that no image was reflected when the lead was scraped off. Vincentius Bellovacensis[192] speaks in a manner still clearer,

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[190] Bayle, Diction. Histor. vol. iv. p. 462.

[191] Printed at Leipzig, 1504, in small folio. There is an edition also printed at Cologne in 1624, and Fabricius quotes a Venetian edition. Pisanus seems to have been a by-name given by some one to Peckham.

[192] Specul. Natur. ii. 78, p. 129.

for he tells us that lead was poured over the glass plate while hot. To the same century also belong the concurrent testimonies of Raimundus Lullius[193], Roger Bacon[194], Antonius di Padua[195], and Nicephorus Gregoras[196], who died after the year 1360[197].

That this invention cannot be much older we have reason to conclude, because glass mirrors were extremely scarce in France even in the fourteenth century, while mirrors of metal were in common use; and we are told that the mirror of Anne de Bretagne, consort of Louis XII., was of the latter kind[198]. Metal mirrors also were made and employed in Persia and the East, where indeed ancient usages continued longest, and glass mirrors were not known there till the commencement of the European trade with these remote regions. The former are still preferred

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[193] Ars Magna, cap. lxvii. p. 517, in Lullii Opera. Argent. 1607, 8vo.

[194] Opus Majus, ed. Jebb. Lond. 1733, fol. p. 346.

[195] Franc. Assisiatis et Ant. Paduani Opera. Lugd. 1653, fol.

[196] Nicephori Schol. in Synesium, in Synesii Op. Par. 1612, fol. p. 419.

[197] In the collection of antiquities at St. Denis, an ancient mirror was shown, which was said to have belonged to Virgil. It was oval, and before Mabillon let it fall, was fourteen inches in length and twelve in breadth, and weighed thirty pounds. It is transparent, and of a brownish-yellow colour. According to experiments made on purpose, it was found to consist of artificial glass, mixed with a considerable portion of lead; and as it had been preserved in the above collection from the earliest periods, the practice of adding lead to glass must be very old. But whether this mirror was covered at the back, and how it was covered, though these are the most important points, I find nowhere mentioned. In the collection of the Grand Duke of Tuscany there is a piece of the same kind, said also to have been the mirror of Virgil. See Le Veil, Kunst auf Glas zu malen, Nurnb. 1779, 4to, p. 23, and Hist. de l'Acad. des Sciences, 1737, p. 412.

[198] Villaret, Hist. de France. Par. 1763, xi. p. 142.

in those countries, because they are not so liable to break, and can be preserved better in a dry hot climate than the amalgam of the latter.

Respecting the progress of this art, I know nothing more than what follows: – At first, melted lead, or perhaps tin, was poured over the glass plate while yet hot as it came from the furnace. This process agrees with that which, since very early periods, has been employed in or around Nuremberg for making convex mirrors by blowing with the pipe into the glass-bubble whilst still hot a metallic mixture, with a little resin or salt of tartar, which prevents oxidation and assists the fusion. When the bubble is covered all over in the inside, and after it has cooled, it is cut into small round mirrors. This art is an old German invention, for it is described by Porta and Garzoni, who both lived in the beginning of the sixteenth century, and who both expressly say, that it was then common in Germany. Curious foreigners often attempted to learn it, and imagined that the Germans kept it a secret. Boyle made various experiments in order to discover the process; and the secretary of the Royal Society endeavoured, by means of the ambassador from Charles II., who, perhaps about 1670, resided at Frankfort, to obtain a knowledge of it; but did not succeed, as we are told by Leibnitz[199]. It was called the art of preparing mirrors without foil; and it was highly esteemed, because it was

[199] In Miscellanea Berolinensia, i. p. 263; but nothing further is said respecting the art, than that it was daily used in the glass-houses. Had I an opportunity, I should make experiments of every kind in order to discover a method of forming plane mirrors also in the like manner.

supposed that it might be useful to those fond of catoptrics, by enabling them to form convex and concave mirrors themselves. This account of Leibnitz seems to have led Von Murr into a slight error, and induced him to believe that the art of making convex mirrors without foil was first found out at Nuremberg in 1670. I introduce this remark because I flatter myself he will not be displeased that I make the above service, rendered by his native city, to be a century and a half older. These small convex mirrors, which reflect a diminished, but a clearer image than our usual mirrors, are perhaps made still, though they are not now carried round so frequently for sale in Germany as they were thirty years ago, at which time, if I remember right, they were called (*Ochsen-augen*) ox-eyes. They were set in a round painted board, and had a very broad border or margin. One of them, in my possession, is two inches and a half in diameter. It is probable that the low price of plane mirrors, when glass-houses began to be more numerous, occasioned these convex ones to be little sought after. The mixture employed in making them was, according to Porta, antimony, lead, and colophonium; but according to Garzoni, it was *una mistura di piombo, stagno, marchesita d'argento, e tartaro*, which in the German edition is translated very badly, "lead, tin, flint, silver, and tartar." The following observation perhaps is not altogether useless: Colophonium, which is employed on many other occasions for soldering, was formerly called mirror-resin, and was sold under that name even in the beginning of the present century. Frisch

assigns no reason for this appellation, and Jacobson gives a wrong one, viz. its having a bright shining surface when broken. The true reason was the above-mentioned use; and as that is now very little known, it is called from that to which it is principally applied, violin-resin.

It appears that, instead of pouring melted metal over plates of glass, artists for some time applied to them the before-mentioned amalgam of tin, or covered them in some other manner, perhaps in the same way as Boyle covered concave glasses in the inside. Porta however saw almost the same process employed at Murano as that which is still followed at present. The tin, hammered to thin leaves, was spread out very smoothly; and quicksilver was poured over it, and rubbed into it, either with the hand or a hare's foot; and when the tin was saturated it was covered with paper. The glass, wiped exceedingly clean, was then laid above it; and while the workman pressed it down with his left hand, he drew out very carefully with his right the paper that lay between the tin and the glass, over which weights were afterwards placed. This much at any rate is certain, that the method of covering with tin foil was known at Murano so early as the sixteenth century[200], and therefore it is much older than J. M. Hoffmann supposes. To conclude, whether this ingenious invention belongs to the Venetians, as several later, and particularly Italian, writers assert,

[200] Wecker, in his book De Secretis, lib. x. p. 572, seems to say, that one must lay the saturated tin leaf so carefully on the glass plate, that no air can settle between them. According to Garzoni, the tin leaf is spread out on a smooth stone table, and after it has been rubbed over with quicksilver, the glass is placed above it.

I can neither prove nor contradict; but it is well known that till about the end of the seventeenth century their mirrors were sold all over Europe and in both the Indies. After that period the glass-houses in other countries were improved, and new ones established; and the discovery made in France, that glass, like metal, could be cast into much larger plates than had been before prepared by blowing and rolling, was in more than one respect prejudicial to the sale of those made at Venice.

So early as the year 1634, attempts were made in France to establish glass-houses for manufacturing mirrors, and Eustache Grandmont obtained a patent for that purpose; but his undertaking was not attended with success. As Colbert exerted himself very much to promote manufactures of every kind, Nicholas de Noyer proposed to make mirrors according to the Venetian method. This plan was adopted by Charles Rivière, sieur du Freni, valet-de-chambre to the king; and having procured the royal permission, he sold it afterwards for a large sum to De Noyer, who, in 1665, received a confirmation of the patent, and an advance of 12,000 livres for four years, on condition of his procuring workmen from Venice, who, after serving eight years in the kingdom, were to be naturalized. De Noyer was joined by several more, who entered into partnership with him, and particularly by one Poquelin, who had hitherto carried on the greatest trade in Venetian mirrors, and who engaged workmen from Murano. The glass-houses were erected at the village of Tourlaville, near Cherbourg, in Lower

Normandy. After the death of Colbert, who was succeeded by Louvois, the charter of the company was in 1684 renewed for thirty years longer, and at that period Pierre de Bagneux was at the head of it.

Scarcely had five years of this period elapsed, when, in 1688, Abraham Thevart made a proposal to the court for casting glass mirrors of a much larger size than any ever before made. This plan, after an accurate investigation, was approved; and in the same year he received the royal permission to use his invention for thirty years, but it was not registered till 1693 or 1694. The first plates were cast at Paris, and astonished every artist who saw them. They were eighty-four inches in height, and fifty in breadth. In order to lessen the excessive expense, the glass-houses were erected at St. Gobin, in Picardy; and to prevent all dispute with the old privileged company, Thevart was expressly bound to make plates at least sixty inches in length and forty in breadth, whereas the largest of those made before had never exceeded forty-five or fifty inches in length. On the other hand, the old company were allowed to make plates of a smaller size, and were prohibited from employing any of the instruments or apparatus invented by Thevart. These however had not been so accurately defined as to remove all cause of litigation between the companies, and for that reason permission was at length granted, in 1695, for both to be united into one, under the inspection of François Plastrier, to whom the king, in 1699, sold the palace of St. Gobin. After this they declined so rapidly, that in 1701 they

were not able to pay their debts, and were obliged to abandon several of the furnaces. To add to their misfortune, some of the workmen whom they had discharged retired to other countries, which were already jealous of the French invention, and wished to turn it to their advantage. The French writers assert that their attempts never succeeded, and that most of the workmen returned again to France, when a new company was formed in 1702, under the management of Antoine d'Agincourt, who by prudent œconomy improved the establishment, so as to render the profit very considerable. At present mirrors are cast as well as blown, both at St. Gobin and at Cherbourg; and in 1758 the price of them was greatly reduced, in order probably to weaken the competition of the foreign glass-houses, among which there are many not inferior to the French.

This short history of the glass manufactories in France is collected from Savary[201] and Expilly[202]. A more particular account perhaps may be expected of the inventor, of his first experiments, and of their success; but notwithstanding a strict search, I have not been able to find any further information on the subject. We are told only that his name was sieur Abraham Thevart, though the historians who record that circumstance have filled their pages with uninteresting anecdotes, and even with the vices of many of the courtiers of the same period.

The principal benefit which has arisen to the art from this

[201] Tome iii. p. 87, art. *Glace*.

[202] Dict. Géog. de la France. Amst. 1762, fol. v. pp. 415, 672.

invention, properly is, that much larger mirrors can be obtained than formerly; for when attempts were made to blow very large plates, they were always too thin. Casting, however, besides great expense in apparatus[203], requires so many expert workmen, and so tedious and severe labour, and is accompanied with so much danger, that it is only seldom that plates of an extraordinary size succeed, and the greater part of them must be cut into smaller plates which might have been blown. Those cast are never so even and smooth as those that have been blown; they require therefore a great deal of polishing, and on that account must be very thick. The monstrous mass requisite for a mirror of the largest size, stands ready melted in a very frail red-hot earthen pot, which is taken from the furnace and placed upon an iron plate, strongly heated, that the mass may be cast upon it into a glass plate. The latter must then be speedily conveyed to the cooling-furnace, and if it be found free from faults, it is ground, polished and silvered; but the last part of the process is generally done at the place where a purchaser can be found for so expensive an article, in order that less loss may be sustained in case it should happen to break by the way.

These great difficulties, which have excited the astonishment of every one who has seen the process, and that of finding sale

[203] A furnace for casting large glass plates, before it is fit to be set at work, cost, it is said, 3500*l.* It seldom lasts above three years, and even in that time it must be repaired every six months. It takes six months to rebuild it, and three months to repair it. The melting-pots are as big as large hogsheads, and contain above 200 cwt. of metal. If one of them burst in the furnace, the loss of the matter and time amounts to 250*l.*– Trans.

for so expensive and magnificent wares, have obliged artists to return to the old method of blowing; and many have been so fortunate in improving this branch of manufacture, that plates are formed now by blowing, sixty-four Flemish inches in height and twenty-three in breadth, which it was impossible to make before but by casting.

The mass of matter necessary for this purpose, weighing more than a hundred pounds, is by the workman blown into the shape of a large bag; it is then reduced to the form of a cylinder, and being cut up, is, by stretching, rolling it with a smooth iron, and other means, transformed into an even plane.

[All but the very commonest mirrors are now made of plate-glass; which is also used to a great extent for window-panes, and is manufactured by casting, rolling and polishing. The enormous plates of glass which are seen in many of the large shops of this city are well-calculated to excite the astonishment of those who are not yet aware of the late improvements in this branch of manufacture. An idea of what may be accomplished by blowing was given in 1845, at the Exhibition at Vienna, where a blown glass 7 feet in length and 3½ in breadth was exhibited; and which was of sufficient thickness to admit of polishing. Nevertheless, the casting of plate-glass is now managed with such comparative ease, that there appears to be no limit to the size to which the plates can be brought, so that the blowing of large panes of glass is given up in this country. Private houses may now be seen decorated with single sheets of glass upwards of 20 feet in height

and 10 in width.

A patent for a very ingenious process for silvering glass was taken out in November 1843 by Mr. Drayton. It consists in depositing silver, from a solution, upon glass, by deoxidizing the oxide of silver in solution, so that the precipitate will adhere to the glass, without the latter having been coated with metallic or other substances. This is effected by mixing 1 oz. of coarsely powdered nitrate of silver with ½ oz. of spirits of hartshorn and 2 oz. of water; after standing for 24 hours, the mixture is filtered (the deposit on the filter, which contains silver, being preserved), and an addition is made thereto of 3 oz. of spirit (by preference, spirit of wine) at 60° above proof, or naphtha; from 20 to 30 drops of oil of cassia are then added, and after remaining for about 6 hours longer, the solution is ready for use. The glass to be silvered must have a clean and polished surface; it is to be placed in a horizontal position, and a wall of putty formed around it, so that the solution may cover the surface of the glass to the depth of from ⅛th to ¼th of an inch. After the solution has been poured on the glass, from 6 to 12 drops of a mixture of oil of cloves and spirit of wine (in the proportion of 1 part by measure of the oil to 3 of spirit of wine) are dropped into it at different places; or the diluted oil of cloves may be mixed with the solution before it is poured upon the glass; the more oil of cloves used, the more rapid will be the deposition of the silver, but the patentee prefers that it should occupy about two hours. When the required deposit has been obtained, the solution is poured off; and as soon

as the silver on the glass is perfectly dry, it is varnished with a composition, formed by melting together equal quantities of bees' wax and tallow. The patentee states that, by experiment, he has ascertained that about 18 grs. of nitrate of silver are used for each square foot of glass.

It has been urged as an objection to this process, that in the course of a few weeks the surfaces of the mirrors formed by it become dotted over with small brownish-red spots, which greatly injures their appearance. Dr. Stenhouse states that these spots are caused by the metallic silver, whilst being deposited on the surface of the glass, carrying down with it mechanically small quantities of a resinous matter, resulting most probably from the oxidation of the oil. This subsequently acts upon the metallic surface with which it is in contact, and produces the small brown spots already mentioned. Mr. Drayton, however, states that the brown spots only occur when the oil employed is old and unfit for use.]

# GLASS-CUTTING. ETCHING ON GLASS

I do not here mean to enter into the history of engraving on stone, as that subject has been already sufficiently illustrated by several men of learning well acquainted with antiquities. I shall only observe, that the ancient Greek artists formed upon glass both raised and engraved figures; as may be seen by articles still preserved in collections, though it is probable that many pieces of glass may have been moulded like paste; for that art also is of very great antiquity[204]. It appears likewise that they cut upon plates of glass and hollow glass vessels all kinds of figures and ornaments, in the same manner as names, coats of arms, flowers, landscapes, &c. are cut upon drinking-glasses at present[205]. If we can believe that learned engraver in stone, the celebrated Natter, the ancients employed the same kind of instruments for this purpose as those used by the moderns[206]. They undoubtedly had in like manner a wheel which moved round in a horizontal direction above the work-table, or that machine which by writers is called a lapidary's wheel.

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[204] Mariette, Traité des Pierres gravées. Par. 1750, fol.

[205] The two ancient glasses found at Nismes, and described in Caylus' Recueil d'Antiquités, ii. p. 363, were probably of this sort.

[206] Natter, Traité de la Méthode antique de graver en Pierres fines, comparé avec la Méthode moderne. Lond. 1754, fol.

If this conjecture be true, what Pliny says respecting the various ways of preparing glass is perfectly intelligible. It is turned, says he, by the wheel, and engraven like silver. In my opinion we are to understand by the first part of this sentence, that the glass was cut by the wheel, like stone, both hollow and in relief, though it is possible that drinking-cups or vessels may have been formed from the glass metal by means of the wheel also[207]. In the latter part of the sentence we must not imagine that Pliny alludes to gravers like those used by silversmiths, for the comparison will not apply to instruments or to the manner of working, which in silver and glass must be totally different; but to the figures delineated on the former, which were only cut out on the surface in a shallow manner; and such figures were formed on glass by the ancient artists, as they are by our glass-cutters, by means of a wheel.

Many, however, affirm that the art of glass-cutting, together with the necessary instruments, was first invented in the beginning of the seventeenth century. The inventor is said to have been Casper Lehmann, who originally was a cutter of steel and iron; and who made an attempt, which succeeded, of cutting crystal, and afterwards glass, in the like manner. He was in the service of the emperor Rodolphus II., who, in the year 1609, besides presents, conferred on him the title of lapidary and glass-cutter to the court, and gave him a patent by which every

[207] Of this kind were the *calices audaces* of Martial, xiv. 94, and those cups which often broke when the artist wished to give them the finishing touch.

one except himself was forbidden to exercise this new art. He worked at Prague, where he had an assistant named Zacharias Belzer; but George Schwanhard the elder, one of his scholars, carried on the same business to a far greater extent. The latter, who was a son of Hans Schwanhard, a joiner at Rothenburg, was born in 1601; and in 1618 went to Prague to learn the art of glass-cutting from Lehmann. By his good behaviour he so much gained the esteem of his master, who died a bachelor in 1622, that he was left his heir; and obtained from the emperor Rodolphus a continuation of Lehmann's patent. Schwanhard, however, removed to Nuremberg, where he worked for many of the principal nobility; and by these means procured to that city the honour of being accounted the birth-place of this new art. In the year 1652 he worked at Prague and Ratisbon by command of the emperor Ferdinand III., and died in 1667, leaving behind him two sons, who both followed the occupation of the father. The elder, who had the same christian name as the father, died so early as 1676; but the other, Henry, survived him several years. After that period Nuremberg produced in this art more expert masters, who, by improving the tools and devising cheaper methods of employing them, brought it to a much higher degree of perfection[208].

That the art is of so modern date seems to be confirmed by

[208] See Sandrart's Teutsche Akademie, vol. i. part 2, p. 345, where there is much valuable information respecting the German artists. Compare also Doppelmayer's Nachricht von Nürnberg. Künstlern.

Zahn, who speaks of it as of a new employment carried on at that time, particularly at Nuremberg. He describes the work-table as well as the other instruments; and gives a figure of the whole, which he appears to have considered as the first[209]. It may be seen, however, from what I have already quoted, that this invention does not belong entirely to the moderns; and, to deny that the ancients were altogether unacquainted with it, would be doing them an injustice. It was forgotten and again revived; and this is the opinion of Caylus.

I must here remark, that before this invention there were artists, who, with a diamond, cut or engraved figures on glass, which were everywhere admired. Without entering, however, into the history of diamonds, which would require more materials than I have yet been able to collect, I will venture to assert that the ancient artists employed diamond dust for polishing or cutting other kinds of stones. Pliny[210] speaks of this in so clear a manner that it cannot be doubted. The same thing has been repeated by Solinus[211], Isidore[212], and Albertus Magnus[213], in a manner equally clear, and Mariette[214] considers it as fully proved; but it does not appear that the ancients made any attempts to cut this

[209] Oculus Artificial. iii. p. 79.

[210] Lib. xxxvii.

[211] Cap. 52, p. 59.

[212] Origin. xvi. 8.

[213] De Miner. lib. ii. 2.

[214] Traité des Pierres gravées, i. pp. 90, 156.

precious stone with its own dust; I mean to give it different faces and to render it brilliant. Whether they engraved on it in that manner I cannot pretend to decide, as the greatest artists are not agreed on the subject. Mariette[215] denies that they did; whereas Natter[216] seems not to deny it altogether, and Klotz[217] confidently asserts it as a thing certain. But the last-mentioned author knew nothing more of this circumstance than what he had read in the above-quoted writers.

The question which properly belongs to my subject is, whether the Greeks and the Romans used diamond pencils for engraving on other stones. That many ancient artists assisted their labour by them, or gave their work the finishing touches, seems, according to Natter, to be shown by various antique gems. But even allowing this to have been the case (for at any rate I dare not contradict so eminent a connoisseur), I must confess that I have found no proofs that the ancients cut glass with a diamond. We are however acquainted with the means employed by the old glaziers to cut glass: they used for that purpose emery, sharp-pointed instruments of the hardest steel, and a red-hot iron, by which they directed the rents according to their pleasure.

The first mention of a diamond being used for writing on glass occurs in the sixteenth century. Francis I. of France, who was fond of the arts, sciences, and new inventions, wrote the

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[215] Ibid. p. 156.

[216] In the preface, p. 15.

[217] Ueber den Nutzen d. geschnitt. Steine. Altenb. 1768, p. 42.

following lines with his diamond ring upon a pane of glass, at the castle of Chambord, in order to let Anne de Pisseleu, duchess of Estampes, know that he was jealous:

> Souvent femme varie,
> Mal habil qui s'y fie.

The historian recorded this not so much on account of the admonition, which is not new, as because it was then thought very ingenious to write upon glass[218]. About the year 1562, festoons and other ornaments, cut with a diamond, were extremely common on Venetian glasses, which at that period were accounted the best. George Schwanhard the elder was a great master in this art[219]; and in more modern times, John Rost, an artist of Augsburg, ornamented in a very curious manner with a diamond pencil, some drinking-glasses which were purchased by the emperor Charles VI.

I now come to the art of etching on glass, which properly was the subject of this article. As the acid which dissolves siliceous earth, and also glass, was first discovered in the year 1771, by Scheele the chemist[220], in fluor-spar, one might imagine that the art of engraving with it upon glass could not be older. It has

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[218] Le Veil, iii. p. 19. This anecdote however is not mentioned by Mezeray, Castelnau, or Laboureur; and Bayle must have been unacquainted with it, or he would have introduced it into his long article on the Duchesse d'Estampes.

[219] Doppelmayer, p. 232.

[220] Abhandlungen der Schwed. Akad. xxxiii. p. 122.

indeed been announced by many as a new invention[221]; but it can be proved that it was discovered as early as the year 1670, by the before-mentioned artist Henry Schwanhard. We are told that some aquafortis having fallen by accident upon his spectacles, the glass was corroded by it; and that he thence learned to make a liquid by which he could etch writing and figures upon plates of glass[222]. How Schwanhard prepared this liquid I find nowhere mentioned; but at present we are acquainted with no other acid but that of fluor-spar which will corrode every kind of glass; and it is very probable that his preparation was the same as that known to some artists as a secret in 1721. The inventor however employed it to a purpose different from that for which it is used at present.

At present the glass is covered with a varnish, and those figures which one intends to etch are traced out through it; but Schwanhard, when the figures were formed, covered them with

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[221] Halle, Fortgesetzte Magie. Berlin, 1788, 8vo, i. p. 516. This author says that the invention came from England, where it was kept very secret; but the honour of the second invention belongs to H. Klaproth.

[222] Schwanhard, by the acuteness of his genius, proved what was before considered as impossible, and found out a corrosive so powerful that the hardest crystal glass, which had hitherto withstood the force of the strongest spirits, was obliged to yield to it, as well as metals and stones. By these means he delineated and etched on glass, figures of men, some naked and some dressed, and all kinds of animals, flowers, and plants, in a manner perfectly natural; and brought them into the highest estimation. – Sandrart, Teutsche Akademie, i. 2, p. 346. – Doppelmayer, p. 250, says, "After 1670 he accidentally found out by the glass of his spectacles, upon which some aquafortis had fallen, becoming quite soft, the art of etching on glass."

varnish, and then by his liquid corroded the glass around them; so that the figures, which remained smooth and clear, appeared when the varnish was removed, raised from a dim or dark ground. He perhaps adopted this method in order to render his invention different from the art known long before of cutting the figures on the glass as if engraven. Had he been able to investigate properly what accident presented to him, he might have enriched the arts with a discovery which gave great reputation to a chemist a hundred years after.

I mentioned this old method of etching in relief to our ingenious Klindworth, who possesses great dexterity in such arts, and requested him to try it. He drew a tree with oil varnish and colours on a plate of glass, applied the acid to the plate in the usual manner, and then removed the varnish. By these means a bright, smooth figure was produced upon a dim ground, which had a much better effect than those figures that are cut into the glass. I recommend this process, because I am of opinion that it may be brought to much greater perfection; and M. Renard, that celebrated artist of Strasburg, whose thermometers with glass scales, in which the degrees and numbers are etched, have met with universal approbation, was of the same opinion, when I mentioned the method to him while he resided here, banished from his home by the disturbances in his native country.

It is probable that Schwanhard and his scholars kept the preparation of this liquid a secret, as the receipt for that purpose was not made known till the year 1725, though it is possible that

one older may be found in some of those books which treat on the arts. In the above-mentioned year, Dr. John George Weygand, from Goldingen in Courland, sent to the editor of a periodical work a receipt which had been written out for him by Dr. Matth. Pauli of Dresden, then deceased, who had etched, in this manner on glass, arms, landscapes, and figures of various kinds[223]. We find by it that a strong acid of nitre was used, which certainly disengages the acid of fluor-spar, though the vitriolic acid is commonly employed for that purpose[224]. That the Bohemian emerald or *hesphorus*, mentioned in the receipt, is green fluor-spar, cannot be doubted, and will appear still more certain from the history of this species of stone, as far as I am acquainted with it, which I shall here insert.

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[223] Breslauer Sammlung zur Natur- und Medicin-Geschichte. 1725, January, p. 107. "Invention of a powerful acid by which figures of every kind, according to fancy, can be etched upon glass. – When *spiritus nitri per distillationem* has passed into the recipient, ply it with a strong fire, and when well dephlegmated, pour it, as it corrodes ordinary glass, into a Waldenburg flask; then throw into it a pulverised green Bohemian emerald, otherwise called *hesphorus* (which, when reduced to powder and heated, emits in the dark a green light), and place it in warm sand for twenty-four hours. Take a piece of glass well cleaned and freed from all grease by means of a lye; put a border of wax round it, about an inch in height, and cover it all equally over with the above acid. The longer you let it stand the better, and at the end of some time the glass will be corroded, and the figures, which have been traced out with sulphur and varnish, will appear as if raised above the plane of the glass." This receipt has been inserted by H. Krunitz in his Œkonomische Encyclopedie, xi. p. 678.

[224] Klindworth covers the glass with the etching ground of the engravers; but in the Annals of Chemistry for 1790, ii. p. 141, a solution of isinglass in water, or a turpentine oil varnish, mixed with a little white lead, is recommended. Complete instructions for acquiring this art may be found there also.

In the works of the old mineralogists, fluor-spar is either not mentioned, or is classed among their natural glasses and precious stones; and in those of the first systematic writers it is so mingled with quartz and calcareous and gypseous spars, that it is impossible to discover it. The old German miners, however, distinguished it so early as the sixteenth century, and called it *fluss*; because they used it to accelerate the fusion of ores that were difficult to be reduced to that state. Agricola, who first remarked this, changed the German name into *fluor*, an appellation, which, like many others, formed by him from German words, such for example as *quarzum* from *quarz*, *spatum* from *spat*, *wismuthum*, *zincum*, *cobaltum*, &c., became afterwards common. If a passage of the ancients can be quoted that seems to allude to fluor-spar, it is that of Theophrastus, where he says that there are certain stones which, when added to silver, copper, and iron ores, become fluid[225]. The first systematic writer who mentioned this kind of stone as a particular genus, was Cronstedt.

Besides being known by its metallurgic use, fluor-spar is known also by having the colours of some precious stones, so that it may be sold, or at least shown as such to those who are not expert judges; because the first time when heated in the dark it shines with a bluish-green lustre. It is possible that fluor-spar may have been among the number of that great variety of stones which the ancients, with much astonishment, tell us shone in the

[225] De Lapidibus, sect. 19.

dark; though it is certain that the principal part of them were only light-magnets, as they are called, or such as retain for a certain period the light they have absorbed in the day-time. The observation, however, that fluor-spar emits light after it is heated, seems to have been first made when artificial phosphorus excited the inquiry of naturalists and chemists; and when they began to search in their own country for stones which, in the property of emitting light, might have a resemblance to the Bologna spar, made known about the year 1630. It is well known that the latter is prepared for that purpose by calcination. Stones of the like kind were sought for; and among these fluor-spar, which is not scarce in Germany.

In my opinion, the observation was made in the year 1676; for in that year Elsholz informed the members of the Society for investigating Nature, that he was acquainted with a phosphorus which had its light neither from the sun nor from fire, but which, when heated on a metal plate over glowing coals, shone with a bluish-white lustre; so that by strewing the powder of it over paper, one might form luminous writing. I doubt much whether this experiment was ever tried; at least I find no further account of it in the papers of the Society, nor in the re-publication of the above author's first dissertation, which appeared in 1681[226].

As far as I know, Kirchmaier, professor at Wittenberg, was

[226] See Ephemerid. ac Nat. Cur. 1676, Dec. 1, obs. 13, p. 32; and Elsholtii De Phosphoris Observationes, Berol. 1681, 4to.

the first who disclosed the secret, in the year 1679[227]. Both call this phosphorus the smaragdine; because the ancients speak much of luminous emeralds, and because green fluor-spar is often exhibited as an emerald. Kirchmaier calls this mineral also *hesperus* and *vesperugo*; and these names have been often given since to fluor-spar, as in the receipt before-mentioned for making a liquid to etch on glass. Kirchmaier's information, however, must have been very little known; for the Jesuit Casatus, who, in 1684, wrote his Treatise on Fire, was not acquainted with it, as he has inserted only the words of Elsholz. This observation must have been new to Leibnitz himself, and to the Academy of Sciences at Berlin, in 1710; for the former then mentioned it to the Society as a philosophical novelty[228].

I shall remark, in the last place, that the manufacturing of vessels and ornaments of every kind from solid fluor-spar was begun in Derbyshire in the year 1765[229]. The articles formed of it are in England called spar ornaments, and sometimes *blue John*. Many beautiful colours must, as is said, be brought forward by means of fire. But the heat must be applied with great caution; for fluor-spar, as is well known, by a strong and particularly a

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[227] G. C. Kirchmaieri De Phosphoris et Natura Lucis, necnon de Igne, Commentatio Epistolica. Wittebergæ, 1680, 4to.

[228] Miscellanea Berolin. 1710, vol. i. p. 97. The fluor-spar earth, or phosphoric earth, as it is called, which in later times has been found in marble quarries, and which some at present consider as an earth saturated with phosphoric acid, is mentioned by the Swede Hierne, in Prodromus Hist. Nat. Sueciæ. Henkel had never seen it.

[229] Watson's Chemical Essays, ii. p. 277.

sudden heating, cracks, and loses its transparency. Since writing the above, I find that M. Raspe[230] denies this bringing forward of colours by fire.

[230] Descriptive Catalogue of Tassie's Engraved Gems, Lond. 1791, 2 vols. 4to, i. p. 51.

# SOAP

That the first express mention of soap occurs in Pliny and Galen, and that the former declares it to be an invention of the Gauls, though he prefers the German to the Gallic soap[231], has already been remarked by many. Pliny says that soap[232] was made of tallow and ashes; that the best was made of goats' tallow and the ashes of the beech-tree, and that there were two kinds of it, hard and soft. The author of a work on simple medicines, which is ascribed to Galen, but which however does not seem to have been written by that author, and of which only a Latin translation has been printed, speaks of soap being made by a mixture of oxen, goats', or sheep's tallow, and a lye of ashes strengthened with quicklime. He says the German soap was the purest, the fattest, and the best, and that the next in quality was the Gallic[233]. This account corresponds more exactly with the process used in Germany at present; whereas the French use mineral alkali, and instead of tallow, employ oil, which appears to be a later invention. Pliny in his description does not speak of quicklime;

[231] Plin. xviii. 12, sect. 51, p. 475.

[232] It is beyond all doubt that the words *sapo* and σάπων were derived from the German *sepe*, which has been retained in the Low German, the oldest and original dialect of our language. In the High German this derivation has been rendered a little more undistinguishable by the *p* being changed into the harder *f*. Such changes are common, as *schap*, *schaf*; *schip*, *schiff*, &c.

[233] De Simplicibus Medicaminibus, p. 90, G.

but as he mentions a mixture of goats' tallow and quicklime a little before, it is probable that the use of the latter was then known at Rome. Gallic and German soap are often mentioned by later writers[234], as well as by the Arabians, sometimes on account of their external use as a medicine, and sometimes on account of their use in washing clothes. The latter purpose is that for which soap is principally employed in modern times; but it does not seem to have been the cause of German soap being introduced at Rome. Washing there was the occupation of indigent scourers, who did not give themselves much trouble concerning foreign commodities. The German soap, with which, as Pliny tells us, the Germans coloured their hair red, was imported to Rome for the use of the fashionable Roman ladies and their gallants. There is no doubt that the *pilæ Mattiacæ*, which Martial recommends as a preventive of gray hair[235]; the *caustica spuma* with which the Germans dyed their hair[236]; and

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[234] According to Aretæus De Diuturnis Morbis, ii. 13, p. 98, soap appears to have been formed into balls.

[235] Mart. xiv. 27. This soap acquired the epithet of *Mattiacum* from the name of a place which was in Hesse.

[236] Caustica Teutonicos accendit spuma capillos, Captivis poteris cultior esse comis. – Mart. xiv. 26. These lines are generally explained in this manner: – "Dye thy hair with soap, and it will become more beautiful than that of the Germans." But in this case all the wit of the advice is lost; and the expression, "eris cultior quam comæ captivæ," seems to me to be very improper. I should rather translate them as follows: – "Let the Germans dye their hair with pomade; as they are now subdued, thou mayst ornament thyself better with a peruke made of the hair of these captives." This was a piece of delicate flattery to Domitian and the Roman pride. That prince thought he had

the Batavian froth or lather which the Romans employed for colouring theirs[237], were German soap. It is probable that the Germans tinged it with those plants which were sent to Rome for dyeing the hair[238]; and according to the modern manner of speaking, it was more properly a kind of pomade than soap.

It appears that the Romans at first considered hair-soap as an ointment made from ashes; for we read in various passages of ancient authors, that the hair was dyed by means of ashes, or an ointment made of ashes and a certain kind of oil. It is however possible that they may have had such an ointment, which undoubtedly would be of a saponaceous nature, before they were acquainted with the German soap, or that they imitated the German pomade with different variations[239].

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conquered the Germans; and the most beautiful German hair, that which was not dyed, could be procured, therefore, at Rome, much easier than before. If the title of this epigram was written by Martial himself, it contains the first mention of the word *sapo*.

[237] Fortior et tortos servat vesica capillos, Et mutat Latias spuma Batava comas. – Mart. viii. 23, 19. The first line of the above proves that people then covered their heads, in the night-time, with a bladder to keep their hair, after it was dressed, from being deranged; and a bladder was undoubtedly as fit for that use as the nets and cauls employed for the like purpose at present.

[238] Femina canitiem Germanis inficit herbis. Ovidius De Arte Amandi, iii. 163.

[239] Valer. Max. i. 5, p. 135: Capillos cinere rutilarunt. Ad rutilam speciem nigros flavescere crines, Unguento cineris prædixit Plinius auctor. Q. Serenus, De Medic. iv. 56. Serenus seems to allude to a passage of Pliny, xxiii. 2, p. 306, where he speaks of an ointment made from the burnt lees of vinegar and oleum lentiscinum. The same thing is mentioned in Dioscorides, v. 132, p. 379. Servius, Æn. iv. quotes the following words from Cato: "Mulieres nostræ cinere capillum ungitabant, ut rutilus esset crinis." Alex. Trallianus, 1, 3, gives directions how to make an ointment for gray hair from

As soap is everywhere used for washing at present, a question arises what substitutes were employed before it was invented. Those with which I am acquainted I shall mention and endeavour to illustrate. They are all still used, though not in general; and they are all of a soapy nature, or at least have the same effects as soap; so that we may say the ancients used soap without knowing it.

Our soap is produced by a mixture of lixivious salts and tallow, by which means the latter becomes soluble in water. The greater part of the dirt on our linen and clothes consists of oily perspiration or grease, or dust which that grease attracts, and which either cannot be washed out, or, but very imperfectly, by water alone. But if warm water, to which lixivious salts have in any manner been added, be taken, and if dirty cloth be rubbed in it, the greasy dirt unites with the salts, becomes saponaceous, and is so far soluble in water that it may be washed out. There are also natural juices which are of a soapy quality, in the state in which we find them, and which can be employed in the stead of artificial soap. Of this kind is the gall of animals and the sap of many plants. The former being less strong in its effects on account of its slimy nature, is used at present particularly for coloured stuffs, the dye of which is apt to fade. As far as I know, however, it was not employed by the ancients[240], but it is certain that in washing they used saponaceous plants.

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soap and the ashes of the white flowers of the Verbascum. The Cinerarii, however, of Tertullian, lib. ii. ad uxor. 8, p. 641, seem to have been only hair-dressers, who were so called because they warmed their curling-irons among the hot ashes.

[240] Pliny says that spots of the skin may be removed by ox-gall.

In the remotest periods it appears that clothes were cleaned by being rubbed or stamped upon in water, without the addition of any substance whatever. We are told by Homer, that Nausicaa and her attendants washed their clothes by treading upon them with their feet in pits, into which they had collected water[241]. The epithet black, which the poet gives to the water, might induce one to conjecture that it had been mixed with ashes, which would convert it into a lye; but where were the ashes to be found? Had they brought them along with them, the bard, where he before enumerates everything that they carried with them, and even oil, would not have failed to mention them; and such a conjecture is rendered entirely groundless by his applying the same epithet to pure water, in other places, where nothing can be supposed to have coloured it[242]. Water, when it stands in deep pits, reflects so few rays of light, that in a poetical sense it may very properly be called black.

We find however mention made at later periods of ashes, and a lye of ashes employed for washing; but I think very seldom, and I do not know how old the use of them may be. According to Julius Pollux, *konia*, mentioned by Aristophanes and Plato, was a substance used for washing; and he says expressly, that we are to understand by it a lye of ashes. This I mention for the sake of those, who, like me, place little confidence in the terms of art given in dictionaries. With the above lye, oil- and wine-jars

[241] Odyss. vi. 91.

[242] Iliad, ix. 14, and xvi. 4.

were cleaned[243]; and it was employed also for washing the images of the gods[244]. The method of strengthening the lye by means of unslaked lime was known, at any rate, in the time of Paulus Ægineta; but it appears that the Romans were not acquainted with the salt itself, which is procured by dissolving common wood-ashes in water: I mean, they did not understand the art of producing it in a dry solid form, or of boiling potashes.

On the other hand, that fixed lixivious salt, the mineral which nature presents in many of the southern countries, was long known and used in washing. This was the *nitrum*, or, as the people of Attica pronounced it, the *litrum*, of the ancients, as has already been remarked by others[245]. It would however be worth the trouble to investigate the proofs still further. By examining them with more mineralogical and chemical knowledge than have hitherto been employed for that purpose, they might be further strengthened, and serve to illustrate many obscure passages. For my part, I have neither leisure nor room here to undertake such a task, though I have collected many observations relative to that subject. It is certain at any rate, that the ancients employed *nitrum* for washing, and it is evident from the testimony of various authors, that it was much used in the baths[246].

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[243] Geopon. vii. 6. – Plin. xiv. cap. 21. – Columella, xii. 50. 14.

[244] Arnobius, vii. p. 237.

[245] The word λίτρον in Pollux ought not to have been translated *sapo*.

[246] Cicer. Ep. Fam. viii. 14. – Pollucis Onom. viii. 9, 39; x. 135. – Ovid. De

That the people of Egypt, in the time of Pliny, made mineral alkali also from the ashes of some plants, we have reason to conclude, because he says that it was necessary to put the Egyptian nitre into vessels well-corked, else it became liquid. Natural alkali is never liable to do so, unless it be very much burnt; and as no reason is assigned for its assuming that form, we may believe that the Egyptian alkali was the strongly burnt ashes of those plants which are still used in Egypt for making salt, and perhaps the same with which the Spaniards were made acquainted by the Arabians, and which they cultivate for making soda.

Strabo speaks of an alkaline water in Armenia, which was used by the scourers for washing clothes[247]. Of this kind also must have been the lake Ascanius, which is mentioned by Aristotle[248], Antigonus Carystius[249], and Pliny[250]. It is worthy of remark, that the ancients made ointments of this mineral alkali and oil, but not hard soap, though by these means they approached nearer to the invention than the old Germans in their use of wood-ashes; for dry solid soap can be made with more ease from the mineral than the vegetable alkali; and when Hungarian, French, and German soap are of equal goodness, the last does

Medicam. Faciei, ver. 73 et 85. – Phavorini Dictionar. p. 527. Gynesius calls clothes washed with *nitrum*, νιτρούμενα, *nitro perfricata*.

[247] Lib. xi. p. 801.

[248] De Mirabil. Auscult. c. 54.

[249] Hist. Mirab. c. 162, p. 216.

[250] Lib. xxxi. 10, p. 564.

more credit to the manufacturers because they cannot employ the mineral alkali. I shall here observe, that this alkali was used for washing by the Hebrews, and that it occurs in the sacred writings under the name of *borith*[251].

The cheapest however, and the most common article used for washing, was the urine of men and animals. When this excrement becomes old, the alkali disengages itself, which may be perceived by its fœtid smell; and such alkalised urine being warmed, and employed to wash greasy clothes, produces the same effects as the *nitrum* of the ancients. It is still used for the like purpose in our cloth manufactories.

To procure a supply of it, the ancient washers and scourers placed at the corners of the streets, vessels which they carried away after they had been filled by the passengers, who were at liberty to use them; and the practice of having such conveniences was certainly more decent than that of employing the walls of churches and other buildings, which the police of Dresden forbade some years ago, but with no effect. At Rome, that which

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[251] J. D. Michaelis Commentationes, 4to, p. 151. I must mention also C. Schoettgenii Antiquitates Fulloniæ, Traj. 1727, 8vo. My readers will do me a pleasure if they compare the above work with this article. No one will accuse me of vanity when I pretend to understand the theory of washing better than the learned Schöttgen; but if I have explained the passages which he quotes in a more satisfactory manner, and turned them to more advantage, I must ascribe this superiority to my knowledge of that art. I shall here take occasion to remark, that there is no subject, however trifling, which may not be rendered useful, or at least agreeable, by being treated in a scientific manner; and to turn such into ridicule, instead of displaying wit, would betray a want of judgment.

at present spoils and renders filthy our noblest edifices, was converted to use. When clothes were washed, they were trod upon with the feet, as was the case in the cloth manufactories at Leeds, Halifax, and other places of England, where the urine was collected by servants, and sold by measure to the manufacturers under the name of *old lant*. On account of the disagreeable smell attending their employment, scourers at Rome were obliged to reside either in the suburbs or in some of the unfrequented streets[252].

My readers here will undoubtedly call to remembrance the source of taxation devised by the emperor Vespasian, who, as his historians tell us, *urinæ vectigal commentus est*[253]. It is not certainly known in what manner this impost was regulated. Did the emperor declare that article, which was not *subterraneum rarius*, to be a regale as a *res derelicta*, so that the scourers were obliged to pay him what he thought a reasonable sum proportioned to the benefit which they derived from it? Or was it imposed only as a poll-tax? For every tax upon anything indispensably necessary to all, is, to speak in the language of finance, the same as what is called a poll-tax, or a tax paid by every one who has a head. The latter conjecture is the most probable, especially as this tax continued two centuries, till the

[252] Plin. xxviii. 6; xxviii. 8. – Martial. vi. ep. 93. – Athenæus, xi. p. 484. Macrobius, ii. 12, speaking of drunken people, "Dum eunt, nulla est in angiporto amphora, quam non impleant, quippe qui vesicam plenam vini habeant." This passage is quoted also in Joh. Sarisberg. Polior. viii. 7, p. 479.

[253] Sueton. in Vita Vespas. viii. 23.

time of Anastasius, and as we read also of *vectigal pro urina jumentorum et canum*, which was exacted from every person who kept cattle. Vespasian therefore was not fortunate in the choice of a name for his tribute, which on that account must have been undoubtedly more detested. A poll-tax at present is called by those who do not speak favourably of it, the Turkish-tax, because the Turks impose it on all unbelievers. When it was introduced by Louis XIV. in 1695, he called it *la capitation*.

Of plants with a saponaceous juice, the ancients, at any rate, used one instead of soap; but it is difficult or rather impossible to define it. I shall not therefore content myself merely with transcribing the passages where it is mentioned, but I shall arrange whatever I can find respecting it in such a manner, as, according to my opinion, the names of plants ought to be explained in dictionaries.

Στρουθίον, Struthium, Latinis Herba lanaria, et Plinio etiam Radicula.

1. Est planta spinosa, *Theophrastus*, *Plinius*.

2. Grata aspectu, sed sine odore, *Theophrastus*, *Plinius*.

3. Folio oleæ, *Plinius*; vel papaveris Heraclei, *Theophrastus*.

4. Caule ferulaceo, tenui, lanuginoso, eduli, *Plinius*.

5. Radice magna, acri, medicinali, *Plinius*, *Dioscorides*; spumescente, *Lucian*.

6. Floret æstate, *Theophrastus*. *Plinius*; sed semen nullum, *Plinius*.

7. Nascitur saxosis et asperis locis, *Plinius*.

8. Sponte, præcipue in Asia Syriaque; trans Euphratem laudatissima; sativa ubique, *Plinius*.

9. Radix conditur ad lanas lavandas, *Theophrastus*, *Plinius*, *Dioscorides*, *Columella*, et alii.

10. Herba ovibus lac auget, *Plinius*.

The above is all that the ancients have told us respecting this plant. The information is indeed very scanty, and at the same time it is not altogether certain; but even if it were, it would be sufficient only to confute some conjectures, but not to establish the systematic name of the plant. I call the properties of it described to us uncertain: first, because I do not know whether Pliny did not mean to distinguish the wild plant from that which was cultivated, and many have understood as alluding to the former that which I have applied to both: secondly, because the words of Theophrastus, being in one passage evidently corrupted, will admit of various constructions; and because in another, on account of some exceptions, of which he speaks, they appear at least to me unintelligible: thirdly, because Pliny, who gives us the best account of it, is the only author who calls the *struthium* or soap-plant *radicula*, a name by which is rather to be understood a dye-plant of the same kind as madder. We have reason therefore to suspect that he has confounded the properties of the two plants, especially as the fourth property was ascribed by others to a *Rubia*, *Asperula*, or *Galium*, which was cultivated in Syria, and named often *radicula Syriaca*. On the other hand, this diminutive is very ill-suited to a root which Pliny himself

calls large.

The words of that author, "tingenti, quicquid sit cum quo decoquatur," have been by some explained as if he meant that the *struthium* was a dye-plant, though as a soapy plant it must have been destitute of colour; and they have hence deduced a proof that Pliny confounded the *struthium* with the *radicula* used in dyeing. On the other hand, Hardouin reads *unguentis* instead of *tingenti*. He assures us that he found the former in manuscripts, and is of opinion that the sap of the *struthium* was used also for ointments.

In my opinion, however, *tingenti* must be retained; and the meaning is that when cloth was to be dyed it was necessary to prepare it for that purpose by soaking it and washing it with the sap of this plant. This he expressly tells us himself; "tingentibus et radicula lanas præparat." It is probable that the ancient dyers mixed their dye-liquors with the juice of the *struthium*, for the same purpose as bran and the seeds of fenugreek are added to dye-liquors at present; that is, to render them thicker and more slimy, in order that the colouring particles may be longer and more equally suspended in or diffused through them[254]. The words *quidquid sit cum quo decoquatur* will now become intelligible. Whatever may be employed for dyeing, says the author, the addition of the juice of the *struthium* is serviceable.

As what has been said contains nothing that can enable us to determine the genus of the *struthium* according to the rules

[254] Porner's Anleitung zur Farbekunst, p. 31.

of botany, we may be allowed to conjecture that it was one of those plants still used for the like purpose in Italy and other neighbouring countries. Fuchs thinks it must have been the *Saponaria officinalis* (soap-wort), the roots of which indeed contain a saponaceous juice that readily changes the saliva into froth. The root was employed for that purpose by the impostor in Lucian; and the juice is used at present for cleaning wool and cloth. In the Helvetian Alps, the sheep, before they are shorn, are washed with a decoction of the plant and its roots; and with a mixture of ashes it serves for cleaning linen. The taste of it is so sharp, that it is compared by some to that of the small burnet-saxifrage.

This *Saponaria officinalis* however differs too much from the remaining properties[255] of the *struthium*. Its root is as thick only as a quill, or at most as one's finger. The stem, which is three feet in height, throws out many branches, and cannot be called *caulis ferulaceus, tenuis*. It is not rough and prickly, and, instead of growing in poor rocky soil, it is rather fond of deep ground and the borders of corn-fields.

We may therefore conjecture with more probability that the *Gypsophila Struthium*, Linn.[256], a plant still used for washing in

[255] Those numbered 3, 4, 5, 6.

[256] This plant was sent by Imperati to Casp. Bauhin, under the name of *lanaria veterum*; and the latter made it first known in his Pinax Plant. iv. p. 206. The former described it himself, and gave a bad engraving of it, in Hist. Nat. p. 871. Löffling found this plant on the Spanish mountains, as well as in the neighbourhood of Aranjuez; and he relates, that in the province of La Mancha the people boil clothes that are to be

the lower part of Italy and Spain, is the *struthium* of the ancients. This opinion acquires some strength by its being adopted among the Italians and Spaniards; and because the plant, as Pliny says, grows in a rocky soil and on the mountains. It is also still called *lanaria* by the Calabrian peasants. It has a tender stem; its leaves are so like those of the olive-tree that they might be compared to them by those who are not botanists; and its root is large, but it is neither rough nor prickly. This contradiction may be accounted for by supposing that Pliny, through a mistake, of which I have already accused him, ascribed falsely to the soap-plant the prickly or rough leaves of the dye-plant which had an affinity to madder. But even after this explanation there still remains to be got over a dubious passage of Theophrastus, who indeed seems to make the plant prickly also.

I do not therefore place entire confidence in this opinion; but suspect rather that we shall receive from the East an account of a plant, still used there, which will correspond more exactly with the soap-plant described by Pliny. I am inclined to think that I have already found some precursory information respecting it in Bauhin, who says that in Syria there is another kind of soap-plant, which has prickly leaves like the thistle, and a thick root of a sharp acrid taste. The root, he adds, was employed for washing

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washed with the root of this plant *instead of soap*. Linnæus did not hesitate to declare the *struthium* of the ancients and the *struthium* of his system to be the same plant; and he gave his countrymen reason to hope that their *Gypsophila fastigiata*, which has a great resemblance to it, might be employed in the like manner. – Amœnitat. Academ. v. p. 329.

clothes and wool; and the confectioners of Damascus formed of it, with honey and wine, a kind of sweetmeat which appeared as white as if it had been made of the finest flour and sugar, and which was so hard that it could scarcely be broken with the teeth. This plant seems to belong to those, the cultivation of which was abandoned in Europe, after the use of them was rendered superfluous by newer discoveries.

That the ancients employed their *struthium* for washing wool is confirmed by various authorities; but I do not remember to have found any evidence of its being used for cleaning clothes which had been worn. Salmasius however quotes a passage from the works, unfortunately never printed, of the old chemist Zosimus, in which he gives directions for restoring, by means of the soap-plant, the lustre of pearls which have become yellow[257].

The meal of many kinds of seeds may be used for washing, as well as various kinds of bran. That of almonds, which on account of its oil is remarkably soft, is employed at present for washing the hands by those who are desirous of having a white delicate skin. Cloth, the colours of which easily fade, and which will neither endure soap nor hard rubbing, may be washed extremely well with bran. Our fullers, therefore, and stocking manufacturers use oat-, barley- and bean-meal, especially when they wish the cloth to be slowly milled. Whether the ancients employed bran in the same manner I have not had an opportunity of examining. I am rather inclined to think that they did; and

[257] Salmas. ad Solin. p. 818. a.

there is a passage of Galen which seems to allude to the use of bean-meal[258]. In all probability the beans of the ancients were the smallest and roundest variety of our horse-beans, or those used as fodder.

In the last place, the ancients, at those periods of which I speak, used fullers-earth much oftener than it is used at present. Till the countries where it was procured be described by travellers who unite a knowledge of antiquities with skill in mineralogy, the species of this earth, mentioned in the works of ancient authors, cannot be distinguished with accuracy. But from the purposes to which they were applied, we can with certainty conclude that they must have been partly of the nature of marl and partly of the nature of soapstone.

According to the then usual method of washing, by which the clothes were stamped with the feet, the *cretæ fulloniæ*, as Pliny[259] calls them, acted in the same manner as our fullers-earth employed at present, partly by scouring and partly by absorbing the greasy dirt. The ancients, after their manner, gave them names only from the countries where they were produced; and hence we find mention made of *terra Cimolia*[260], *Chia*[261], *Lemnia*[262], *Sarda*[263], *Umbria*[264], *Samia*, *Tymphæa*[265], and others.

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[258] De Alimentor. Facultate, i. cap. 19. in Op. vol. iv. p. 315.

[259] Lib. xvii. 18.

[260] Pollux. – Plin.

[261] Dioscor.

[262] This *terra Lemnia* is entirely different from sealing-earth. See Galen. De Simplic.

Many of them, like that brought from Sardinia, could not be used in cleaning coloured stuffs; and for this reason, perhaps, because some colours would not stand hard scouring, or endure their caustic nature.

The fullers, however, did not use these earths merely for washing, but also for whitening many kinds of cloth. This was done by rubbing fine white earth into the cloth, in the same manner as soldiers do to give some parts of their dress a brighter appearance. A like process is employed by glovers and those who wash or clean leather. The earth used by the latter is a yellowish-white iron-ochre, called from the purpose to which it is applied collar-earth[266]. When a perfect white was required, a kind of white potters-clay or marl was employed; and the closer it adhered to the cloth, and the less easily it could be rubbed out, it was so much the better. The poor at Rome rubbed it over their clothes on festivals, in order that they might appear brighter[267].

It deserves here to be particularly remarked, that some of these earths, such as that of Chios, were employed in the baths

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Med.

[263] Plin.

[264] Plin. The *Sarda* was cheap, and purchased by measure; the *Umbria* was dearer, and sold by weight.

[265] Theophrast. Dioscor.

[266] I here mean that it got its name from being employed to clean that piece of armour, formerly used, which covered only the breast and the back, and which was called a *koller*. The Swedes also call yellow iron-ochre *kiöllerfärg* or *kyllerfarg*.

[267] See Taubmann's Annotations to Plauti Aulular. iv. sc. 9, 6.

instead of nitrum; and this is the case in the Levant still. De la Valle extols in this respect a kind of reddish earth, and says that people of the first distinction never bathe without it. Perfumes are often mixed with it; and it is formed into small balls, which when used are suffered to dissolve in the water. Different kinds of vessels, and particularly those in which wine and oil had been kept, were cleansed with these earths also[268]. Glass flasks which have had oil in them, cannot be cleansed better or more speedily than by shaking in them a mixture of fullers-earth or potters-clay. When these are not to be had, blotting-paper may be used. The oil is absorbed by the earth or the paper, and with them can be easily washed out.

To render cloth perfectly white, it was also fumigated with sulphur by the fullers, who were not ignorant that many colours were destroyed by its vapours[269]. We are told by Apuleius that the wife of a scourer concealed her gallant under a vessel of basket-work, over which cloth used to be laid to whiten by the effects of sulphur kindled under it. Our washer-women employ a cask in this mode of bleaching, and our clothiers a small close apartment, in which the wet cloth is suspended upon hooks.

Pliny has described the method of washing used at Rome, but many things respecting it appear to me obscure[270]. The cloth

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[268] Geopon. vii. 6. – Plin. xiv. cap. 21. – Columella, xii. 50, 14.

[269] Pollux, vii. 11, 41, 715. – Plin. xxxv. 17, p. 719; and xxxv. 15, p. 714. – Isidor. Origin. xvi. 1.

[270] Lib. xxxv. cap. 17, sec. 57.

was first washed with Sardian earth; it was then fumigated with sulphur, and afterwards rinsed with real Cimolian earth. The word *desquamatur* was undoubtedly a term of art, which cannot be further explained, because we are unacquainted with the operation to which it alludes. Pliny seems to have been particular in mentioning real Cimolian earth, because the false kind became black by the steam of the sulphur which the cloth absorbed. Was it adulterated with some metallic oxide or with white lead? It was dear enough to induce people to mix it with such articles; and in that case it must necessarily have become black.

The expression *funditur sulphure* seems to be attended with no less difficulty. In comparing the different readings, I find that the oldest editions have *offunditur*, which has been changed into *effunditur*, and lastly into *funditur*. It is probable however that instead of *offunditur* we ought to read *offenditur*, which would make the whole clear. I am much surprised that this reading was not adopted by Hardouin. As Pliny says in other parts of his work "offendit stomachum," and "offendit aciem oculorum," he might undoubtedly have applied that word to the earth and its colour.

Fast colours, which the acid of sulphur might render pale, but could not entirely destroy, would by washing with Cimolian earth be improved or rather restored, as the earth would absorb and carry off the acid. There was also another kind of earth (*saxum*) which was useful in the preparation of cloth fumigated with sulphur, but which injured the dye, probably because it was too calcareous, and which was perhaps our common chalk.

I do not intend to treat here of the whole art of Roman fullers, which belongs rather to the history of weaving or manufacturing cloth in general; but I hope I shall be forgiven if I add the few following observations. The fullers received the cloth as it came from the loom, in order that it might be scoured, walked and smoothed. It was walked by being stamped upon with the feet. The rough wool raised by this operation was combed off, partly with the skin of a hedgehog, and partly with the tops of some plants of the thistle kind, in order to give the cloth a nap. Shearing seems not then to have been known: I have at least met with no passage where it is mentioned: and the case is the same with the use of presses; which, in my opinion, were not invented till the sixteenth century. The whole process of smoothing seems to have consisted in making the wool or nap lie as evenly as possible one way, which certainly must have given to the cloth a much better appearance.

As cloth at present is more dressed and shorn on one side than another, the ancient fullers prepared theirs in the like manner; so that clothes could be turned, after the inside of them had been new dressed. Whether they made felt, also, I have not yet inquired; but I conjecture that the manufacturing it was the occupation of those called *lanarii*, *coactores*, and *coactilarii*.

The occupation of the fullers was at Rome very extensive, and afforded employment to a great number of people, but it at length entirely decayed. Schöttgen is of opinion that it belongs to those arts which have been lost. But other writers have declared arts

which are exercised now in greater perfection than formerly to be lost, merely because they were not acquainted with them; or because, on account of the alterations they have undergone, they did not know where to find them. All the different operations of fulling have become so complex by new methods, improvements, and inventions, that they can no longer be conducted by one man; and the whole business has for that reason been separated or divided into several distinct branches.

The scouring of cloth when it comes from the loom, was, together with walking, separated from the rest, after the invention of the walk-mill. How old that invention may be, I cannot accurately determine; but we find it mentioned in the beginning of the thirteenth, and even at the end of the tenth century. Such a mill formerly was call *fullencium*, or *molendinum cum fullone*[271]. The dressing and smoothing of cloth, since the invention of shearing and pressing, requires so much art, that these operations can be performed only by skilful workmen, who are called cloth-shearers or cloth-dressers. The scouring of cloth dirtied in manufacturing, is by the invention of soap, bleaching, and other processes, become so easy that it can be performed by women. The Romans for the most part wore a white dress made in the form of a cloak; which indeed, as shirts were not then used, must have often stood in need of being cleaned[272].

[271] Du Cange in his Glossarium.

[272] I acknowledge myself one of those who cannot form a proper idea of the Roman *toga*. It is certain that the weavers made each piece of cloth only large enough to be fit

We, on the other hand, wear in general short close clothes of coloured cloth; which by the fashion in which they are made, are less exposed to be dirtied; and we are more accustomed also to use clothes of linen or cotton, which can be washed with much less labour. Felt, which is employed almost for hats alone, is manufactured by our hat-makers. Whoever takes a general view of all these employments together, will be readily convinced that they maintain more people, and in a better manner, than the whole *ars fullonia* did at Rome.

[The principal kinds of soap manufactured in this country are, – white soap, composed chiefly of tallow and soda, but for some purposes of olive oil and soda; yellow soap, made of tallow, rosin and soda, a little palm oil being occasionally added; mottled soap, formed of tallow, kitchen stuff and soda, its peculiar appearance being communicated by dispersing the lees through it towards the end of the operation; brown soap, made from palm oil, rosin and soda. Soft soap is made with potash

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for this article of dress; or that when one *toga* was wove, it was cut from the loom, in order that another might be begun. On this account we find so often the expressions *texere vestes*, *texere togas*. It appears, also, that the *toga*, when it came from the hands of the weaver, was quite ready for use; and we therefore never read of tailors, but when torn clothes were to be mended. The *toga* had no sleeves, and perhaps no seam. If it was stitched along the edges before, half-way up, the assistance of a tailor would not be necessary for that purpose. It was bound round the body with a girdle, and fastened with clasps. Such a mantle could be easily made and easily scoured. One may now readily comprehend why the Roman authors never mention cloth manufactories, or cloth, among the articles of commerce, but speak only of clothes; and why we never read of cloth being measured.

and drying oils, either alone or mixed with tallow, and other coarse fatty matters. The fatty matter is mixed with the alkaline ley, and the whole boiled gently for some time, until the fat is completely saponified, which may be known by its becoming clear and transparent, and its susceptibility of being drawn into long threads. A quantity of common salt is then added to the boiling mixture, until the soap loses its thready character, and drops from the spatula in short thick lumps. The soap is then removed, either after cooling, or at once ladled out. Common fatty matters, as tallow, fat-oils, &c., are compounds of a fatty acid with a base, thus resembling salts; the base is a peculiar sweet principle, glycerine; by ebullition with the caustic lye, the neutral fatty compound is decomposed, the fatty acid combining with the base soda, and forming the soap, whilst the glycerine with the excess of alkali remains in the liquid.

The so-called *silicated* soap, of which large quantities are now manufactured, is made by combining silicate of soda with hard soap in the hot and pasty state; in this way from 10 to 30 per cent. of the silicate may be introduced. Such soap possesses, according to Dr. Ure, very powerful detergent qualities, but it is apt to feel hard and somewhat gritty in use. The silicated soda is obtained by boiling ground flints in a strong caustic lye. Many substances are used to adulterate soap, such as potatoe-starch, clay, &c., for which *improvements*, as they are termed, numerous patents have been granted in this country.

In Great Britain the hard kind of soap is chiefly made at

Liverpool and London, but in considerable quantities also at Runcorn, Bristol, Brentford, Hull, Bromsgrove, Plymouth and Sethwick, and at Glasgow and Leith in Scotland; the soft soap is made principally at Liverpool, Glasgow and Bradford; and silicated soap is likewise extensively manufactured at Liverpool.

From the excise returns, it appears that 140,712,535 pounds of hard, 9,788,851 pounds of soft, and 3,921,862 pounds of silicated soap were made in England in 1841; and 10,708,464 pounds of hard, and 4,535,030 pounds of soft soap in Scotland; making in all 169,666,742 pounds, which is an increase of about 30 per cent. since 1832[273].

The excise duty on soap was first imposed in Great Britain in 1711, when it was fixed at 1*d.* per pound. It was raised in 1713 to 1½*d.* per pound; and again, in 1782, when hard and soft soap were first distinguished, the former being rated at 2¼*d.*, and the latter at 1¾*d.* per pound. In 1816, that on hard soap was increased to 3*d.* per pound. But since May 31, 1833, the duty has been 1½*d.* per pound on hard soap, and 1*d.* per pound on soft. In 1839, the number of soap manufacturers in England was 177; in Scotland 19; and in Ireland 183. Each requires an annual license, costing 4*l.*

An allowance of duty is made on soap used in the woollen, silk, flax, and cotton manufactures, which in 1841 was granted on 10,190,160 pounds of hard, and 9,090,184 pounds of soft soap; the allowances amounting to 78,112*l.* In the same year the

[273] Waterston's Encyclopædia of Commerce.

net amount yielded by the soap-duty to the public revenue was 815,864*l.* Ireland is not subject to the soap-duty.

The soap-maker was formerly subjected to an arbitrary and vexatious interference from the excise; but of late years the regulations have been greatly improved, and there is now no superintendence of the process of manufacture, which may be conducted in any way and of any material.]

# MADDER

This plant, the root of which is either dried and bruised, or used fresh, for dyeing red, has a weak, square, jointed stem; and rises to the height of eight feet when supported, otherwise it creeps along the ground. At each joint there are from four to six leaves, about three inches in length, almost an inch broad in the middle, and pointed at both ends. The upper side of the leaves is smooth; but the middle nerve of the under side is armed with small rough prickles; and others of the same kind may be found on the stem. On this account, the leaves, which drop annually, adhere readily to other bodies, like those of the *asperugo*. The branches, which in June bear flowers divided into four yellow leaves, proceed from the joints. The fruit, a kind of berry, which, towards the time of its ripening, though that seldom happens among us, is first of a brownish colour, and then black, contains a round seed. The roots grow sometimes to the thickness of one's finger, push themselves deep into the earth, are surrounded by many small fibres, have a yellowish-red pith, and are covered with a black bark or rind. This plant grows wild in the Levant, as well as in Italy, the southern parts of France, and in Switzerland. The cultivated kind is well known, and is propagated with much advantage in various countries of Europe.

When one compares this short description with what Dioscorides says of a plant which he calls *ereuthodanon*, it will

be readily seen that he meant our madder. He even compares its long square stem, armed with a great many hooks, to that of the *asperugo*; and he tells us that the leaves stand in the form of a star around the joints. The fruit was at first green, then red, and lastly black. The thin long roots, adds he, which are red, serve for dyeing; and on that account the cultivated kind (he must therefore have been acquainted with the wild sort) is reared with much benefit in Galilee, around Ravenna in Italy and in Caria, where it is planted either among the olive-trees, or in fields destined for that purpose. It is remarked in some manuscripts, that this plant had a name given it by the Romans, which, as Marcellus Virgil observes, meant the same thing as *Rubia sativa*, and that it was called in Etruria *Lappa minor*, doubtless because, like the bur, it adhered to other bodies. On account of the colour which it communicated, it was called also sometimes *cinnabaris*[274].

[274] Some also may with equal propriety have called it *sandyx*; and I am of opinion that under this name we are to understand our madder, at least in a passage of Virgil, Eclogue iv. 45, where he says, "Sponte sua sandyx pascentes vestiet agnos." As the wool of the sheep became red by eating the madder which grew in the fields, it could be immediately manufactured, without dyeing it artificially. We manufacture the wool of our brown sheep in its natural colour, and this was done also by the ancients. Cloths of this kind were the *panni nativi coloris*, as they are called by Pliny, xxxvi. 7; and the words of Martial, xiv. 133, allude to a dress made of such cloth:Non est lana mihi mendax, nec mutor aëno, … me mea tinxit ovis. I shall here take occasion to remark, that the word lutum, in the line preceding the above passage of Virgil, must be translated yellow-weed, and not woad. The former, Reseda luteola, dyes yellow; but the latter, Isatis, dyes blue. Lutum, however, in Cæsar De bello Gallico, v. 14, seems to have been woad: "Omnes se Britanni luteo inficiunt, quod et cæruleum efficit colorem." It appears, therefore, that both names were liable to be confounded

In opposition to this asserted identity I find only one doubt; namely, that among those plants which, on account of the position of their leaves, were called *stellatæ*, and which were all so like that we must reduce them to one natural order, there are more sorts, the roots of which dye red, and which on that account are very improperly called wild madder. Why, therefore, should the plant of Dioscorides be our madder, and not some other plant of the like nature? For this reason, in my opinion: because the ancients, who were acquainted with all these plants, which grew wild in their lands, were equally prudent as the moderns, and cultivated that kind only which was the most productive or beneficial, viz. our *Rubia tinctorum*.

This opinion will be strengthened by comparing the accounts given of that plant by other ancient writers. Theophrastus agrees almost perfectly with Dioscorides; and adds, that it did not grow upright, but was fond of reclining. The comparison, therefore, with the leaves of ivy cannot be just; but that I shall leave

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in the Latin, as they are in the German; unless Davis be right, who, instead of luteo, reads vitro. That sandyx, in Virgil, signifies a plant rather than a mineral, is to me far more probable. The author speaks of plants which the sheep ate while feeding (pascentes); and both the above-mentioned dye-plants, yellow-weed and woad, grow wild in Italy. The opinion of Pliny, who understood the passage so, is not to be despised; and therefore the poetical account, that the pasture dyed the wool, is not altogether without foundation; especially as not only the roots, but also the leaves of madder, communicate a colour to the solid parts of animal bodies. I will however allow that most people readily fall into the error of being led away by imagination; and often suppose that they find in passages of ancient authors more than others can discover, or perhaps even than they contain.

to the critics. Pliny says expressly, that the *erythrodanum* or *ereuthodanum* was in his mother-tongue called *rubia*; and that its red roots were used to dye wool and leather red[275].

In the middle ages this plant was called *varantia*, a name which must have arisen from *verantia*. The latter means the real, genuine dye; as *aurantia* signified a golden yellow. Till the year 1736, this plant was little regarded, except among dyers, farmers and merchants, who purchased it from the farmers, in order to sell it to the dyers with profit; and among a few herb-dealers and physicians, who, on the authority of the ancients, ascribed to it eminent virtues, which others doubted or altogether denied. In the above year, however, a property of it was discovered by accident, as usual, which rendered it an object of more attention. John Belchier, an English surgeon, having dined with a cotton-printer, observed that the bones of the pork which was brought to the table were red. As he seemed surprised at this circumstance, his host assured him that the redness was occasioned by the swine feeding on the water mixed with bran in which the cotton cloth was boiled, and which was coloured by the madder used in printing it. Belchier[276], to whom this effect was new, convinced

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[275] Lib. xxiv. 9, p. 341.

[276] The first account of this circumstance may be found in the Philosophical Transactions, vol. xxxix. n. 442, p. 287; n. 443, p. 299. Among the principal experiments made on this subject, are those of the Italian Matth. Bazanus, in Comment. Bononiens. and of J. H. Benj. Böhmer, in a dissertation entitled Radicis Rubiæ tinctorum effectus in Corpore Animali, Lips. 1751. Other works and observations relative to this singularity are mentioned in Haller's Elementa

himself by experiments that the red colour of the bones had arisen from the madder employed in printing the cotton, and from no other cause; and he communicated his discovery to the Royal Society, in a paper which was printed in their Transactions.

This singularity was now soon known to all the naturalists, several of whom made new experiments, the result of which brought to light many truths useful to physiology. Besides the roots of madder, those of the *Galium* (yellow ladies-bed-straw) and other plants which have an affinity to madder, produce the like effects; but this is the case neither with saffron nor woad, nor with many others much used in dyeing. The colouring takes place soonest in young animals; and is strongest where the bones are hardest and thickest. On the other hand, it does not reach the soft parts; appears only a little in the milk; and in general is not perceptible in the animal juices[277].

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Physiologiæ, v. p. 327.

[277] That the *Rubia* colours the milk has been denied by many, who are mentioned in Haller's Physiol. viii. p. 328. Young, in his Treatise De Lacte, says only that it has no effect on carnivorous animals. Being once engaged in making experiments on the madder dye, I gave the plant to a cow for several days, and I found that the milk became reddish and streaked with veins which were of a darker colour than the other parts. That well-known farmer, Gugenmus, gave the madder-plant, formed into hay, to his cows, who ate it readily. Their milk was somewhat reddish, and the butter and cheese acquired by these means in winter an agreeable colour. Perhaps the effects do not take place when the animals get other food at the same time. Or may not the state of their health occasion some difference? This much is certain, that *Chelidonium* (swallow-wort) makes the milk of cows that are weak appear bloody, while the same effect does not follow, or at least immediately, in those that are strong. Ruellius, De Natura Stirpium, Basiliæ, 1543, fol. p. 572, says of the Rubia, "Folia capillum tingunt." If he

As the English calico-printers were acquainted with this effect of madder before it was known to naturalists, it is not improbable that it was known much sooner in other places, where the plant has been much cultivated and used since the earliest periods. From what J. E. Stief says, we have reason to believe that the people in the neighbourhood of Breslau, his native city, who gave the stalks of the madder plant to their cows instead of straw, must have first discovered that it possessed the property of communicating a red colour to the bones[278].

As many truths not yet investigated by means of new experiments, and which on that account have not yet been acknowledged, are concealed among the evidently false assertions to be found in the works of the ancients, and as these works were thrown aside too early, before their contents were properly examined, I was induced to suspect that some hints of this colouring property might also be mentioned in them, which indeed is the case.

We learn from the works of Galen and Dioscorides, that the ancient physicians remarked that the use of certain roots, which they administered to their patients, communicated a colour to their urine and excrements; and this observation has been repeated by Cardan, Thurneisser, Porta, Castor, Durantes, and others. Had those ancient physicians, who often prescribed these roots, and paid attention to the colour of the excrements of their

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meant that the hair became red by eating the leaves, he committed a mistake.

[278] Dissertatio de Vita Nuptiisque Plantarum. Lipsiæ, 1741, p. 11.

patients, been accustomed to open their bodies when they died under their hands, they would have perhaps remarked, in human bones, what was observed long after in the bones of animals, when the roots were no longer used in medicine; and what, if I am not mistaken, was never yet observed in the bones of the human species[279].

Böhmer, who made researches respecting the antiquity of this observation, found it neither in Rombert. Dodonæus, Mich. Ettmuller, Morin, Will. Salmon, nor others, who, however, speak of coloured urine. In his opinion the oldest writer who speaks of coloured bones is Mizaldus; but what he relates is all taken from the treatise of Lemnius De Miraculis Occultis Naturæ; and the latter therefore is the oldest writer that I at present can mention as acquainted with this property. He was a physician in Zealand, where madder has been cultivated since the earliest ages, and where he had an opportunity of remarking it. He says that the bones of animals became red, as had been observed when the flesh was dressed, by their eating only the leaves, and not the roots. In the first edition of the above work, printed in octavo, in the year 1559, which consists of two books, this information

[279] I do not know that any one ever remarked human bones to have been dyed by madder, though the proposal for using the roots of it against the rachitis might have given occasion to make observations on that subject. See G. L. Hansen, Diss. de Rachitide. Gottingæ, 1762, p. 36. Professor Arnemann, who has a very numerous and valuable collection of skeletons, and who carefully examined many of the like kind during his travels, assured me that he never saw any bones that had been dyed by madder in the human body.

will not be found; but it may be contained in the second of 1564, which comprehends four books.

[The madder plant is much cultivated in Holland, but Macquei observes that the Dutch were first indebted to the Flemish refugees for their knowledge of the method of preparing this plant. Its culture has often been attempted in England, but always without success[280]. It is also largely cultivated in Alsace and Provence in France, especially near Avignon, in Asiatic Turkey, and in Italy; from which places it is largely exported. The Turkey and Provence madder is procured from *Rubia peregrina*; the remainder from *R. tinctorum*. To prepare the root, which is the part used in dyeing, it is removed from the ground, picked, dried and ground.

Madder contains three distinct colouring principles; two of these are red, viz. alizarine and purpurine, and one, xanthine, is yellow.

Since 1836, two new products have been introduced into commerce, which are destined to replace madder in the operations of dyeing and calico-printing; one is called garancine, the other colorine. Garancine is prepared by washing and macerating madder, and filtering through linen. The grounds are then crushed and mixed with sulphuric acid, equal to half the amount of madder first employed; the acid should be somewhat dilute. It is then poured hot upon the madder, agitated, and when the mixture appears intimate, the temperature is raised to 212°,

[280] On Vegetable Substances, by the Society for the Diffusion of Useful Knowledge.

and maintained for about an hour. It is then again mixed with water, filtered, and thoroughly washed. It is finally pressed, dried and passed through the sieve. This is the process patented by MM. Lagier, Robiquet and Colin, in 1828.

It was first introduced into commerce by the house of Lagier and Thomas, at Avignon, in 1829.

The great advantage of garancine over madder is that it does not change the white, and that the bleaching of the stuffs dyed with it is reduced to a mere nothing. Hot water or bran are the only means used for clearing them. Madder is an adjective colour, that is to say, one which requires to be combined with some basic substance or mordant to render its fixture upon the dye-stuff permanent.]

# JUGGLERS, ROPE-DANCERS, AUTOMATA, ETC

Under this title I comprehend not only those properly called jugglers, who, for the sake of money, by quick and artful motions of their hands, bodies, and limbs, and by various preparations, delude the senses in an agreeable manner, or practise an innocent deception on the spectators, so that they think they hear and see what they do not really hear and see, but also rope-dancers; people who place their bodies in positions according to all appearance dangerous; and those who for pay exhibit animals taught to perform uncommon tricks, as well as automata, which by their concealed construction seem to produce wonderful effects.

But is it worth while to inquire into the antiquity of all these arts, unprofitable to the public, which form the favourite amusements of the populace? The selfish question *cui bono*, which is often thrown out by way of reproach to men of letters, but oftener to naturalists, and even to jurists, when, in their researches, they advance beyond the beaten track, I might easily get rid of by civilly telling the querists to pass over this article if they think they are not likely to derive benefit from it. I might also apologise for employing my time and labour on this subject, by using the words of a certain historian: “Frivola hæc

fortassis cuipiam et nimis levia esse videantur, sed curiositas nihil recusat." I shall however adopt neither of these methods; as I flatter myself that this essay may afford as much amusement as many that are read daily; and that therefore it may not only be excused, but even justified.

Those arts and employments which are most necessary in life were undoubtedly the earliest, and they have still continued to be the most important; but when these were sufficiently occupied, or carried on by as many persons as could live by them, the rest, who were excluded from them, conceived the idea of amusing the former when tired with their labour, that by these means they might obtain from them a part of the fruits of their industry. I request my readers to reflect how many occupations have been devised for no other purpose. They will find that several of these have acquired a pre-eminence over the necessary or useful arts; and to the same class belong jugglers.

All political writers tell us, as a fundamental principle of government, that population ought to be increased. This maxim however is just only under certain circumstances; that is, when employment can be procured to a greater number of inhabitants than a country already possesses. Of beggars we have to maintain too many. All our trades and occupations are not only filled up with workmen, but overflow. Our farmers can employ no more labourers, and our manufacturers no more hands than they have at present; our regiments are full; and in every employment there are more candidates and more supernumeraries than is consistent

with the good of the public. Must it not therefore give us pleasure, when necessity invents new means of acquiring a livelihood, although they could be dispensed with? It is much better that those who have learned no useful art; who have lost their youth in the service of others; or who are destitute, through any other cause, should gain their bread by amusing their fellow-citizens, than that they should either beg or steal.

These arts are indeed not unprofitable, for they afford a comfortable subsistence to those who practise them; but their gain is acquired by too little labour to be hoarded up; and, in general, these roving people spend on the spot the fruits of their ingenuity; which is an additional reason why their stay in a place should be encouraged. I have however known some who saved so much from their earnings, that, in their old age, they were enabled to enter into some business more certain as well as more profitable.

People of this description will never want encouragement and support while they exhibit with confidence anything uncommon, and know how to suit the nature of their amusements to the taste of the spectators. The greater part of mankind love deception so much, that they reward liberally those who impose on their senses, as is proved by the ready sale of gilt articles, artificial gems, and a thousand other things which are not in reality what they appear to be. I do not know whether Montagne is right in considering it as a sign of the weakness of our judgement, that we take a pleasure in beholding objects on account of their

rarity, novelty, or the difficulty that attends them, though they may be subservient to no useful purpose[281]. This appears to me to proceed from that innate curiosity which serves as a spur to incite us to enlarge our knowledge, and to engage in researches and undertakings that often lead to discoveries of greater importance.

Jugglers indeed seldom exhibit anything that can appear wonderful to those acquainted with natural philosophy and mathematics; but these even often find satisfaction in seeing truths already known to them applied in a new manner; and they readily embrace every opportunity of having them further illustrated by experiments. Many however are too precipitate, and attempt to explain before they have sufficiently examined, of which the golden tooth at the end of the sixteenth century, the conjuring-rod at the end of the seventeenth, and the chess-player and speaking-machine at the end of the eighteenth, may serve as instances. But it often happens, that what ignorant persons first employ, merely as a show, for amusement or deception, is afterwards ennobled by being applied to a more important purpose. The machine with which a Savoyard, by means of shadows, amused children and the populace, was by Lieberkühn converted into a solar microscope; and to give one example more, which may convince female readers, if I can hope for such, the art of making ice in summer, or in a heated oven, enables guests, much to the credit of their hostess, to cool the most expensive dishes. The Indian discovers precious stones, and the European,

[281] Essais, i. 54.

by polishing, gives them a lustre.

But if the arts of juggling served no other end than to amuse the most ignorant of our citizens, it is proper that they should be encouraged for the sake of those who cannot enjoy the more expensive deceptions of an opera. They answer other purposes however than that of merely amusing; they convey instruction in the most acceptable manner, and serve as a most agreeable antidote to superstition, and to that popular belief in miracles, exorcism, conjuration, sorcery, and witchcraft, from which our ancestors suffered so severely. Wherever the vulgar were astonished at the effects of shadows, electricity, mirrors, and the magnet, interested persons endeavoured by these to frighten them; and thus misapplied the powers of nature to promote their own advantage. The pontiffs and their clergy ought, undoubtedly, to be detested for discouraging experimental philosophy. That science they considered as a formidable enemy; and they thought they gained no small advantage when they induced the house of Medici, by granting it the cardinalship, to suppress the Academy del Cimento. When Gasner exhibited his deceptions, some one proposed to him to try his art at Berlin or Göttingen, and to drive out there if it were only the smallest of all the devils; but these cities were not theatres where he was likely to succeed, and he never ventured to appear in them[282]. It is however better that the populace, if they will absolutely pay

[282] The juggler mentioned in Xenophon requested the gods to allow him to remain only in places where there was much money and abundance of simpletons.

for being deceived, should be exposed to a momentary deception from jugglers than to a continual deception from priests. As the former are not covered with the sacred cloak of religion, their deceptions are more easily seen through and detected; and they consequently soon cease to be hurtful. So late as the year 1601, a horse, which had been taught to perform a number of tricks, was tried, as possessed by the devil, and condemned to be burnt[283]. At present horses of this kind are so often exhibited publicly in the heretical countries of Europe, that the Spanish Inquisition, perhaps, will soon be ashamed of considering such proofs of the docility of these animals, and of the patient dexterity of their teachers, as the work of the devil, as they did at the above period. Those who view the art of the juggler in the same light as I do, will, I hope, forgive me for introducing these observations, and allow me to continue them while I inquire into the antiquity of this employment; especially as I shall endeavour by these means to illustrate more fully my subject.

Had that book which Celsus wrote against the Magi been preserved, we should have been much better acquainted with the art of the ancient conjurors or jugglers. This Celsus, without

[283] Le Siècle de Louis XIV. Berlin, 1751, 12mo, i. p. 44. This horse was seen in the above-mentioned year by Casaubon, to whom the owner, an Englishman, discovered the whole art by which he had been trained. See Casauboniana, p. 56. We are assured by Jablonski, in his Lexicon der Künste und Wissenschaften, p. 547, that he was condemned to the flames at Lisbon. In the year 1739, a juggler in Poland was tortured till he confessed that he was a sorcerer, and without further proof he was hanged. The whole account of this circumstance may be found in the Schlesischen gelehrten Neuigkeiten for the year 1739.

doubt, is the same author whose virulent attack against the Christians was refuted by Origen; and we have, therefore, greater cause to regret that a work on the above subject, by so learned and acute a philosopher, should have been lost. He is mentioned with respect by Lucian, and even by Origen; and the former derived from him the account which he gives of Alexander the impostor[284]. More ancient authors also wrote upon the same subject. Some of them are mentioned by Diogenes Laërtius in his preface; and Suidas quotes the Magicon of Antisthenes, though neither of these speaks of Celsus; but of all those writings none are now extant.

The deception of breathing out flames, which at present excites in a particular manner the astonishment of the ignorant, is very ancient. When the slaves in Sicily, about a century and a half before our æra, made a formidable insurrection, and avenged themselves in a cruel manner for the severities which they had suffered, there was amongst them a Syrian named Eunus[285], a man of great craft and courage, who, having passed through many scenes of life, had become acquainted with a variety of arts. He pretended to have immediate communication with the gods; was the oracle and leader of his fellow-slaves; and, as is usual on such occasions, confirmed his divine mission by miracles. When, heated by enthusiasm and desirous of inspiring his followers with courage, he breathed flames or sparks among

[284] See Luciani Opera, ed. Bipont. v. pp. 388, 407.

[285] Florus, iii. 19, 4.

them from his mouth while he was addressing them. We are told by historians, that for this purpose he pierced a nut-shell at both ends, and, having filled it with some burning substance, put it into his mouth and breathed through it. This deception, at present, is performed much better. The juggler rolls together some flax or hemp, so as to form a ball about the size of a walnut; sets it on fire; and suffers it to burn till it is nearly consumed; he then rolls round it, while burning, some more flax; and by these means the fire may be retained in it for a long time. When he wishes to exhibit, he slips the ball unperceived into his mouth and breathes through it; which again revives the fire, so that a number of weak sparks proceed from it; and the performer sustains no hurt, provided he inspire the air not through the mouth, but the nostrils[286].

By this art the rabbi Bar-Cocheba, in the reign of the emperor Hadrian, made the credulous Jews believe that he was the hoped-for Messias[287]; and two centuries after, the emperor Constantius was thrown into great terror, when Valentinian informed him that he had seen one of the body-guards breathing out fire and flames in the evening[288].

For deceptions with fire the ancients employed also naphtha,

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[286] Directions for performing this trick may be found in various works, such as Joh. Wallbergen's Zauberkünste, Stuttgard, 1754, 8vo, and Natürliches Zauberbuch, Nurnberg, 1740, 8vo.

[287] See Bayle's Diction. i. p. 450, art. Barchochebas.

[288] Philostorgii Hist. Eccles. vii. 7, p. 93.

a liquid mineral oil, which kindles when it only approaches a flame. Galen informs us, that a person excited great astonishment by extinguishing a candle and again lighting it, without any other process than holding it immediately against a wall or a stone. The whole secret of this consisted in having previously rubbed over the wall or stone with sulphur. But as the author, a few lines before, speaks of a mixture of sulphur and naphtha, there is reason to think that he alludes to the same here. Plutarch[289] relates how Alexander the Great was astonished and delighted with the secret effects of naphtha, which were exhibited to him at Ecbatana. The same author, as well as Pliny, Galen, and others, has already remarked, that the substance with which Medea destroyed Creusa, the daughter of Creon, was nothing else than this fine oil[290]. She sent to the unfortunate princess a dress besmeared with it, which burst into flames as soon as she approached the fire of the altar. The blood of Nessus, wherein the dress of Hercules, which took fire likewise, had been dipped, was undoubtedly naphtha also[291]; and this oil must have been always employed when offerings caught fire in an imperceptible manner[292]. In all periods of the world priests have acted as jugglers to simple and ignorant people.

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[289] Vita Alexandri, p. 687.

[290] Galen, *l. c.*

[291] Ovid. Met. lib. ix. 160.

[292] Instances may be found collected in Huetii Alnetanæ Quæstion. lib. ii. and in Bayle's Dictionary, art. Egnatia.

In modern times, persons who could walk over burning coals or red-hot iron, or who could hold them in their hands and their teeth, have often excited wonder. In the end of the seventeenth century, an Englishman, named Richardson, who, as we are assured, could chew burning coals, pour melted lead upon his tongue, swallow melted glass, &c., rendered himself very famous by these extraordinary feats[293]. Laying aside the deception[294]

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[293] Journal des Sçavans, 1667, pp. 54, 222; and 1680, p. 292. Deslandes, Mémoires de Physique, ii. and Bremenscher Magazin, i. p. 665. See also Busbequii Omnia, Basil, 1740, 8vo, p. 314.

[294] [Deception might have been easily practised in this case. Fusible metal, as suggested by Sir David Brewster, Nat. Magic, p. 301, which consists of mercury, tin and bismuth, and which melts at a low temperature, might easily have been substituted in place of lead; and fluids, the boiling-point of which is lower than water, might easily have been substituted for that liquid.A solution of spermaceti in sulphuric æther, tinged with alkanet root, which solidifies at 50° F., and melts and boils with the heat of the hand, is supposed to be the substance which is used at Naples, when the dried blood of St. Januarius melts spontaneously and boils over the vessel which contains it.The experiments of M. Tillet, Dr. Fordyce and Sir Charles Blagden, will show the great heat which may be endured by the human body. Some of these gentlemen remained in a room where the heat was one or two degrees above 260° F. for eight minutes; a beaf-steak was cooked in the same atmosphere, and was overdone in thirty-three minutes; when the steak was blown upon with a pair of bellows, it was found to be pretty well done in thirteen minutes. But Sir F. Chantry exposed himself to a still greater heat in the furnace used for drying his moulds. When raised to its highest temperature, the thermometer indicated 350° F., and the iron floor was red-hot. The workmen often entered it at 340°. On one occasion Sir F., accompanied by five or six of his friends, entered the furnace, and after remaining two minutes, they brought out a thermometer which indicated 320°. Some of the party experienced sharp pains in the tips of their ears, and in the septum of the nose, whilst others felt a pain in their eyes. – Brewster, *l. c.*]

practised on the spectators, the whole of this secret consists in rendering the skin of the soles of the feet and hands so callous and insensible, that the nerves under them are secured from all hurt, in the same manner as by shoes and gloves. Such callosity will be produced if the skin is continually compressed, singed, pricked, or injured in any other manner. Thus do the fingers of the industrious sempstress become horny by being frequently pricked; and the case is the same with the hands of fire-workers, and the feet of those who walk bare-footed over scorching sand[295].

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[295] [The peculiar property of minerals and various salts, as alum, in forming and protecting articles of dress, &c. from the effects of fire, has long been known. But the art of practically applying it, is due to the ingenuity of the Chevalier Aldini of Milan. His dress consisted of a strong cloth covering which had been steeped in a solution of alum, for the body, arms and legs; whilst the head-dress was a large cap enveloping the whole head down to the neck, with holes for the nose, eyes and mouth; the covering for the feet was composed of asbestos, or amianthus cloth. The stockings and cap were single, but the gloves were double, to enable the fireman to take burning or red-hot bodies into his hands. A metallic dress was added to this, consisting of a cap, with a mask, leaving a space between it and the asbestos cap; a cuirass; a piece of armour for the trunk and thighs; a pair of boots of double wire-gauze; and an oval shield five feet long by two and a half wide, made by stretching the wire-gauze over a slender frame of iron. All these pieces were made of wire-gauze.It was found, that when armed with this apparatus, a man could walk upon hot iron, in the midst of high flames, keep his head over a pan of flaming fire, &c. for several minutes, and this in some cases where the heat was so intense that bystanders were obliged to stand at the distance of eight or ten yards. This was remarkably shown in 1829, in the yard of the barracks of St. Jervais. Two towers were erected, two stories high, and were surrounded with heaps of inflamed faggots and straw. One of the firemen, with a child on his back, in a wicker basket covered with metallic gauze, and having a cap of amiantheric cloth, rushed into a narrow place, where the flames were raging eight yards high. The violence of the

In the month of September, 1765, when I visited the copper-works at Awestad, one of the workmen, for a little drink-money, took some of the melted copper in his hand, and after showing it to us, threw it against a wall[296]. He then squeezed the fingers of his horny hand close to each other; put it a few minutes under his armpit, to make it sweat, as he said; and, taking it again out, drew it over a ladle filled with melted copper, some of which he skimmed off, and moved his hand backwards and forwards, very quickly, by way of ostentation. While I was viewing this performance, I remarked a smell like that of singed horn or leather, though his hand was not burnt. The workmen at the Swedish melting-houses showed the same thing to some travellers in the seventeenth century; for Regnard saw it in 1681, at the copper-works in Lapland. It is highly probable that the people who hold in their hands red-hot iron, or who walk upon it, as I saw done at Amsterdam, but at a distance, make their skin callous before, in the like manner. This may be accomplished by frequently moistening it with oil of vitriol; according to some the juice of certain plants will produce the same effect; and we are assured by others that the skin must be very frequently rubbed, for a long time, with oil, by which means, indeed, leather also will become horny.

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fire was so great that he could not be seen, while a thick black smoke spread around, throwing out a heat which was insupportable to the spectators. The man remained so long invisible that serious doubts were entertained of his safety. He at length, however, issued from the fiery gulf uninjured.]

[296] The same thing was performed by Schreber in 1760.

Of this art, traces may be found also in the works of the ancients. A festival was held annually on Mount Soracte, in Etruria, at which the Hirpi, who lived not far from Rome, jumped through burning coals; and on this account they were indulged with peculiar privileges by the Roman senate[297]. Women also, we are told, were accustomed to walk over burning coals at Castabala in Cappadocia, near the temple dedicated to Diana[298]. Servius remarks, from a work of Varro now lost, that the Hirpi trusted not so much to their own sanctity as to the care which they had taken to prepare their feet for that operation.

I am not acquainted with everything that concerns the trial by ordeal, when persons accused were obliged to prove their innocence by holding in their hands red-hot iron; but I am almost convinced that this also was a juggling trick of the priests, which they employed as might best suit their views. It is well known that this mode of exculpation was allowed only to weak persons, who were unfit to wield arms, and particularly to monks and ecclesiastics, to whom, for the sake of their security, that by single combat was forbidden. The trial itself took place in the church entirely under the inspection of the clergy; mass was celebrated at the same time; the defendant and the iron were consecrated by being sprinkled with holy water; the clergy made the iron hot themselves; and they used all these preparatives, as jugglers do many motions, only to divert the attention of

[297] Plin. vii. 11. – Virg. Æn. xi. – Silius Ital. v. – Strabo, v.

[298] Strabo, xii.

the spectators. It was necessary that the accused persons should remain at least three days and three nights under their immediate care, and continue as long after. They covered their hands both before and after the proof; sealed and unsealed the covering: the former, as they pretended, to prevent the hands from being prepared any how by art; and the latter to see if they were burnt.

Some artificial preparation was therefore known, else no precautions would have been necessary. It is highly probable that during the first three days the preventive was applied to those persons whom they wished to appear innocent; and that the three days after the trial were requisite to let the hands resume their natural state. The sacred sealing secured them from the examination of presumptuous unbelievers; for to determine whether the hands were burnt, the last three days were certainly not wanted. When the ordeal was abolished, and this art rendered useless, the clergy no longer kept it a secret. In the thirteenth century an account of it was published by Albertus Magnus, a Dominican monk[299]. If his receipt be genuine, it seems to have consisted rather in covering the hands with a kind of paste than in hardening them. The sap of the *Althæa* (marsh-mallow), the slimy seeds of the flea-bane, which is still used for stiffening by the hat-makers and silk-weavers, together with the white of an egg, were employed to make the paste adhere; and by these means the hands were as safe as if they had been secured by

[299] In his work De Mirabilibus Mundi, at the end of his book De Secretis Mulierum, Amstelod. 1702, 12mo, p. 100.

gloves. The use of this juggling trick is very old, and may be traced back to a pagan origin. In the Antigone of Sophocles, the guards placed over the body of Polynices, which had been carried away and buried contrary to the orders of Creon, offered, in order to prove their innocence, to submit to any trial: "We will," said they, "take up red-hot iron in our hands, or walk through fire[300]."

The exhibition of balls and cups, which is often mentioned in the works of the ancients as the most common art of jugglers, is also of great antiquity. It consists in conveying speedily and with great dexterity, while the performer endeavours by various motions and cant phrases to divert the attention of the simple spectators from observing his movements too narrowly, several light balls, according to the pleasure of any person in company, under one or more cups; removing them sometimes from the whole; and conveying them again back in an imperceptible manner. In general, three leaden cups are used, and as many balls of cork; and to prevent all discovery by their slipping from the thumbs of the juggler, or making a noise, as he must lay hold of them with much quickness, the table before which he sits is covered with a cloth.

These small balls were by the ancients called *calculi*; and the cups *acetabula*, or *paropsides*. Casaubon[301] has already quoted most of those passages in ancient authors which relate

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[300] Antigone, 270.

[301] Animad. in Athen. lib. i. 15.

to this subject; and they have been repeated by Bulenger[302]; but neither of these writers makes mention of the fullest and clearest description given in the letters of Alciphron[303]. We have there an account of a countryman who came to town, and was conducted by a merchant to the theatre, where he saw with great astonishment the exhibition of cups and balls. "Such an animal," says he, "as the performer I would not wish to have near me in the country; for in his hands my property would soon disappear." The art of oratory, because it deceives the auditors, is frequently compared to that of balls and cups. From the Latin word *gabata*, mentioned by Martial, together with *paropsides*, the French have made *gobelets* and hence their common expressions *jouer des gobelets*, and *joueur des gobelets*, which they use when speaking of jugglers.

In all ages of the world there have been men who excited great wonder by extraordinary strength. Instances of this have been already collected; but they do not belong to my present subject[304]. I can, however, prove that above fifteen hundred years ago there were people who, by applying a knowledge of the mechanical powers to their bodies, performed feats which astonished every ignorant spectator; though it is certain that any

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[302] De Theatro, lib. i. 40, in Grævii Thes. Ant. Rom. ix.

[303] Lib. iii. epist. 20. – Seneca, Epist. 45. Compare Suidas, Pollux, and Athenæi Deipn. 4. It is probable that Quintilian alludes to this art in his Institut. x. 7, 11.

[304] Plin. vii. 20, p. 385. – Martial. v. 12. – Suidas, speaking of Theogenes Thasius. – Haller, Elem. Physiol. iv. p. 486.

sound man of common strength could perform the same by employing the like means. Of these one may say with Celsus, "Neque hercule scientiam præcipuam habent hi, sed audaciam usu ipso confirmatam."

About the beginning of the last century, such a strong man, or Samson, as he called himself, a native of Germany, travelled over almost all Europe; and his pretended art has been mentioned by so many writers, that we may conclude it had not been often exhibited before; and that it was then considered as new. His name was John Charles von Eckeberg; he was born at Harzgerode in Anhalt; and at that time was thirty-three years of age. When he fixed himself between a couple of posts, on any level place, two or more horses were not able to draw him from his position; he could break ropes asunder, and lift a man up on his knee while he lay extended on the ground. But what excited the greatest astonishment was, that he suffered large stones to be broke on his breast with a hammer, or a smith to forge iron on an anvil placed above it.

This last feat was exhibited even in the third century, by Firmus or Firmius, who, in the time of Aurelian, endeavoured to make himself emperor in Egypt. He was a native of Seleucia in Syria; espoused the cause of Zenobia, the celebrated queen of Palmyra; and was at length executed publicly by order of the emperor Aurelian. It is of this Firmus, and not of another, who a century after was overcome in Africa by the father of the emperor Theodosius, that Vopiscus speaks where he relates that

he could suffer iron to be forged on an anvil placed on his breast. For this purpose he lay on his back; but he put himself in such a position, by resting with his feet and shoulders against some support, that his whole body formed an arch; so that he seemed rather to be suspended than to lie at full length[305]. This art, which is explained and illustrated by Desaguliers[306] and Professor Kuhn[307] of Dantzic, has now become so common that it is often exhibited without occasioning much surprise.

In the works of the ancients, rope-dancers are frequently mentioned. The passages where they occur have been collected by various authors, though never completely; and I am inclined to think that those who have seen many performers of this kind would be able to clear up some that are obscure. I have seen many myself; but I have forgot the greater part of what I observed; and there are other reasons also which prevent me from undertaking that task: I dread the reproach of "multum agendo nihil agis." That I may not, however, pass over this subject

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[305] Vopiscus, Vita Firmi. See the figure in Desaguliers, tab. xix. fig. 5. He describes the position thus: – The pretended Samson puts his shoulders (not his head, as he used to give out) upon one chair, and his heels upon another (the chairs being made fast), and supports one or two men standing on his belly, raising them up and down as he breathes, making with his backbone, thighs and legs, an arch whose abutments are the chairs.

[306] A course of Experimental Philosophy. Lond. 1745, 4to, i. p. 266. [A popular account of these extraordinary feats, with illustrations and explanations of the principles on which they depend, is given by Sir David Brewster in his interesting volume on Natural Magic, p. 246.]

[307] Versuche und Abhandl. der Naturforsch. Geselsch. in Danzig.

entirely, I shall present the reader with what follows[308]. We meet with various appellations given to rope-dancers, which do not, as some have imagined, point out different kinds, but allude only to new-invented arts, leaps, or dexterities, which, while recommended by novelty, were much wondered at, though they were afterwards imitated by all. To these belong the *schœnobatæ*, *oribatæ*, *neurobatæ*, *petaminarii*, *funambuli*, &c. Some of the ancient rope-dancers seem to have used a balancing-pole, or at least to have had weights in their hands to preserve an equipoise[309]. It is certain also that rope-dancers were not wanting in the middle ages. In the year 1237 they were very common in Italy[310]; and in 1393 there were some of them at Augsburg, who exhibited their dexterity on the rope, and received from each spectator three German halfpence[311].

To place men upon the shoulders of each other in such a manner that every row consists of a man fewer, till they form a pyramid ending in a single person, upon whose head a boy often stands with his feet upwards, is likewise an ancient piece of dexterity. This exhibition is varied many ways; and on that

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[308] A great many of these passages of the ancients have been collected by Bulenger, in his work De Theatro, i. cap. 41. See also Des Camps in a dissertation contained in Recherches Curieuses d'Antiquité, par Spon. A Lyon 1683. – Mercurialis De Arte Gymnast. and Fabricii Biblioth. Antiq. p. 995.

[309] An epigram, ascribed to Petronius, at page 542 of the edition of Hadrianides, belongs to this subject.

[310] Muratori Antiquit. Ital. Med. Ævi, ii. p. 846.

[311] Von Stetten, Kunstgeschichte von Augsburg, ii. p. 177.

account it is difficult to form even conjectures respecting it, especially as the description given of it by a Roman poet is very unintelligible[312].

I am however still less acquainted with an art in which hoops and wheels were employed by the *petauristæ*, who excited great astonishment among the populace. The first part of the art may have consisted in nothing more than the varied contortions and tumbling which we still see practised by children trained for that purpose. Cilano explains a well-known passage of Manilius, as if the performers had darted through suspended iron hoops, made often red-hot. Of this I entertain less doubt than how we ought to understand the *corpora jactata petauro* of Juvenal[313]; and the *corpora valido excussa petauro* of Manilius[314], which many have attempted to explain already. At any rate this wheel was different from that upon which a female dancer, as mentioned by Xenophon, wrote and read while it turned round with great velocity[315].

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[312] Claudian. de Mallii Consul. 320. In Cilano's Römischen Alterthümer, ii. fig. 8, there is a representation like what I have often seen exhibited. But the most dangerous and the most curious is that of which an engraving is given in Splendor Urbis Venetiarum, to be found in Grævii Thesaurus Antiquit. Italiæ, v. 3. p. 374.

[313] Sat. xiv. 265.

[314] Lib. v. 433.

[315] Symposium, p. 655, edition of Basle, 1555. fol. Εἰσεφέρετο τῇ ὀρχηστρίδι τροχὸς τῶν κεραμεικῶν ἐφ' οὗ ἔμελλε θαυμασιουργήσειν. In the old edition of J. Ribittus, this passage is thus translated: "Allata est saltatrici orbis saltatorius, in quo admiranda erat editura." The first question that arises is, what was τροχὸς τῶν κεραμεικῶν. The last word alluded to a place at Athens where wrestling was

The art of exhibiting various feats of horsemanship, which has been practised so much in modern times, seems to have come first from the East. At any rate, those performers in that way who, in the thirteenth century, were at the Byzantine court, and who travelled all over Europe, came from Egypt. They could stand on the horses when at a gallop; mount and dismount while on full speed at the chase; tumble on horseback, and do many other things equally extraordinary[316]. At the end of the sixteenth century, an Italian, who had learned this art while a slave in

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exhibited every year; and on that account Aristophanes uses the expression πληγαὶ κεραμεικαί. This however affords no explanation. Bulenger, who quotes the same passage, translates it in the following manner: "Illata est saltatrici figularis rota, per quam se trajiceret, et miracula patraret." He means here therefore a potter's wheel, the invention of Anacharsis, but that was always called κεραμικὸς τροχὸς, and not τροχὸς τῶν κεραμεικῶν. But even allowing that a potter's wheel is meant, it is wrong to add *per quam se trajiceret*; for the potter's wheel is not like a hoop, but like a plate or dish; and when turned round revolves not vertically, but horizontally. Besides, how the performer could write or read on a wheel that she jumped through, he has not thought proper to explain. "Scribere et legere in rota dum versatur, mirabile quiddam est." If a potter's wheel be meant, I consider it as certainly possible for a person to stand upon it whilst it revolves with the greatest velocity, and even to read or write; but it would be necessary to lift up the legs, in turn, with the utmost quickness.

[316] Nicephorus Gregor. viii. 10. p. 215. This company of rope-dancers came from Egypt. They travelled through the greater part of Asia, and all Europe, as far as the extremity of Spain. At Constantinople they extended the ropes, on which they first exhibited their art, between the masts of ships. One is almost induced to believe that stupid superstition did not then prevail so much in Europe as at the beginning of the last century. The historian says that the company at first consisted of forty persons; but that the half of them were cast away on their passage to Constantinople. He does not, however, tell us that they or their horses were anywhere burnt as conjurors, or possessed with the devil.

Turkey, went about exhibiting his dexterity in various parts of Europe. Montagne saw him at Rome in 1581[317]; and the year following he was at Paris[318]. Some of these feats were performed by the ancient *desultores*.

Whether the ancients taught horses, dogs, birds, and other animals, to perform various tricks which are frequently exhibited at present for money, I do not know; but it is certain that what they made the elephant, which undoubtedly is the most sagacious and tractable of all animals, perform, exceeds everything yet known of the kind. Without repeating what has been so often related, I shall only mention the elephant which walked upon a rope backwards and forwards, as well as up and down; and which Galba first caused to be shown to the Roman people. After this, so much confidence was placed in the dexterity of the animal, that a person sat on an elephant's back while he walked across the theatre upon a rope extended from the one side to the other. Lipsius, who has collected the testimonies, thinks they are so strong that they cannot be doubted[319].

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[317] See the German translation of his Travels, ii. p. 238.

[318] Journal du Règne de Henri III. p. 57. – Recueil de Pièces servant à l'Hist. de Henri III. Cologne, 1666, 12mo.

[319] Epistolarum Selectarum Centuria. Antverpiæ, 1605, 4to, i. epist. 50. p. 59. – Plin. viii. 1 and 3. – Seneca, epist. 86. – Suetonii Vit. Galbæ. – Dio Cassius. A great many also may be found collected in Hartenfels Elephantographia, Erfordiæ, 1715, 4to. It appears that in the thirteenth century some ventured to ride a horse upon a rope. See the Chronicle Alberichi Monachi Trium-Fontium, inserted by Leibnitz in Accessiones Historicæ, vol. ii., where a description is given of the solemnities at the wedding of Robert, brother to the king of France, in the year 1237.Several instances

The training of horses to obey a private signal, imperceptible to the most attentive spectator, and to perform actions which appear, to those unacquainted with the art, to display rational faculties, I have never found mentioned in the works of the ancients. That the Sybarites however taught their horses to dance to the sound of music, is asserted by a variety of authors[320]. In the sixteenth century, dogs trained in the like manner excited great wonder[321].

In the year 1766, an Englishman, named Wildman, made himself much known by taming or training bees, in such a manner that they not only followed him wherever he went, but settled even on his face and hands without stinging him, and seemed as if obedient to his orders[322]. Some years after, a person who practised the like art, travelled about through Germany, and gave himself out to be Wildman; but M. Riem proved that he was not Wildman, and published the secret by which he acquired so much power over these insects[323]. I cannot say

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of the dexterity of the elephant may be found in Lipsii Laus Elephantis, inserted in Dissertat. Ludicrarum et Amœnitatum Scriptores varii, Lugd. Bat. 1638. – Trans.

[320] Æliani Hist. An. xvi. 23. vi. 10. – Athenæus, lib. xii. – Plinius.

[321] One instance may be found in Theophanis Chronographia, which was printed at Paris 1655, fol. It occurred in the seventeenth year of the reign of Justinian, or 543.

[322] Universal Magazine, 1766, October, p. 217.

[323] Der entlarvte Wildman, Betrüger grosser Höfe. Berlin, 1774, 8vo. See also Göttingische Gelehrte Anzeig. 1775, p. 816. The name of *impostor* given to Wildman was, however, too harsh; for I do not think that he who performs anything extraordinary, never done by any one before, becomes an impostor when another discovers his art.

whether the ancients were acquainted with this art; but I shall here remark, that it was known in the kingdom of Galam, at Senegal, a hundred years before Wildman; for when Brue, a Frenchman, was there in 1698, he was visited by a man who called himself the king of the bees[324]. "Let his secret," says that traveller, "consist in what it may, this much is certain; that they followed him wherever he went, as sheep do their shepherd. His whole body, and particularly his cap, was so covered with them that they appeared like a swarm just settled. When he departed they went along with him; for besides those on his body, he was surrounded by thousands which always attended him[325]."

In modern times, persons destitute of arms and hands, or who have these limbs formed very imperfectly, but who possess the art of supplying that want by the use of their feet and toes, show themselves sometimes for money; and as they entertain the spectators by exciting their wonder, they deserve from them that support which they are not able to obtain in any other manner. Instances of such people who had acquired this art, have been very common within the last two centuries[326]; but in the works of

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[324] The voyage of Brue is in Labat's Afrique Occidentale, iv.

[325] [A curious exhibition of this kind has been made public for several years in the Strand, viz. the "industrious fleas." These noxious animals are here seen to draw and drive a coach and four; fire off a small cannon; and various other performances of a similar kind.]

[326] Several instances of the like kind may be found also in Monstrorum Historia Memorabilis a J. G. Schenkio a Grafenberg filio, Francof. 1609, 4to, p. 28 *et seq.* One of the most curious is that of Thomas Schweicker, born at Halle in Prussian Saxony,

the ancients I have found only one. An Indian king, named Porus, sent to the emperor Augustus an embassy with presents, among which were some rare animals, and a man without arms, who with his feet, however, could bend a bow; discharge arrows; and put a trumpet to his mouth and blow it. Dio Cassius confesses that he did not know how this was possible; but Strabo refers for his authority to Nicolaus of Damascus, who saw all the presents as they passed through Antioch[327]. Had this deformed person, whom Strabo compares to a Hermes, travelled about, according to the modern practice, as a show, he would have been better known, and in all probability his example would have induced others to imitate his art[328]. Manilius says, however, that there were people, who, in playing at ball, could use their feet with as much dexterity as their hands, who could catch the ball with them, and again throw it back; but the poet, perhaps, did not allude to the small hand-ball, but to the large one which is struck with the fist, and which may be stopped also by the foot. Besides,

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in the year 1586. Camerarius saw him not only write, but even make a pen with his feet. – Trans.

[327] Strabo, lib. xv. p. 1048. ed. Almel. – Dio Cassius, lib. liv. p. 739. Suetonius, Eutropius, Eusebius and Orosius, speak of this embassy, but make no mention of the presents.

[328] [In modern times the idle portion of the public has been gratified by the exhibition of the Siamese twins; the diminutive monster Tom Thumb; and quite recently a child with three legs. The birth of such monsters is equivalent to a legacy or fortune to the parents, who by their exhibitions realise large sums: the morbid taste of the public, especially the weaker portion, for such sights is truly deplorable.]

the passage is read and explained different ways[329].

Figures or puppets, which appear to move of themselves, were employed formerly to work miracles; but they could hardly be used for that purpose at present in any catholic country of Europe, though they still serve to amuse the vulgar. Among these are the *marionettes*[330], as they are called, the different parts of which are put in motion imperceptibly by a thread. Of a still more ingenious construction are those which are moved by the turning of a cylinder, as is the case in the machines with which some of the old miners in Germany earn a livelihood; but the most ingenious of all are those which are kept in continual movement for a certain time, by the help of wheels with a weight or spring. The latter are called *automata*; and, when they represent human figures, *androides*. Under the former general name are comprehended our watches, the most useful of all, and also jacks[331], with many others. The latter appellation is

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[329] Man. Astron. lib. v. 165.

[330] Frisch derives this word from *morio*, a fool or buffoon.

[331] This piece of kitchen furniture was known in the middle of the sixteenth century. Montagne saw one at Brixen, in Tyrol, in the year 1580, and wrote a description of it in his Journal, as a new invention. He says it consisted entirely of wheels; that it was kept in motion by a heavy piece of iron, as clocks are by a weight, and that when wound up in the like manner, it turned the meat for a whole hour. He had before seen, in some other place, another driven by smoke. – Reise, i. pp. 155, 249. The latter kind seem to be somewhat older. Scappi, cook to pope Pius V., gave a figure of one in his book Opera di M. Bartolomeo Scappi, printed at Venice 1570, which is exceedingly scarce. I lately saw a copy, which, instead of eighteen, had twenty-four engravings. It was printed twice afterwards at the same place, viz. in 1571 and 1605, in quarto. The

given to small puppets, which, when their inner works have been wound up, run upon the table or pavement, and as they advance move their head, eyes, and hands. They have been exhibited sometimes under the name of *courrante Margarethe*, which gave rise perhaps to the word *marionette*.

The proper *marionettes* are very old. They were common among the Greeks, and from them they were brought to the Romans. They were known by the name of *neurospasta*, and were much used at their shows. Aristotle speaks of some which moved their head, eyes, hands and limbs in a very natural manner[332]. They are mentioned with equal precision by Galen, Xenophon, Antoninus, Horace, Gellius, and others. To these belong the *phalli*, which were carried round during the festivals of Osiris and Bacchus, and of which one member only, that properly meant by the name, and which was almost as large as the whole body, moved upon certain threads being pulled[333]. Count Caylus has given an engraving of the body of a small puppet, made of ivory or bone; but he requires too much when he desires us to consider that fragment, merely on his word, as a piece of Greek or Roman antiquity. He at least ought to have informed us where it was

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third edition says, "con due aggiunte, cio é il Trinciante et il Maestro di casa." Bayle seems to confound this book with that of Platina De Honesta Voluptate, or to think that the latter was the real author of it. This however cannot be, as there were more than a hundred years between the periods when Scappi and Platina lived. Platina died in 1481, and not in 1581, as we read in Bayle.

[332] De Mundo. cap. vi.

[333] Herodot. ii. 48. p. 127. – Lucian. de Syria Dea, 16, ed. Bipont. ix. p. 99.

found, and by what means he procured it. In regard to such articles, it is as easy to deceive as to be led into an error; and objects of bone are certainly of no great duration[334].

The question concerning the antiquity of automata, properly so called, which are moved by wheels, weights and springs, I shall leave to those who have read the works of the ancient mathematicians, and who may be desirous of writing on the history of mechanics. As far as I know, the ancients were not acquainted with the art of making them, unless some propositions of Ctesibius, mentioned by Vitruvius, allude to that subject. When clocks were brought to perfection, some artists added to them figures, which at the time of striking performed various movements; and as they succeeded in these, some attempted to make, detached from clocks, single figures, which either moved certain limbs, or advanced forward and ran. In the middle of the sixteenth century, when Hans Bullmann[335], a padlock-maker at Nuremberg, constructed figures of men and women which moved backwards and forwards by clock-work, beat a drum, and played on the lute according to musical time, they excited universal astonishment as a new invention. It was about the same period that watches came into use. The accounts however which speak of much older automata deserve to be examined with more attention.

The most ancient of all are undoubtedly the tripods

[334] Recueil des Antiquit. iv. p. 259.

[335] Doppelmayer, p. 285.

constructed by Vulcan[336], which being furnished with wheels, advanced forwards to be used, and again returned to their places. But what was impossible to the gods of Homer? An unbeliever might conjecture that these tripods, which are mentioned also by Aristotle[337], and which perhaps were only a kind of small tables or dumb-waiters, had wheels so contrived that they could be put in motion and driven to a distance on the smallest impulse, like the fire-pans in our country beer-houses, at which the boors light their pipes.

That Dædalus made statues which could not only walk, but which it was necessary to tie, in order that they might not move, is related by Plato[338], Aristotle, and others. The latter speaks of a wooden Venus, and remarks that the secret of its motion consisted in quicksilver having been poured into it. What the author here means I cannot comprehend; but I do not imagine that this Venus threw itself topsy-turvy backwards, like the Chinese puppets. However this may be, it is astonishing that the Chinese should have fallen upon the invention of giving motion to puppets by means of quicksilver, and in so ingenious a manner, that Muschenbroek[339] thought it worth his while to describe their whole construction, and to illustrate it by figures. But before this

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[336] Iliad, xviii. 373. It deserves to be remarked, that there were also such τρίποδες αὐτόματοι at the banquet of Iarchas. See Philostrat. Opera, ed. Olearii, pp. 117, 240.

[337] Polit. i. 3.

[338] In his Menon, p. 426. – Euthyphron, pp. 8, 11.

[339] Introd. in Philos. Nat. i. p. 143.

method was known in Europe, Kircher had an idea of putting a small waggon in motion by adding to it a pipe filled with quicksilver, and heating it with a candle placed below it[340]. The account of Aristotle is more mysterious, for he does not inform us how the quicksilver acted.

Callistratus, another writer, who was the tutor of Demosthenes, gives us to understand that the statues of Dædalus were made to move by the mechanical powers[341]. But what has been asserted by Palæphatus, and by Gedoyn[342], Banier, Goguet, and others among the moderns, is most probable. The first statues of the Greeks were imitations of those of the Egyptians, for the most part clumsy figures, with their eyes shut, their arms hanging down close to the body on each side, and their feet joined together. Those made by Dædalus had their eyes open, as well as their feet and hands free; and the artist gave them such a posture, that they seemed either reclining, or appeared as if ready to walk or to run. As Anacreon[343], struck with wonder, exclaimed when he saw a waxen image of his favourite object, "Begone, wax, thou wilt soon speak!" the astonished Greeks in like manner cried out, when they beheld the statues of Dædalus, "They will soon walk." The next generation affirmed that they really walked; and their posterity, adding still to what was told them, asserted that they

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[340] Physiologia Kircheriana, fol. p. 69.

[341] In Philostrati Opera, ed. Olearii, p. 899.

[342] In Mém. de l'Acad. des Inscr. xiii. p. 274.

[343] Ode xxvii.

would have run had they not been bound.

Equally imperfect is the account given of the wooden pigeon constructed by Archytas of Tarentum. We are informed that it flew; but when it had once settled, it could not again take flight. The latter is not incredible; but even if we allow that aërostatic machines were then known, it is impossible to believe the former. At present one cannot determine with any probability, what piece of mechanism gave rise to this relation[344]. The head of Albertus Magnus, which is said not only to have moved, but to have spoken, is too little known for any opinion to be formed concerning it. The construction of it must have been very ingenious and complex, if it be true that he was employed upon it thirty years[345].

In the fourteenth and following centuries, automata, as I have said, were frequently made. Among these was the iron fly of John Müller or Molitor, or, as he is sometimes called, Regiomontanus, which is said to have flown about; and his artificial eagle, which flew to meet the Emperor Maximilian on his arrival at Nuremberg, June the 7th, 1470. None of the contemporary writers, however, though they often speak of this very learned man, make the least mention of these pieces of mechanism; and it is probable that the whole tale originated with

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[344] Aulus Gellius, x. 12.

[345] See Naudé's Apology, Bayle's Dictionary, &c. Thomas Aquinas is said to have been so frightened when he saw this head, that he broke it to pieces, and Albertus thereupon exclaimed, "Periit opus triginta annorum!"

Peter Ramus[346], who never was at Nuremberg till the year 1571. J. W. Baier[347] endeavours to prove that the above-mentioned fly, moved by wheel-work, leaped about upon a table; and that the eagle perched upon the town-gate, stretched out its wings on the emperor's approach, and saluted him by an inclination of its body. We know that Charles V., after his abdication, amused himself during the latter period of his life with automata of various kinds[348].

The most ingenious, or at least the most celebrated automata, were those made by Vaucanson, which he exhibited publicly at Paris, for the first time, in 1738. One of them, which represented a flute-player sitting, performed twelve tunes, and, as we are assured, by wind issuing from its mouth into a German-flute, the holes of which it opened and shut with its fingers. The second was a standing figure, which in the like manner played on the Provençal shepherd's pipe, held in its left hand, and with the right beat upon a drum or *tambour de Basque*. The third was a duck, of the natural size, which moved its wings, exhibited all the gestures of that animal, quacked like a duck, drank water, ate corn, and then after a little time let drop behind it something

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[346] Schol. Mathemat. lib. ii. p. 65.

[347] Dissertat. de Regiomontani Aquila et Musca Ferrea. Altorfi, 1709. – See Mémoires de Trevoux, 1710, Juillet, p. 1283. – Doppelmayer, p. 23. – Fabricii Bibl. Med. Ætat. iv. p. 355. – Heilbronner Hist. Math. p. 504.

[348] Strada De Bello Belgico. Mogunt. 1651, 4to, p. 8. He calls the artist Jannellus Turrianus Cremonensis.

that resembled the excrement of a duck[349]. These pieces must have been often imitated. I saw some of the like kind in the year 1764, at the palace of Zarsko-Selo, near Petersburg, and was told that they had been purchased from Vaucanson[350]. As far as I can remember, the tambourin was damaged. I saw there also a regiment of soldiers, which went through their exercise, moved by wheel-work[351].

In the year 1752, one Du Moulin, a silversmith, travelled about through Germany with automata like those of Vaucanson. In 1754, he wished to dispose of them to the margrave of Bayreuth; but he was obliged to pawn them in Nuremberg, at the house of Pfluger, who offered to sell them for 3000 florins, the sum lent upon them. They were afterwards purchased by counsellor Beireis, at Helmstadt, who kindly showed them to me. It is much to be regretted that the machinery of them is

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[349] In the year 1738, Le Méchanisme du Fluteur Automate, par Vaucanson, was printed at Paris, in a thin 4to. It contains only a short description of the flute-player, which is copied into the Encyclopédie, i. p. 448, under the article Androide. The duck, as far as I know, has been nowhere described.

[350] Vaucanson died at Paris in 1782.

[351] [The publisher is in possession of an elegantly formed mechanical bird-cage, in which two artificial bullfinches wheel about on a perch, flutter their wings, and move their beaks, while emitting musical sounds in imitation of their natural note. A fountain constructed of spiral glass plays in the centre. Beneath the cage is a clock which sets the whole in motion hourly, for three or four minutes; but it may be set going independently, like a musical snuff-box. It is presumed to have been made by Vaucanson about a hundred years ago, and was at one time a principal attraction at Weeks's celebrated Museum, where that singular piece of mechanism the Tarantula spider was first exhibited.]

greatly deranged; the flute-player emits only some very faint tones; but the duck eats, drinks, and moves still. The ribs, which are of wire, had been covered with duck's feathers, so as to imitate nature; and as these are now lost, one can see better the interior construction; respecting which I shall only observe, that the motion is communicated by means of a cylinder and fine chains, like that of a watch, all proceeding through the feet of the duck, which are of the usual size. Nicolai[352] says that Du Moulin came to Petersburg in 1755, and died at Moscow in 1765. It is probable that he made the automata which I saw in Russia. Those which he left behind him at Nuremberg seem either not to have been completed, or to have been designedly spoiled by him; for they appeared to have defects which could not be ascribed to any accident. M. Beireis however has begun to cause them to be repaired.

Of all these automata, the duck I confess appeared to me the most ingenious; but I can prove that like pieces of mechanism were made before the time of Vaucanson. We are told by Labat[353], that the French general De Gennes, who, about the year 1688, defended the colony of St. Christopher against the English, constructed a peacock which could walk about, pick up from the ground corn thrown before it, digest it, according to appearance, and afterwards drop something that resembled

[352] Nicolai, Reise, i. p. 287.

[353] Nouveau Voyage aux Iles de l'Amerique. A la Haye 1724, 2 vols. 4to, ii. pp. 298, 384. From his county he was called Count de Gennes.

excrement. This man was of an ancient noble family in Brittany, which had however been so reduced, that the father carried on a handicraft. The son became acquainted with the marquis de Vivonne, who, on account of his promising talents, bred him to the sea. He rose to be commander of a vessel, conducted a squadron to the Straits of Magellan, where it was intended to form a colony, and obtained in Cayenne a tract of land, which he got erected into a county, under the name of Oyac. He invented machines of various kinds useful in navigation and gunnery, and, as we are told, constructed clocks that moved without weights or springs.

The flute-player also of Vaucanson was not the first of its kind. In the beginning of the sixteenth century, the anonymous author of that well-known poem Zodiacus Vitæ, saw at Rome a figure made in the like manner by a potter. It is much to be regretted that no account is given of its construction.

> Vidi ego dum Romæ, decimo regnante Leone,
> Essem, opus a figulo factum, juvenisque figuram,
> Efflantem angusto validum ventum oris hiatu[354].

I shall here beg leave to say a few words respecting an object of juggling, which, however old it may be, still excites astonishment, and has often imposed upon the credulity of

[354] Zodiacus Vitæ, xi. 846.

men of learning[355]: I mean those speaking machines, which, according to appearance, answer various questions proposed to them, sometimes in different languages, sing, and even blow a huntsman's horn. The figure, or only a head, is often placed upon a box, the forepart of which, for the better deception, is filled with a pair of bellows, a sounding-board, cylinder, and pipes, supposed to represent the organs of speech. At other times the machine is only like a peruke-maker's block, hung round with a Turkish dress, furnished with a pair of arms, and placed before a table, and sometimes the puppet stands upon the table, or against a wall. The sounds are heard through a speaking-trumpet, which the figure holds in its mouth.

Many jugglers are so impudent as to assert that the voice does not proceed from a man, but is produced by machinery, in the same manner as the music of an organ. Some, like the last whom I saw, are more modest or timorous, and give evasive answers to the questions asked them respecting the cause of the

[355] See a small treatise Ueber H. D. Muller's Redende Maschine, und über redende Maschinen überhaupt. Nurnberg, 1788, 8vo. – Algem. Teutsches Biblioth. vol. lxxxvii. p. 473. The Speaking Figure and the Automaton Chess-player exposed and detected. London, 1784, 8vo. – [This celebrated chess-playing automaton, invented by M. Vankempelin, was repaired and exhibited in London in 1820, by the ingenious mechanician Maelzel, with considerable success. The figure and machinery were always submitted to the inspection of the visitors, and shifted along the floor in various directions before the game commenced, and the deception was so adroitly managed as to escape the detection of the most scrutinizing. The proprietor always took care to secure the best chess-player in the town before he commenced operations, the wonder therefore was greatly increased by the superiority of the automaton's play. Mr. Lewis directed it in London. It is now generally admitted that a boy was concealed inside.]

voice, with as much art as those who exhibit with balls and cups. Concerning these speaking machines, however, different opinions are entertained. Some affirm that the voice issues from the machine; others, that the juggler answers himself, by speaking as ventriloquists do, or by having the power to alter his voice; and some believe that the answers are given by a man somewhere concealed. The violence with which these opinions are maintained exposes the juggler often to the danger of losing his life; for, when the illusion is detected, the populace, who in part suffer themselves willingly to be deceived, and who even pay the juggler for his deception, imagine that they have a right to avenge themselves for being imposed on. The machines are sometimes broken; and the owners of them are harshly treated as impostors. For my part, I do not see why a juggler, with a speaking machine, is a more culpable impostor than he who pretends to breathe out flames and to swallow boiling oil, or to make puppets speak, as in the Chinese shadows. The spectators pay for the pleasure which they receive from a well-concealed deception, and with greater satisfaction the more difficult it is for them to discover it. But the person who speaks or sings through a puppet, is so well hid, that people of considerable penetration have imagined that such concealment was impossible. At present this art is well known.

Either a child or a woman is concealed in the juggler's box; or some person, placed in a neighbouring apartment, speaks into the end of a pipe which proceeds through the wall to the puppet,

and which conveys the answers to the spectators. The juggler gives every necessary assistance to the person by signs previously agreed on. I was once shown, in company with M. Stock, upon promising secrecy, the assistant in another apartment, standing before the pipe, with a card in his hand on which the signs were marked; and he had been brought into the house so privately that the landlady was ignorant of the circumstance. The juggler, however, acknowledged that he did not exhibit without fear; and that he would not venture to stay long at a place like Göttingen, or to return with his Turks, though the populace were so civil as to permit him to depart peaceably with what he had gained.

The invention of causing statues to speak by this method seems so simple, that one can scarcely help conjecturing that it was employed in the earliest periods to support superstition; and many have imagined that the greater part of the oracles spoke in the same manner[356]. This, however, is false, as has been proved by the Jesuit Baltus, and the anonymous author of a Reply to Fontenelle's History of Oracles[357]. It appears that the pagan priests, like our jugglers, were afraid that their deceptions, if long practised, might be discovered. They considered it therefore as more secure to deliver the answers themselves; or cause them to be delivered by women instructed for that purpose, or by writing, or by any other means. We read, nevertheless, that idols[358] and

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[356] Van Dale De Oraculis. Amstelod. 1700, 4to, i. 10, p. 222.

[357] Réponse à l'Histoire des Oracles de M. de Fontenelle.

[358] A few instances are related by Livy, Valerius Maximus, and Plutarch. Among

the images of saints once spoke; for at present the latter will not venture to open their mouths. If their votaries ever really heard a voice proceed from the statue, it may have been produced in the before-mentioned manner.

Whether the head of Orpheus spoke in the island of Lesbos, or, what is more probable, the answers were conveyed to it by the priests, as was the case with the tripod at Delphi, cannot with certainty be determined. That the impostor Alexander, however, caused his Æsculapius to speak in this manner, is expressly related by Lucian[359]. He took, says that author, instead of a pipe, the gullet of a crane, and transmitted the voice through it to the mouth of the statue. In the fourth century, when bishop Theophilus broke to pieces the statues at Alexandria, he found some which were hollow, and placed in such a manner against a wall that a priest could slip unperceived behind them, and speak to the ignorant populace through their mouths[360]. I am acquainted with a passage which seems to imply that Cassiodorus, who, it is well known, constructed various pieces of mechanism, made also speaking machines; but I must confess that I do not think I understand the words perfectly[361].

That people ventured more than a hundred years ago to exhibit speaking machines for money, has been proved by Reitz in his

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the fables of the Christian church they are more numerous.

[359] Vol. v. p. 90. editio Bipont.

[360] Theodoreti Hist. Eccles. v. 22.

[361] Cassiodori Variar. i. ep. 45.

annotations to Lucian, where he produces the instance of one Thomas Irson, an Englishman, whom he himself knew, and whose art excited much wonder in king Charles II. and his whole court. When the astonishment, however, became general, one of the pages discovered, in the adjoining chamber, a popish priest who answered in the same language, through a pipe, the questions proposed to the wooden head by whispering into its ear. This deception Irson often related himself[362].

I shall now add only a few observations respecting the Chinese shadows, which I have occasionally mentioned before. This ingenious amusement consists in moving, by pegs fastened to them, small figures cut out of pasteboard, the joints of which are all pliable, behind a piece of fine painted gauze placed before an opening in a curtain, in such a manner as to exhibit various

[362] [*Speaking Automaton.*– There is a piece of mechanism now exhibiting to the public at the Egyptian Hall – the work of Professor Faber, of Vienna, and the result, as he states, of twenty-five years of labour and preparation. The name which he has given to this product of his ingenuity is the Euphonia; and the work, as that name implies, is another of those many combinations which have attempted, by the anatomical and physiological study of the structures that contribute to the human voice, to attain to an imitation of that organ as regards both sound and articulation. As an example of inductive and mechanical skill this exhibition is well deserving of attention. The professor himself, by an arrangement of bellows-pipes, pedal and keys, which he plays somewhat like the keys of a piano, prompts the discourse of his automaton; which certainly does enunciate both sounds and words. When we entered the room we found it singing to a select society. It requires all our sense of the ingenuity and perseverance which have been bestowed on the work to induce our assent to the proposition which calls the voice human; but undoubtedly it is a remarkable result of contriving skill and scientific patience. —*Athæneum.*]

scenes, according to pleasure; while the opening covered with gauze is illuminated, towards the apartment where the spectators sit, by means of light reflected back from a mirror; so that the shadows of the pegs are concealed. When it is requisite to cause a figure to perform a variety of movements, it is necessary to have several persons, who must be exceedingly expert. When a snake is to be represented gliding, the figure, which consists of delicate rings, must be directed at least by three assistants.

This amusement, which one can hardly see the first time without pleasure, is really a Chinese invention. Many years ago, I have seen Chinese boxes on which such moveable figures were apparent only when the box was held against the light. In China, these shadows are used at the well-known feast of lanterns; and a description of them may be found in the works of some travellers. That they were common also in Egypt, we are informed by Prosper Alpinus[363], who admired them much; but he was not able to discover the method by which they were produced, as it was kept a secret. I was told by an Italian, who exhibited them at Göttingen some years ago, that they were first imitated, from the Chinese, at Bologna.

[363] Historia Ægypti Natural. Lugd. Bat. 1735, 4to, p. 60.

# ARTIFICIAL ICE. COOLING LIQUORS

The art of preserving snow for cooling liquors during the summer, in warm countries, was known in the earliest ages. This practice is mentioned by Solomon[364], and proofs of it are so numerous in the works of the Greeks and the Romans, that it is unnecessary for me to quote them, especially as they have been collected by others[365]. How the repositories for keeping it were constructed, we are not expressly told; but what I know on the subject I shall here lay before the reader.

That the snow was preserved in pits or trenches, is asserted by many[366]. When Alexander the Great besieged the city of Petra, he caused thirty trenches to be dug and filled with snow, which was covered with oak branches, and which kept in that manner for a long time[367]. Plutarch says that a covering of chaff and coarse cloth is sufficient[368]; and at present a like method is pursued in Portugal. Where the snow has been collected in a deep gulf, some grass or green sods, covered with dung from the sheep-pens, is

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[364] Proverbs, xxv. ver. 13.

[365] Bartholini de Nivis Usu Medico Observationes, Hafn. 1661.

[366] Seneca, Quæst. Natur. iv. 13.

[367] Athenæus, iii. p. 124.

[368] Sympos. vi. quæst. 6. – Augustinus De Civitate Dei, xxi. 4, p. 610.

thrown over it; and under these it is so well preserved, that the whole summer through it is sent the distance of sixty Spanish miles to Lisbon[369].

When the ancients therefore wished to have cooling liquors, they either drank the melted snow or put some of it in their wine, or they placed jars filled with wine in the snow, and suffered it to cool there as long as they thought proper. It appears that in these trenches it could not remain long clean; on the contrary, it was generally so full of chaff, that the snow-water was somewhat coloured with it, and had a taste of it, and for this reason it was necessary to strain either it or the wine that had been cooled by it[370].

That ice also was preserved for the like purpose, is probable from the testimony of various authors[371]; but it appears not to have been used so much in warm countries as in the northern. Even at present snow is employed in Italy, Spain, and Portugal; but in Persia, ice[372]. I have never anywhere found an account of Grecian or Roman ice-houses. By the writers on agriculture they are not mentioned.

Mankind however soon conceived the idea of cooling water

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[369] Mémoires Instructifs pour un Voyageur. How the snow repositories at Constantinople are constructed, is related by Bellon in his Observat. iii. 22.

[370] The dissipated Heliogabalus caused whole mounts of snow to be heaped up in summer in order to cool the air. See Lampridius, Vita Heliogab. cap. 23.

[371] Plin. xix. 4. – Latinus Pacatus in Panegyr. Theodos.

[372] De la Valle, iii. p. 60, where the Persian ice-pits are described, as well as in Chardin, iv. p. 195.

without snow or ice, from having remarked that it became cold more speedily when it had been previously boiled, or at least warmed, and then put in a vessel among snow, or in a place much exposed to the air. Pliny seems to give this as an invention of Nero[373]; and a jocular expression in Suetonius[374] makes it at any rate probable that he was fond of water cooled by this method; but it appears to be much older. It seems to have been known even to Hippocrates: at least Galen[375] believes so. And Aristotle[376] was undoubtedly acquainted with it; for he says that some were accustomed, when they wished water to become soon cold, to place it first in the sun and suffer it to grow warm. He relates also that, the fishermen near the Black Sea poured boiling water over the reeds which they used in fishing on the ice to cause them to freeze sooner. Galen[377] on this subject is still more precise. He informs us that the above practice was not so much used in Italy and Greece, where snow could be procured, as in Egypt and other warm countries, where neither snow nor cool springs were to be found. The water after it had been boiled was put into earthen vessels or jars, and exposed in the evening on the upper part of the house to the night air. In the morning these vessels were put into the earth (perhaps in a

[373] Hist. Nat. xxxi. 3, 23, p. 552.

[374] Vita Neronis, cap. 48: Hæc est Neronis decocta.

[375] In lib. vi. Hippocrat. de Morbis Vulgar. comment. 4, 10.

[376] Meteorol. i. cap. 12.

[377] In the place before quoted.

pit), moistened on the outside with water, and then bound round with fresh or green plants, by which means the water could be preserved cool throughout the whole day. Athenæus[378], who gives a like account from a book of Protagorides, remarks, that the pitchers filled with water, which had become warm by standing all day long in the sun, were kept continually wet during the night, by servants destined to that office, and in the morning were bound round with straw. In the island of Cimolus[379], water which had become warm in the day-time was put into earthen jars, and deposited in a cool cellar, where it grew as cold as snow. It was generally believed therefore, that water which had been warmed or boiled, was soonest cooled, as well as acquired a greater degree of refrigeration; and on this account boiled water is mentioned so often in the works of the ancients[380].

The same opinion prevails at present in the southern countries of Asia, and people there still let their water boil before they expose it to the air to cool[381]. The experiments however which have been made on this subject by philosophers, have proved very different in the result. When one indeed places boiling and cold water, all other circumstances being equal, in frosty air, the latter will become ice before the former has cooled; but when one exposes to the cold, water that has been boiled, and unboiled

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[378] Deipnos. iii. p. 124.

[379] Ibid. p. 123.

[380] See Pitisci Lex. Antiq. Rom. under the word Decocta.

[381] Philosoph. Transact. vol. lxv. part i. p. 126.

water of equal temperatures, the former will be converted into ice somewhat sooner.

The experiments made by Mariotte[382], Perrault[383], the Academy del Cimento[384], Marian[385] and others, showed no perceptible difference in the time of freezing, between boiled and unboiled water; but the former produced ice harder and clearer, the latter ice more full of blisters. In later times, Dr. Black of Edinburgh has, from his experiments, asserted the contrary. Boiled water, he says, becomes ice sooner than unboiled, if the latter be left at perfect rest; but if the latter be stirred sometimes with a chocolate stick, it is converted into ice as soon as the former. This difference he explains in the following manner: – Some motion promotes congelation; this arises in the boiled water through its re-imbibing air; and therefore it must necessarily freeze before the unboiled, provided the latter be kept at perfect rest. Fahrenheit had before remarked that water not moved, would show a cold several degrees below the freezing-point, without becoming ice[386].

M. Lichtenberg, with whom I conversed on these contradictory results, assured me that he was not surprised at this difference in the experiments. The time of congelation is

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[382] Traité du Mouvement des Eaux.

[383] Du Hamel, Hist. de l'Academ. l. i. c. 3, p. 99.

[384] Tentamina Experimentorum Acad. del Cim. p. 183.

[385] Dissertation sur la Glace. Paris, 1749, 12mo, p. 187.

[386] Philosoph. Transact. vol. lxv. part i. p. 124.

regulated by circumstances, with which philosophers are not yet sufficiently acquainted. A certain, but not every degree of stirring hastens it; so that every icy particle which is formed on the side of the vessel, or which falls from the atmosphere, may convert the water sufficiently cooled into ice instantaneously; and such unavoidable accidents must, where all other circumstances are equal, cause a great difference in the period of freezing.

I am inclined to think that the cooling of water, in ancient times, of which I have already spoken, is not to be ascribed so much to the boiling as to the jars being kept continually wet, and to the air to which it was exposed. A false opinion seems therefore to have prevailed respecting the cause; and because it was considered to be the boiling, many have not mentioned the real cause, which appeared to them only to afford a trifling assistance, though it has been remarked both by Galen and Athenæus. We know at present that coolness is produced by evaporation. A thermometer kept wet in the open air falls as long as evaporation continues[387]. With sulphuric æther, and still better with that of nitre, which evaporates very rapidly, water may be made to freeze even in the middle of summer; and Cavallo saw in summer a Fahrenheit's thermometer, which stood at 64°, fall in two minutes, by means of æther, to +3, that is to 29° below

[387] [In India, one mode of cooling wines, is to suspend the bottle in a thick flannel bag, or folds of blotting-paper, kept constantly wetted, and placed in the sun's rays, or a current of air, or both; by which means the evaporation, and therewith intense coldness, is produced.]

the freezing-point[388].

On this principle depends the art of making ice at Calcutta and other parts of India, between 25° 30′ and 23° 30′ of north latitude, where natural ice is never seen unless imported. Trenches two feet deep, dug in an open plain, are strewed over with dry straw; and in these are placed small shallow unglazed earthen pans, filled with water at sunset. The ice which is produced in them is carried away before sunrise next morning, and conveyed to an ice-cellar fifteen feet deep; where it is carefully covered with straw to be preserved from the external heat and air. A great deal, in this process, depends upon the state of the atmosphere. When calm, pure and serene, it is most favourable to the congelation; but when the winds are variable, or the weather heavy and cloudy, no ice is formed; and the same is often the case when the nights are raw and cold[389].

It was once believed that this freezing was occasioned principally by the water having been boiled; but it seems to be

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[388] Philosoph. Transact. vol. lxxi. part ii. p. 511. [M. Boutigny's beautiful experiment of making ice in a red-hot crucible is a striking phænomenon of this kind. It is thus performed: – A deep crucible of platinum is heated to a glowing red heat; liquid sulphurous acid, which has been preserved in the fluid state by a freezing mixture, and some water are then at the same instant poured into the crucible. The rapid evaporation of the volatile sulphurous acid, which boils below the freezing-point of water, produces such an intense degree of cold as to freeze the water, which is then thrown out of the crucible as a solid lump.]

[389] Philosoph. Transact. vol. lxxi. part ii. p. 252: the process of making ice in the East Indies; by Robert Barker.

owing much rather to evaporation[390]. It is not however said that the vessels are kept continually wet on the outside, but that they are unglazed, and so porous or little burnt, that the water oozes through them; and on that account their exterior surface appears always moist[391]. By vessels of this kind the trouble of wetting is saved. What has been said respecting the influence of the weather serves, in some measure, to confirm my conjecture. The more it favours evaporation, the ice is not only formed more easily, but it is better; and when evaporation is prevented by the wind or the weather, no ice is produced. The latest accounts how ice is made at Benares, say expressly that boiled water is not employed; and that all those vessels, the pores of which are stopped by having been used, do not yield ice so soon or so good. In porcelain vessels none is produced; and this is the case also when the straw is wet[392].

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[390] [There is no question that this refrigeration is caused by the evaporation of a portion of the water, whereby a very large quantity of heat becomes latent in the vapour. A clear serene sky being necessary for the success of the production of the ice, would tend to show that the further loss of heat by radiation, which always ensues to a great extent at nights, when the sky is clear, is necessary.]

[391] … a number of small, shallow, earthen pans. These are unglazed, scarce a quarter of an inch thick, about an inch and a quarter in depth, and made of an earth so porous, that it was visible from the exterior part of the pans, the water had penetrated the whole substance. [Our ordinary wine-coolers, which consist of extremely porous vessels, act from evaporation. A portion of the water, which is placed in the interior of the cooler, evaporates through its pores, and produces cold by rendering a considerable amount of heat latent.]

[392] See the account of Lloyd Williams, in the Universal Magazine, June 1793, p. 410. Thin unglazed vessels are employed at present in Egypt also for cooling water,

Another method of cooling water also seems to have been known to Plutarch. It consisted in throwing into it small pebbles or plates of lead[393]. The author refers to the testimony of Aristotle; but this circumstance I cannot find in the works of that philosopher which have been preserved. It seems to be too unintelligible to admit of any opinion being formed upon it; and the explanation given by Plutarch conveys still less information than the proposition itself. This is the case, in general, with almost all the propositions of the ancients. We indeed learn from the questions that they were acquainted with many phænomena; but the answers scarcely ever repay the trouble which one must employ in order to understand them. They seldom contain any further illustration; and never a satisfactory explanation.

It appears that the practice of cooling liquors, at the tables of the great, was not usual in any country besides Italy and the neighbouring states, before the end of the sixteenth century. In the middle of that century there were no ice-cellars in France; for when Bellon relates, in the Account of his travels, in 1553, how snow and ice were preserved at Constantinople throughout the whole summer, for the purpose of cooling sherbet, he assures us that the like method might be adopted by his countrymen; because he had found ice-cellars in countries warmer than France. The word *glacière* also is not to be met with in the older dictionaries; and it does not occur even in that of Monet, printed

as we are told in several books of travels.

[393] Sympos. vi. 5, p. 690.

in 1635[394]. Champier, the physician who attended Francis I. when he had a conference with the emperor Charles V. and pope Paul III. at Nice, saw the Spaniards and Italians put snow, which they caused to be brought from the neighbouring mountains, into their wine in order to cool it. That practice, which excited his astonishment, he declared to be unhealthful; and this proves that in his time it had not been introduced at the French court[395].

Grand d'Aussy quotes an anecdote, related by Brantome, from which he forms the same conclusion. The dauphin, son of Francis I., being accustomed to drink a great deal of water at table, even when he was overheated, Donna Agnes Beatrix Pacheco, one of the ladies of the court, by way of precaution, sent to Portugal for earthen vessels, which would render the water cooler and more healthful; and from which all the water used at the court of Portugal was drunk. As these vessels are still used in Spain and Portugal, where the wine is cooled also with snow, both methods might have been followed in France. I have in my collection of curiosities, fragments of these Portuguese vessels; they are made of red bole; are not glazed, though they are smooth, and have a faint gloss on the surface like the Etruscan vases. They are so little burnt that one can easily break them with the teeth; and the bits readily dissolve to a paste in the mouth. If water be poured into such vessels, it penetrates their substance; so that, when in the least stirred, many air-bubbles are produced; and it

[394] The word however may be found in Dictionnaire par Richelet, Genève 1680, 4to.

[395] J. B. Campegii Libri xxii. de re cibaria, xvi. 9, p. 669.

at length oozes entirely through them[396]. The water that has stood in them acquires a taste which many consider as agreeable; and it is probable that it proceeds from the bark of the fir-tree, with which, as we read, they are burnt. When the vessels are new, they perform their service better; and they must then also have a more pleasant smell. If they really render water cold, or retain it cool, that effect, in my opinion, is to be ascribed to the evaporation. Their similarity to those in which the Indians make ice is very apparent.

Towards the end of the sixteenth century, under the reign of Henry III., the use of snow must have been well known at the French court, though it appears that it was considered by the people as a mark of excessive and effeminate luxury. In the witty and severe satire on the voluptuous life of that sovereign and his favourites, known under the title of L'Isle des Hermaphrodites[397],

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[396] Most vessels of this kind in Portugal are made at Estremos, in the province of Alentejo. The description given of them by Brantome is as follows: – "Cette terre étoit tannée, si subtile et si fine qu'on diroit proprement que c'est une terre sigillée; et porte telle vertu, que quelque eau froide que vous y mettiez dedans, vous la verrez bouillis et faire de petits bouillons, comme si elle estoit sur le feu; et si pourtant elle n'en perd sa froideur, mais l'entretient, et jamais l'eau ne fait mal à qui la boit, quelque chaud qu'il fasse, ou quelque exercice violent qu'il fasse." This clay seems to be the same as that which the ladies in Spain and Portugal chew for the sake of its pleasant taste, though to the prejudice of their health. They are so fond of it that their confessors make them abstain from the use of it some days by way of penance for their transgressions. See Madame D'Aunoi, Voy. en Espagne, ii. pp. 92, 109. Mémoires Instructifs pour un Voyageur. A vessel of the above kind is called *bucaro* and *barro*. See Diccion. de la Lengua Castellana, Madrid, 1783, fol.

[397] This curious work contains so much valuable information respecting the French

a work highly worthy of notice but which is exceedingly scarce, we find an order of the Hermaphrodites that large quantities of ice and snow should everywhere be preserved, in order that people might cool their liquors with them, even though they might occasion extraordinary maladies, which, it seems, were then apprehended. In the description of an entertainment we are told that snow and ice were placed upon the table before the king; and that he threw some of them into his wine; for the art of

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manners in the sixteenth century, that some account of it may not prove unacceptable to my readers. The title is, Déscription de L'Isle des Hermaphrodites, nouvellement découverte … pour servir de Supplement au Journal de Henri III. The preface, to which there is no signature, says that the book was printed for the first time in 1605. In the first editions neither date nor place is mentioned; but one edition is dated 1612. It appears to have been written in the reign of Henry IV., after the peace of Vervins, concluded in 1598, which the author mentions in the beginning. Henry IV. would not suffer any inquiry to be made respecting the author that he might be punished, because, he said, though he had taken great liberty in his writing, he had written truth. He is not therefore known. Some have conjectured that it was the production of cardinal Perron, and others of sieur d'Emery, Thomas Artus. But the former would not have chosen to lash vices such as those mentioned in this satire, with so much wit and severity; and the latter could not have done it. The one was too vicious, and the other too vehement. The cardinal must have delineated his own picture; and Artus have exceeded what he was capable of. The same opinion respecting Artus is entertained by Marchand, in his Dict. Historique. The frontispiece, which in many editions is wanting, represents an effeminate voluptuary with a womanish face, dressed half in men's and half in women's clothing. Marchand says the inscription is Les Hermaphrodites. In some editions however it is much more cutting: "Pars est una patris; cætera matris habet." This pentameter is taken from Martial, lib. xiv. ep. 174. The whole work is inserted also in Journal de Henri III., par Pierre de l'Estoiles, à la Haye 1744, 8vo, iv. p. 1. For further information on this subject see Le Long, Bibliothèque Historique de la France, ii. p. 326, n. 19128.

cooling it without weakening it was not then known. The same method was practised even during the whole first quarter of the seventeenth century[398].

Towards the end of the above century this luxury must have been very common in France. At that period there were a great many who dealt in snow and ice; and this was a free trade which every person might carry on. Government, however, which could never extort from the people money enough to supply the wants of an extravagant court, farmed out, towards the end of the century, a monopoly of these cooling wares. The farmers, therefore, raised the price from time to time; but the consumption and revenue decreased so much that it was not thought worth while to continue the restriction; and the trade was again rendered free. The price immediately fell; and was never raised afterwards but by mild winters or hot summers.

The method of cooling liquors by placing them in water in which saltpetre has been dissolved, could not be known to the ancients, because they were unacquainted with that salt. They might however, have produced the same coolness by other salts which they knew, and which would have had a better effect; but this, as far as I have been able to learn, they never attempted. The above property of saltpetre was first discovered in the first half of the sixteenth century; and it was not remarked till a long period afterwards, that it belongs to other salts also.

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[398] In the Contes de Gaillard, printed in 1620, it is said, "Il alla un jour d'esté souper chez un voluptueux, qui lui fit mettre de la glace en son vin."

The Italians at any rate were the first people by whom it was employed; and about the year 1550, all the water, as well as the wine, drunk at the tables of the great and rich families at Rome, was cooled in this manner. Blasius Villafranca, a Spaniard, who practised physic in that capital, and attended many of the nobility, published, in the before-mentioned year, an account of it, in which he asserts, more than once, that he was the first person who had made the discovery publicly known. In his opinion it was occasioned by the remark that salt water in summer was always cooler than fresh water. According to his directions, which are illustrated by a figure, the liquor must be put into a bottle or globular vessel with a long neck, that it may be held with more convenience; and this vessel must be immersed in another wide one filled with cold water. Saltpetre must then be thrown gradually into the water; and while it is dissolving, the bottle must be driven round with a quick motion on its axis, in one direction. Villafranca thinks that the quantity of saltpetre should be equal to a fourth or fifth part of the water; and he assures us, that when again crystallized, it may be employed several times for the same use, though this, before that period, had by many been denied. Whether other salts would not produce the like effect, the author did not think of trying; but he attempts to explain this of saltpetre from the principles of Aristotle; and he tells his noble patrons what rules they should observe for the preservation of their health, in regard to cooling liquors.

Towards the end of the sixteenth century this method of

cooling liquors was well known, though no mention is made of it by Scappi, in his book on cookery. Marcus Antonius Zimara, however, speaks of it in his Problems[399]. I do not know at what time this Appulian physician lived. In a list of the professors of Padua, his name is to be found under the year 1525, as *Explicator philosophiæ ordinariæ*; and because another is named under the year 1532, we have reason to conjecture that he died about that time. But in that case the physician Villafranca would probably have been acquainted with the Problemata of Zimara; and would not have said that no one had spoken of this use of saltpetre before him.

Levinus Lemnius[400] also mentions the art of cooling wine by this method so much, that the teeth can scarcely endure it. We are informed by Bayle that the earliest edition of his work, which has been often reprinted, was published at Antwerp, in the year 1559, in octavo. It contains only the first two books; but as the above account occurs in the second book, it must be found in this edition.

Nicolaus Monardes, a Spanish physician, who died about the year 1578, mentions this use of saltpetre likewise. It was invented, as he says, by the galley-slaves; but he condemns it as prejudicial to health. From some expressions which he uses, I am

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[399] Problema 102. These Problemata are often printed with the Problemata Aristotelis, Alexandri Aphrodis. and others. The collection which I have was printed at Amsterdam, 1685, 12mo.

[400] De Miraculis, libri iv. Colon. 1581, 8vo, p. 288.

inclined to think that he was not sufficiently acquainted with it; and that he imagined that the salt itself was put into the liquor. At a later period we find some account of it in various books of receipts; such as that written by Mizaldus in 1566, and which was printed for the first time the year following[401].

In the Mineralogy of Aldrovandi, first printed in 1648, this process is described after Villafranca; but where the editor, Bartholomæus Ambrosianus, speaks of common salt, he relates that it was usual in countries where fresh water was scarce to make deep pits in the earth; to throw rock-salt into them; and to place in them vessels filled with water, in order that it might be cooled. This remark proves that the latter salt was then employed for the same purpose; but it has led the editor into a very gross error. He thinks he can conclude from it, that the intention of potters, when they mix common salt with their clay, is not only to render the vessel more compact, but also to make it more cooling for liquors. But the former only is true. The addition of salt produces in clay, otherwise difficult to be fused, the faintest commencement of vitrification; a cohesion by which the vessel becomes so solid that it can contain fluids, even when unglazed; but for this very reason it would be most improper for cooling, which is promoted by the evaporation of the water that oozes through.

The Jesuit Cabeus, who wrote a voluminous commentary on the Meteorologica of Aristotle, which were printed at Rome in

[401] Centuriæ ix Memorabilium. Francof. 1599, 12mo, p. 67.

1646, assures us that with thirty-five pounds of saltpetre one can not only cool a hundred pounds of water, by quickly stirring it, but convert it also into solid ice; and for the truth of this assertion he refers to an experiment which he made. Bartholin says that for the above account he can give him full credit[402]; but the truth of it is denied by Duhamel, who suspects that this Jesuit took the shooting crystals of the salt to be ice[403].

Who first conceived the idea of mixing snow or ice with saltpetre and other salts, which increases the cold so much, that a vessel filled with water, placed in that mixture, is congealed into a solid mass of ice that may be used on the table, I cannot with certainty determine; but I shall mention the earliest account of it that I have been able to find. Latinus Tancredus, a physician and professor at Naples, whose book De Fame et Siti was published in 1607, speaks of this experiment; and assures us that the cold was so much strengthened by saltpetre, that a glass filled with water, when quickly moved in the above mixture, became solid ice[404].

In the year 1626, the well-known commentary on the works of Avicenna, by Sanct. Sanctorius, was published at Venice. The author in this work relates, that in the presence of many spectators, he had converted wine into ice, not by a mixture of

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[402] De Nive, p. 38.

[403] J. B. Du Hamel, Opera Philosophica, Norimb. 1681, 4to.

[404] L. Tancredi de Fame et Siti libri tres. Ven. 1607, 4to, lib. iii.

snow and saltpetre, but of snow and common salt[405]. When the salt was equal to a third part of the snow, the cold was three times as strong as when snow was used alone.

Lord Bacon, who died in 1626, says that a new method had been found out of bringing snow and ice to such a degree of cold, by means of saltpetre, as to make water freeze. This, he tells us, can be done also with common salt; by which it is probable he meant unpurified rock-salt; and, he adds, that in warm countries, where snow was not to be found, people made ice with saltpetre alone; but that he himself had never tried the experiment[406]. Boyle, who died in 1691, made experiments with various kinds of salts; and he describes how, by means of salt, a piece of ice may be frozen to another solid body[407]. Descartes says that in his

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[405] When snow or ice is mixed with salt, both begin to be liquid. This process is employed in Russia to clean windows covered with frost. They are rubbed with a sponge dipped in salt, and by these means they become immediately transparent. [The *rationale* of this appears to consist in the salt absorbing water and deliquescing, and in this fluid the snow subsequently dissolves, the mixture requiring a much lower temperature for its assuming the solid state.]

[406] Historia Vitæ et Mortis, § 44. – De Augmentis Scient. v. 2. – Silva Silvarum, cent. i.

[407] History of Cold, title i. 17; title v. 3; title xv. 7. [The method of making one or two freezing or cooling mixtures will not perhaps be without interest here. Where snow is not at hand, a mixture of 5 parts of powdered nitre and 5 of powdered sal-ammoniac may be mixed with 16 parts of water. This reduces the thermometer from +50° to about +10° F., or, 9 parts of phosphate of soda, 6 of nitrate of ammonia, and 4 of dilute nitric acid, reduce the thermometer from +50° to -21°; 5 parts of common salt, 5 of nitrate of ammonia and 12 of snow, reduce it from the ordinary temperature to -28°. The most intense degree of cold, probably known, has been produced by Dr.

time this was a well-known phænomenon, but highly worthy of attention[408].

Since that period the art of making ice has been spoken of in the writings of all philosophers where they treated on heat and cold, and with many other experiments has been introduced into various books of receipts. It was then employed merely for amusement[409]; and no one suspected that it would ever form an important item of luxury. In the like manner Fugger's first bills of exchange were said to be useful only for gambling, and gunpowder was called a trifling discovery.

In the beginning of the seventeenth century, drinking-cups made of ice and iced fruit were first brought to the table; but towards the end of that century it appears that the French began to congeal in this manner all kinds of well-tasted juices, which were served up as refreshments at the tables of the great and

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Faraday in his experiments upon the liquefaction of gases. This was effected by placing solid carbonic acid mixed with æther, under the air-pump, and exhausting.]

[408] Des Cartes Specimina Philosophiæ. Amst. 1650, 4to, p. 216.

[409] Von Hohberg says, in his Adliches Landleben, "The following, which serves more for amusement than use, is well-known to children. If one put snow and saltpetre into a jug, and place it on a table, over which water has been poured, and stir the snow and salt well round in the jug with a stick, the jug will be soon frozen to the table." This baron, therefore, who, after he had sold his property in Austria on account of the persecution against the Protestants, wrote at Regensburg (Ratisbon), where he died in 1688, at the age of seventy-six, was not acquainted with iced delicacies. Had they been known to him, he would have certainly mentioned them where, in his Book of Cookery, he gives ample directions for laying out a table of the first rank.

wealthy[410]. This was a grand invention for the art of cookery; which became common among the German cooks, both male and female, about the middle of the last century; and since that time our confectioners sell single glasses of iced articles at balls and in the theatres.

I am acquainted with no older information respecting this invention than what is contained in Barclay's Argenis, which is, indeed, a romance; but the author's account makes the possibility of its being used so clear, that we may certainly conclude it was then employed; especially as he mentions it several times. Arsidas finds in the middle of summer, at the table of Juba, fresh apples, one-half of which was encrusted with transparent ice. A basin, made also of ice and filled with wine, was handed to him; and he was informed that to prepare all these things in summer was a new art. Snow was preserved throughout the whole year in pits lined with straw. Two cups made of copper were placed the one within the other, so as to leave a small space between them, which was filled with water; the cups were then put into a pail, amidst a mixture of snow and unpurified salt coarsely pounded, and the water in three hours was converted into a cup of solid ice, as well-formed as if it had come from the hands of a pewterer.

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[410] [The application of ice to the purposes of confectionary, has, within the last few years, become much more extensive; encouraged, no doubt, by the facility with which it is now procurable at all seasons of the year, and in any quantity. Imitations of peaches, nectarines, apricots, and other fruits, are now produced in ice paste in such perfection, as at first sight to deceive the most practised eye; and such elegances are no longer confined to the tables of the wealthy.]

In the like manner apples just pulled from the tree were covered with a coat of ice.

The first edition of the Argenis was printed at Paris in 1621, and in that year the author died at the age of thirty-nine.

After brandy, from being a medicine, came into general use as a liquor at table, and was drunk in common by the populace, the Italians, above all, endeavoured to render it weaker and more pleasant by various mixtures; and by raising its value to make it more respectable, and at the same time more useful to people of the first rank. That their wares might be distinguished with more certainty, they gave them the name of *liquori*; and under that appellation sold them to foreign nations. The French were the first who adopted the use of these articles; particularly after the marriage of Henry II., when duke of Orleans, with Catharine de Medici, in the year 1533. This event brought to France great numbers of Italians, who made the French acquainted with these delicacies of their native country; and who taught them to prepare and to use them. They were the first, therefore, who made and sold the fine *liqueurs* at Paris; and in order to serve those who could not bear heating liquors, or rather to serve themselves by filling their pockets with money, their successors in this business invented about the year 1630 or 1633 that beverage called *lemonade*, because the juice of lemons or oranges was its chief component part. This liquor soon came into high repute, as it not only served for cooling and refreshing people during the sultry heats of summer, but was even recommended by

physicians against putrid diseases.

The *limonadiers*, or venders of lemonade, endeavoured to increase the first property, which occasioned the far greatest consumption, by the means of ice; and one of them, Procope Couteaux, an Italian from Florence, about the year 1660, conceived the happy idea of converting such beverage entirely into ice, by a process which had been before employed only by jugglers. The ready sale which he found for his invention induced others to make articles of the like kind. His example, therefore, was followed by Le Fevre and Foi; and these three for some years enjoyed a monopoly of this new-fashioned commodity. About the year 1676, liquors cooled by, or changed into ice, must however have been the principal things sold by the *limonadiers*; for being then formed into a company, the following delicacies were mentioned in the patent which they received on that occasion: "Eaux de gelée et glaces de fruits et de fleurs, d'anis et de canelle, franchipanne, d'aigre de cetre, du sorbec," &c. There were at that time in Paris two hundred and fifty masters in this employment. In 1690, when De la Quintiny wrote, iced liquors were extremely common[411].

People, however, long imagined that such articles could be

[411] Instruction pour les Jardins. Paris, 1730, 4to, i. p. 263. The author says that ice in summer is indeed useful; but, as a gardener, he wishes that frost could be prevented; and that ice might be imported from the North, as olives and oranges are from the South. Some years ago, as no ice could be procured on account of the great mildness of the preceding winter, the merchants at Hamburg sent a ship to Greenland for a load of it, by which they acquired considerable profit.

used only during the hot months of summer. In the year 1750, Dubuisson, successor to the celebrated Procope, *au café de la rue des Fossés de S. Germain des Près*, and author of the Art du Déstillateur, began to keep ready prepared, the whole year through, ices of every kind for the use of those who were fond of them. At first they were little called for, except in the dog-days; but some physicians recommended them in certain disorders. Have the physicians then, by their opinion, done most service to the venders of *liqueurs* and to cooks, or the latter to the physicians? This would make a fine subject for an inaugural dissertation. It is, however, certain, for we are told so by Dubuisson himself, that after two cures, in which ices had been of the greatest service, the *more discerning* part of the public made use of them in every season of the year. That this part of the public might never lose their conceit, the venders of *liqueurs* always employed their thoughts upon new inventions. Among the latest is that of iced butter, which acquired its name on account of some likeness to that substance. It was first known at the Parisian coffee-house (*caveau*) in 1774. The Duke de Chartres often went thither to enjoy a glass of iced liquor; and the landlord, to his great satisfaction and surprise, having one day presented him with his arms formed of eatable ice, articles of a similar kind immediately became fashionable.

[Ice is now used extensively for a variety of œconomical purposes, such as packing salmon, cooling liquors, &c. Of late years it has become a regular article of commerce. In September

1833, a cargo of ice, shipped at Boston, was discharged at Calcutta. It was sold at threepence per pound, while the native ice fetched sixpence. It was packed in solid masses, within chambers of double planking, with a layer of refuse tan or bark between them. The quantity shipped was 180 tons, of which about 60 wasted on the voyage, and 20 on the passage up the river to Calcutta. Thousands of tons are now annually shipped from Boston (United States) to our East Indies, to the West Indian Archipelago, and to the Continent of South America, and quite recently 'The Wenham Lake Ice Company' have erected extensive ice-houses in London and at Liverpool, and arranged for the transportation to this country of thousands of tons of ice. One surprising circumstance connected with the trade, is the fact that their ice, though transported to this country in the heat of summer, is scarcely reduced in bulk. The masses are so large that they expose a very small surface to atmospheric action in proportion to their weight, and therefore do not suffer from exposure to it, as the smaller and thinner fragments do, which are obtained in our own or other warmer climates. It appears, also, that ice frozen upon very deep water, is more hard and solid than ice of the same thickness obtained from shallow water; and even when an equal surface is exposed, melts more slowly. In this country, the collection of ice, even by those largely engaged in the trade, is an occasional and fitful undertaking; depending, both as to time and quantity, upon the accidental occurrence of severe frost; and when the process of collection is carried on, it

is with very few artificial aids. In America, on the other hand, this labour can be regularly carried on through the whole winter; while the adjuncts of machinery for cutting and storing, and of steam for transporting it, are brought extensively into action.

The details connected with this trade, as carried on in America, are so novel and so interesting, that we lay them before our readers with the confident belief that the result of our labours will prove attractive to them. Wenham Lake, whence a large proportion of the ice now imported to this country is obtained, is eighteen miles from Boston, in the State of Massachusets; it occupies a very elevated position, and lies embosomed in hills of majestic height and bold rugged character. The lake has no inlet whatever, but is fed solely by the springs which issue from the rocks at its bottom, a depth of 200 feet from its surface. The ice-house, which is capable of storing 20,000 tons of ice, is built of wood, with double walls, two feet apart, all around; the space between which is filled with sawdust; thus interposing a medium, that is a non-conductor of heat, between the ice and the external air; the consequence of which is, that the ice is scarcely affected by any condition or temperature of the external atmosphere, and can be preserved without waste for an indefinite time.

The machinery employed for cutting the ice is very curious, and was invented for that express purpose. It is worked by men and horses in the following manner: – From the time when the ice first forms, it is carefully kept free from snow until it is thick enough to be cut; that process commences when the ice is a

foot thick. A surface of some two acres is then selected, which at that thickness will furnish about 2000 tons, and a straight line is then drawn through its centre from side to side each way. A small hand-plough is pushed along one of these lines, until the groove is about three inches deep and a quarter of an inch in width, when the 'Marker' is introduced. This implement is drawn by two horses, and makes two new grooves, parallel with the first, twenty-one inches apart; the gauge remaining in the original groove. The marker is then shifted to the outside groove, and makes two more. Having drawn these lines over the whole surface in one direction, the same process is repeated in a transverse direction, marking all the ice out into squares of 21 inches. In the meantime, the 'Plough,' drawn by a single horse, is following in these grooves, cutting the ice to a depth of 6 inches. One entire range of blocks is then sawn out, and the remainder are split off toward the opening thus made with an iron bar. This bar is shaped like a spade and of a wedge-like form. When it is dropped into the groove, the block splits off; a very slight blow being sufficient to produce that effect, especially in very cold weather. The labour of 'splitting' is slight or otherwise, according to the temperature of the atmosphere. 'Platforms,' or low tables of frame-work, are placed near the opening made in the ice, with iron slides extending into the water, and a man stands on each side of this slide, armed with an ice-hook. With this hook the ice is caught and by a sudden jerk thrown up the 'slide' on to the 'platform.' In a cold day everything is speedily covered with

ice by the freezing of the water on the platforms, slides, &c., and the enormous blocks of ice, weighing some of them more than two cwt., are hurled along these slippery surfaces, as if they were without weight. Beside this platform, stands a 'sled' of the same height, capable of containing about three tons; which, when loaded, is drawn upon the ice to the front of the store-house, where a large stationary platform of exactly the same height, is ready to receive its load; which, as soon as discharged, is hoisted block by block, into the house.

Forty men and twelve horses will cut and stow away 400 tons a day. In favourable weather 100 men are sometimes employed at once. When a thaw or a fall of rain occurs, it entirely unfits the ice for market, by rendering it opake and porous; and occasionally snow is immediately followed by rain, and that again by frost, forming snow-ice, which is valueless, and must be removed by the 'plane.' The operation of 'planing' is somewhat similar to that of 'cutting.' A plane gauged to run in the grooves made by the 'marker,' and which shaves the ice to the depth of three inches, is drawn by a horse, until the whole surface of the ice is planed. The chips thus produced are then scraped off; and if the clear ice is not reached, the process is repeated. If this makes the ice too thin for cutting, it is left in *statu quo*

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