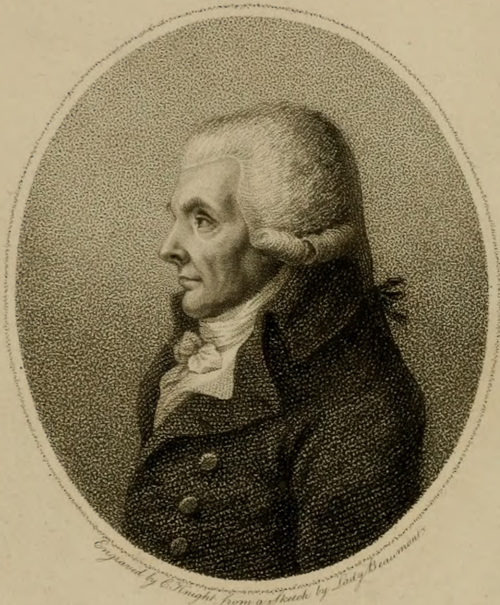

Mr. G. Sanderson.

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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

" Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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CONTENTS

OF THE

SEVENTEENTH VOLUME.

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on

TO THE PUBLIC.

The encouragement which the Proprietor of this work has experienced from the public claims his warmest acknowledgements. He therefore embraces the opportunity afforded him by the commencement of a seventeenth volume, to return his most grateful thanks for the favours conferred upon him; and to assure his friends that the approbation bestowed on his labours, while it gratifies his utmost wishes, will stimulate him to secure, by new exertions, a continuance of that patronage which it shall always be his ambition to obtain.

He engaged in the present undertaking that he might contribute his mite towards the improvement of science, by giving the earliest account of every thing new or curious in those branches of knowledge, in particular, which form the foundation of the most useful of our arts, and consequently of the riches and prosperity of this country; and he has the satisfaction of reflecting that many things have been communicated through the channel of this work which without it might have still been buried in obscurity. As a proof that this has been the case, he will here only observe, that the editors of a valuable scientific work, the Encyclopædia Britannica, have copied, in their supplement, many articles from the Philosophical Magazine, and have not been ashamed to acknowledge the source from which they derived them.

 The

The Conductor can, with some degree of pride, state also, that this work has met with the most favourable reception on the continent, in the principal journals of which it is frequently quoted; and that among the number of his foreign correspondents he can mention the celebrated VOLTA, BRUGNATELLI, PICTET, VAN MONS, LAMETHERIE, and several other eminent men, who have occasionally sent him letters and articles of information.

If any further testimony of the respectable light in which this journal is held were wanting, it might be added, that it has been honoured with communications from some of the most celebrated philosophers and literary men of the united kingdom, to whom the Proprietor considers himself under great obligations, and whose future favours he earnestly solicits.

The Philosophical Magazine being thus established on the firmest foundation, its obvious utility and the favourable opinion entertained of it by men of science, the Proprietor will close this short address by assuring the public that it is his determination to spare no pains or expense to preserve the reputation it has acquired; and that, in consequence of some arrangements he has lately made with his friends in different parts of Europe, he has reason to hope that he shall be enabled to enhance its value by opening new sources of information, which will increase its utility and render it still more worthy of protection.

THE

PHILOSOPHICAL MAGAZINE.

I. *On the Modifications of Clouds, and on the Principles of their Production, Suspension, and Destruction; being the Substance of an Essay read before the Askesian Society in the Session* 1802-3. *By* LUKE HOWARD, *Esq.*

[Continued from vol. xvi. p. 357.]

Of the Formation of the Cirrus.

It must have been owing entirely to the want of distinctive characters for clouds, and the consequent neglect of observing their changes, that the nature of this modification more especially has not engaged the attention of electricians. The attraction of aggregation operating on solid particles diffused in fluids does indeed produce a great variety of ramifications in the process of crystallization: but these are either uniform in each substance, or have a limited number of changes; and in no instance do we see the same substance separating from the same medium, and, unconfined in its movements, rival the numerous metamorphoses of the cirrus.

The great elevation of these clouds in their ordinary mode of appearance has been ascertained both by geometrical observations* and by viewing them from the summits of the highest mountains, when they appear as if seen from the plain. A more easy and not less convincing proof may be had by noting the time during which they continue to reflect the different coloured rays after sunset, which they do incomparably longer than any others. The same configuration of cirrus has been observed in the same quarter of the sky for two successive days, during which a smart breeze from the opposite quarter prevailed below.

It is therefore probable that this modification collects its water in a comparatively calm region, which is sometimes incumbent on the current next the earth, and almost out of the reach of its *daily* variations in temperature and quantity

* "The small white streaks of condensed vapour which appear on the face of the sky in serene weather I have, by several careful observations, found to be from three to five miles above the earth's surface." —Dalton.

of vapour; but at other times is interposed between the latter and a supervening current from another climate, in which case it may be affected by both currents.

The cumulus has been just now considered as an insulated body, consisting of perfectly moveable parts which accommodate themselves to the state of *retaining* electricity, We shall attempt to explain the nature of the cirrus by comparing it to those imperfect conductors, which being interposed between electrics and conductors, or between the latter in different states, serve to restore by degrees the equilibrium of the electric fluid.

If a lock of hair be properly fixed on the prime conductor and electrified *plus*, the hairs will be separately extended at as great a distance from each other as possible; in which state they will continue some time. The reason appears to be, that the contiguous air is then *minus*; and consequently these two moveable substances put themselves into the state most favourable to a communication which is but slowly effected between bad conductors.

The same appearances will take place if the lock be electrified *minus*, the contiguous air being *plus*; and in each case the hairs will move *from* a body similarly electrified and brought near them, and *towards* one contrariwise electrified, &c. Moreover, if we could insulate such a charged lock in the midst of a perfectly tranquil atmosphere of sufficient extent, in which particles of conducting matter were suspended, the latter would be attracted by it so long as the charge continued; after which they would be at large as before.

Dry air being an electric, and moist air but an indifferent conductor, it is reasonable to suppose that an immediate communication of electricity between masses of air differently charged can scarcely happen to any great extent, except by the intimate mixture of such masses; an occurrence which may possibly result in some such cases, and occasion strong winds and commotions in the atmosphere. If we consider how frequently, and to what an extent, the electricity of the air is disturbed (as appears from numerous experiments) by evaporation, by the formation and passage of clouds, by elevation or depression of temperature, (by friction upon surfaces of ice?) it seems probable that the particles of water floating in a calm space may be frequently converted into conductors, by which the equilibrium is in part restored after such disturbance.

Viewing the cirrus in this light, it becomes important for those who are well versed in electricity to study its appear-

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ances, and compare them with the changes that ensue in the atmosphere. A number of observations, made hitherto chiefly in one place, and without system or aid from concurrent ones in other places, have furnished the preceding data (see vol. xvi. p. 100), which may serve as hints for future investigation.

At present we can only conjecture that the local detached cirri which ramify *in all directions* are collecting particles of water from the surrounding space, and at the same time equalizing their own electricity with that of the air or vapour.

That when numerous oblique short tufts appear, they are conducting between the air above and that below them.

That a decided direction of the extremities of pendent or erected cirri from the mass they join towards any quarter, is occasioned by the different electricity of a current of air which is pressing upon the space they are contained in from thence. This is the most important point to attend to, as these *tails* sometimes veer half round the compass in the course of a few hours; and many observations have confirmed the fact that they point *towards the coming wind*, and are larger and lower as this is about to be stronger.

Lastly, that cirri in parallel lines stretching from horizon to horizon denote a communication of electricity carried on through these clouds *over* the place of observation; the two predisposing masses of atmosphere being very distant, and the intermediate lower atmosphere not in a state to conduct it. It is at least a circumstance well deserving inquiry, by what means the clouds in stormy seasons become arranged in these elevated parallel bars, which must be at least 60 miles long, and are probably much more, considering their elevation, and that both extremities are often invisible.

Of the Nature of the intermediate Modifications.

The conversion of the cirrus into the cirro-cumulus is a phænomenon which at some seasons may be daily traced, and serves to confirm the opinion that there exists somewhat of the same difference between the cumulus and the cirrus, as between a *charged* and a *transmitting* or an influenced conductor among solid bodies. On this supposition, the orbicular arrangement of the particles ought to take place as soon as the mass has ceased to conduct from particle to particle, or to be so acted on by a contiguous conductor as to have a *plus* and *minus* state within itself at the same time: and as this sort of communication in a cloud may be as slow as in other imperfect conductors, the equi-

 librium

librium among the particles may be restored at one extremity some time before the other has ceased to transmit; whence a visible progress of the change which may be traced in a cirrus of sufficient length.

That an extensive horizontal cirrus should become divided across its ramifications, and that these divided parts should assume more or less of a round form, is also consistent with the idea of a change of this sort*. It is not so easy to give a reason why these small orbicular masses should remain in close arrangement, or even in contact, for several hours, forming a system of small clouds which yet do not interfere with each other or run together into one, but remain as it were in readiness to reform the cirrus, which sometimes happens very suddenly, though they more frequently evaporate by degrees.

The same remark must be applied to the curious and as it were capricious divisions and subdivisions, both longitudinal and transverse, which happen in the cirro-stratus when this cloud is verging towards the cirro-cumulus. In general, nevertheless, its appearance is sufficiently distinct from that of the cirrus and cirro-cumulus. The cirrus by its great extent in proportion to its mass, its distinct lines and angular flexures in all directions, and the cirro-cumulus by the roundness and softness of its forms, indicates an essential difference in the state of the containing atmosphere. The cirro-stratus appears to be always in a subsiding state, slowly diminishing by evaporation or dispersion, and at the same time more feebly acted upon by electricity than the preceding modifications. Indeed, the lower atmosphere is usually pretty much charged with dew or haze at the time of its appearance, and therefore in a state to conduct it to the earth.

Of the Nature of the Compound Modifications, and of the Resolution of Clouds into Rain, &c.

From the theory of evaporation it appears that no permanent cloud can be formed in the atmosphere, however low the temperature, without a sufficient pressure from vapour previously diffused. Hence, although in cold weather the breath and perspiration of animals, as also water at a certain excess of temperature, occasion a visible cloud, and,

* A quickly evaporating cumulus sometimes leaves a regular cirrus behind, formed out of the remnant of the cloud which in the intermediate state, and just when it begins to show the sky through it, exactly represents the pores and fibre of sponge. This may be attributed to the quantity of electricity passing into or from the cloud at that time

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in fact, from the same cause as heretofore stated, (the water first condensed being followed by undiffused vapour;) yet this cloud speedily evaporates again at all times, except when precipitation is actually going on at large in the atmosphere next the ground; when it is only *dispersed* therein. By comparing the different effects of a clear frosty air, and of a misty though much warmer one, on the perspiration and breath of horses warmed by labour, we may be assisted in reasoning on the great case of evaporation, which, in some sense, is the *perspiration* of the earth.

The most powerful predisposing cause of evaporation appears to be a superior current in the atmosphere coming from a region where the low temperature of the surface, or its dry state, occasions a comparative deficiency of vapour. Hence, after heavy rain in winter, we see the sudden evaporation, first of the remaining clouds, then of the water on the ground, followed by a brisk northerly wind and sharp frost.

The very snow which had fallen on its arrival is sometimes totally evaporated again during the prevalence of such a wind. On the contrary, the first appearance of clouds forming in cold weather gives us to expect a speedy remission of the frost, although the cause is not generally known to be a change to a southerly direction already begun in the superior atmosphere, which consequently brings on an excess of vapour.

This excess of vapour, coming with a superior current, may be placed next to depression of temperature among the causes of rain. The simultaneous decomposition of the higher *imported* vapour, and of that which is formed on the spot, or already diffused in the inferior current, would necessarily produce two orders of cloud, differing more or less in electricity as well as in other respects. To the slow action of these upon each other, while evaporation continues below, may be attributed the singular union which constitutes the cumulo-stratus. It is too early in the present state of the subject to attempt to define the precise mode of this action, or to say by what change of state a cumulus already formed is thrown into this modification. That the latter phænomenon is an electrical effect, no one who has had opportunity to see its rapid progress during the approach of a thunder storm can reasonably doubt.

To assert that rain is in almost every instance the result of the electrical action of clouds upon each other, might appear to many too speculative, were we even to bring the authority of Kirwan for it, which is decidedly in favour of this

this idea: yet it is in a great measure confirmed by observations made in various ways upon the electrical state of clouds and of rain, not to insist on the probability that a thunder storm is only a more sudden and sensible display of those energies which, according to the order observable in the creation in other respects, ought to be incessantly and silently operating for more general and beneficial purposes.

In the formation of the nimbus, two circumstances claim particular attention: the spreading of the superior masses of cloud in all directions until they become, like the stratus, one uniform sheet; and the rapid motion and visible decrease of the cumulus when brought under the latter. The cirri, also, which so frequently stretch from the superior sheet upward, and resemble erected hairs, carry so much the appearance of temporary conductors for the electricity, extricated by the sudden union of its minute drops into the vastly larger ones which form the rain, that one is in a manner compelled, when viewing this phænomenon, to indulge a little in electrical speculations. By one experiment of Cavallo's, with a kite carrying three hundred and sixty feet of conducting string, in an interval between two showers, and kept up during rain, it seems that the superior clouds possessed a positive electricity before the rain, which on the arrival of a large cumulus gave place to a very strong negative, continuing as long as it was over the kite. We are not, however, warranted from this to conclude the cumulus which brings on rain always negative, as the same effect might ensue from a positive cumulus uniting with a negative stratus. Yet the general negative state of the lower atmosphere during rain, and the positive indications commonly given by the true stratus, render this the more probable opinion. It is not, however, absolutely necessary to determine the several states of the clouds which appear during rain, since there is sufficient evidence in favour of the conclusion, that clouds formed in different parts of the atmosphere operate on each other, when brought near enough, so as to occasion their partial or entire destruction; an effect which can only be attributed to their possessing beforehand, or acquiring at the moment, the opposite electricities.

It may be objected that this explanation is better suited to the case of a shower than to that of continued rain, for which it does not seem sufficient. If it should appear, nevertheless, that the supply of each kind of cloud is by any means kept up in proportion to the consumption, the

 objection

objection will be answered. Now, it is a well-known fact, that evaporation from the surface of the earth and waters often returns and continues during rain, and consequently affords the lower clouds, while the upper are recruited from the quantity of vapour brought by the superior current, and continually subsiding in the form of dew; as is evident both from the turbidness of the atmosphere in rainy seasons, and the plentiful deposition of dew in the nocturnal intervals of rain. Neither is it pretended that electricity is any further concerned in the production of rain than as a secondary agent, which modifies the effect of the two grand predisposing causes—a falling temperature and the influx of vapour.

The theory of rain, however, was not intended to be discussed in the present essay, which has already been extended to the usual limits. We may therefore conclude with requesting, that those who possess the means, and have acquired the habit of experimental observation, will take suitable opportunities to submit to this test the preceding conjectures on the nature of several clouds. These might have been extended further, but that the author was unwilling to go beyond the line which the experiments of several eminent philosophers, and a few of his own, seemed to point out as safe in the present state of the subject.

The author thinks he cannot more properly terminate this essay than in publicly acknowledging the obligation he lies under to his friend Silvanus Bevan jun. for his frequent and zealous aid in his observations and drawings.

II. *Account of the Kookies or Lunctas: written by* JOHN MACRAE, *Esq. and communicated to the Asiatic Society by* J. H. HARRINGTON, *Esq.**

THE Kookies are a race of people that live among the mountains to the north-east of the Chittagong province, at a greater distance than the Choomeeas from the inhabitants of the plains; to whom therefore they are little known, and with whom they very rarely have any intercourse, except when they occasionally visit the hauts, or markets, on the

* From the *Asiatic Researches*, vol. vii. Mr. Macrae, author of this paper, is a surgeon in the honourable East India company's service at Chittagong, and received his information from a native of Runganeeah who had long resided among the Cúcis as their captive.

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the borders of the jungles in the Runganeeah and Aurungabad districts, to purchase salt, dried fish, and tobacco.

The following account of them was taken from a native of the Runganeeah district, who, when a boy, was carried away, in one of their predatory excursions, and, after a captivity of twenty years, found means to return to his family.

The Kookies, or Lunctas (as they are also called), are the least civilized of any of the people we as yet know among these mountains: like all mountaineers, they are of an active, muscular make, but not tall; they are stouter, and of a darker complexion than the Choomeeas*, and, like them, have the peculiar features of all the natives of the eastern parts of Asia, namely, the flat nose, small eye, and broad round face.

The tradition of the Kookies respecting their origin is, that they and the Mugs are the offspring of the same progenitor, who had two sons by different mothers. The Mugs, they say, are the descendants of the eldest, and the Kookies of the youngest son. The mother of the youngest having died during his infancy, he was neglected by his step-mother, who, while she clothed her own son, allowed him to go naked; and this partial distinction being still observed, as he grew up, he went by the name of Luncta, or the naked. Upon the death of their father, a quarrel arose between the brothers, which induced the Luncta to betake himself to the hills, and there pass the remainder of his days. His descendants have continued there ever since, and still go by the name of Lunctas; though, properly speaking, the term is only applicable to the male part of them, as the females wear a short apron before, made of cloth of their own manufacture, and which falls down from the loins to the middle of the thigh; and both sexes occasionally throw a loose sheet of cloth over their bodies to defend them from the cold.

This tradition of their origin receives much support from the great similarity of the Mug and Kookie languages, many words of which are exactly the same, and their general resemblance is such that a Mug and Kookie can make themselves understood to each other.

The Kookies are all hunters and warriors, and are divided into a number of distinct tribes totally independent of each other,

* Choomeeas are the inhabitants of the first range of hills bordering on the plains to the north and east of the province of Chittagong, and are tributary to the honourable company; their villages are called *chooms*.

other, though all of them acknowledge, more or less, the authority of three different rajahs, named Thandon, Mankene, and Halcha, to whom the various tribes are attached, but whose power over them is very limited, except in that tribe with which the rajah lives, where he is absolute. The rajahships are hereditary, and the rajahs, by way of distinction, wear a small slip of black cloth round their loins; and, as a further mark of superior rank, they have their hair brought forward, and tied in a bunch, so as to overshade the forehead, while the rest of the Kookies have theirs hanging loose over the shoulders. The females also of the rajah's family wear an apron of black cloth with a red border, which falls down to the knee,—a colour and fashion prohibited to the rest of the sex, black being the royal colour.

The rajahs receive a tribute in kind from the tribes to support their dignity; and, in cases of general danger, they can summon all the warriors to arms; but each tribe is under the immediate command of its own particular chief, whose word is a law in peace and war, and who has the power of life and death in his tribe. The chieftainship is not hereditary like the rajahship, but elective, though in general the nearest relation of the last chief succeeds him, if deemed by the tribe a proper person for the trust; and the rajah cannot remove a chief once elected, should he disapprove of him.

The Kookies are armed with bows and arrows, spears, clubs, and daws, an instrument in common use among the natives of this province, as a hand hatchet, and exactly resembling the knife of the Nyars on the Malabar coast, which is a most destructive weapon in close combat. They use shields, made of the hide of the gyal, a species of cow peculiar to their hills; and the inside of their shields they ornament with small pendulous plates of brass, which make a tingling noise as the warriors toss about their arms either in the fight or in the dance. They also wear round their necks large strings of a particular kind of shell found in their hills; about their loins, and on their thighs immediately above their knee, they tie large bunches of long goat's hair, of a red colour; and on their arms they have broad rings of ivory, in order to make them appear the more terrific to their enemies.

The Kookies choose the steepest and most inaccessible hills to build their villages upon, which, from being thus situated, are called *parahs*, or, in the Kookie language, *k'hooah*. Every parah consists of a tribe, and has seldom fewer

fewer than four or five hundred inhabitants, and sometimes contains one or two thousand. Towards our frontiers, however, where there is little apprehension of danger, a tribe frequently separates into several small parties, which form so many different parahs on the adjoining hills as may best suit their convenience. To give further security to the parahs, in addition to their naturally strong situation the Kookies surround them with a thick bamboo pallisade; and the passages leading into them, of which there are commonly four or five in different quarters, they strictly guard day and night, especially if there is any suspicion of danger; but, whether there is or is not, they are at all times extremely jealous of admitting strangers within the parah: they build their houses as close to each other as possible, and make them spacious enough to accommodate four or five families in every house. They construct them after the manner of the Choomeeas and Mugs, that is, on platforms or stages of bamboo, raised about six feet from the ground, and enter them by ladders, or, more frequently, by a single stick, with notches cut in it, to receive the foot: underneath the stages they keep their domestic animals. All these precautions of defence strongly indicate the constant state of alarm in which they live, not only from the quarrels of the rajahs with each other, but also from the hostile feuds of the different tribes, not excepting those who are attached to the same rajah. Depredations on each other's property, and the not giving up of such refugees as may fly from one parah to another, are the most frequent causes of quarrel; when they carry on a most destructive petty warfare, in which the several tribes are more or less involved according as the principals are more or less connected among them. On these occasions, when an enterprise is not of sufficient importance to induce the chief to head all the warriors of the parah, he always selects a warrior of approved valour and address to lead the party to be detached.

They always endeavour to surprise their enemy, in preference to engaging him in open combat, however confident of superiority they may be. With that view, when on any hostile excursion, they never kindle a fire, but carry with them a sufficiency of ready-dressed provisions to serve during the probable term of their absence; they march in the night, proceeding with the greatest expedition, and observing the most profound silence; when day overtakes them, they halt, and lie concealed in a kind of hammoc, which they fasten among the branches of the loftiest trees, so that they cannot be perceived by any person passing underneath.

From

From this circumstance of ambuscade, the idea has originated of their living in trees instead of houses. When they have in this manner approached their enemy unperceived, they generally make their attack about the dawn, and commence it with a great shout, and striking of their spears against their shields. If they are successful in their onset, they seldom spare either age or sex: at times, however, they make captives of the children, and often adopt them into their families, when they have none of their own; and the only slaves among them are the captives thus taken.

The heads of the slain they carry in great triumph to their parah, where the warriors are met, on their arrival, by men, women, and children, with much rejoicing; and they have the peculiar privilege of killing any animal in the place they may choose (not excepting the chief's), to be given as a feast in celebration of their victory: but, should the party have been unsuccessful, instead of being thus met with every demonstration of joy, and led into the parah amidst the exultations of its friends, it enters in the greatest silence, and as privately as possible; and all the warriors composing it remain in disgrace until such time as they retrieve their characters, either jointly or individually, by some act of valour.

The Kookies are often attacked by the Banjoogees, who, though not so numerous a race of people, yet, from being all united under one rajah, always prevail, and exact an annual tribute of salt from the two Kookie rajahs Thandon and Mankene, who, from having a greater intercourse with the Choomeeas, receive a larger supply of this article from the plains below than their more remote neighbours. Salt is in the highest estimation among them all; whenever they send any message of consequence to each other, they always put in the hand of the bearer of it a small quantity of salt, to be delivered with the message, as expressive of its importance. Next to personal valour, the accomplishment most esteemed in a warrior is superior address in stealing: and if a thief can convey undiscovered to his own house his neighbour's property, it cannot afterwards be claimed; nor, if detected in the act, is he otherwise punished than by exposure to the ridicule of the parah, and being obliged to restore what he may have laid hold of.

This must tend to encourage the practice of thieving; which, no doubt, is considered in such high estimation, because the same sagacity and address necessary to give success to the thief qualifies the warrior, in an eminent degree, to steal unperceived upon and surprise his enemy, and thus

thus ensures him victory. So thought the antient warriors of Sparta, who, like the Kookies of the present day, held in estimation the man who could steal with superior expertness.

The Kookies, like all savage people, are of a most vindictive disposition; blood must always be shed for blood; if a tiger even kills any of them near a parah, the whole tribe is up in arms, and goes in pursuit of the animal; when, if he is killed, the family of the deceased gives a feast of his flesh in revenge of his having killed their relation. And should the tribe fail to destroy the tiger in this first general pursuit of him, the family of the deceased must still continue the chace; for, until they have killed either this or some other tiger, and have given a feast of his flesh, they are in disgrace in the parah, and not associated with by the rest of the inhabitants. In like manner, if a tiger destroys one of a hunting party, or of a party of warriors on a hostile excursion, neither the one nor the other (whatever their success may have been) can return to the parah, without being disgraced, unless they kill the tiger. A more striking instance still of this revengeful spirit of retaliation is, that if a man should happen to be killed by an accidental fall from a tree, all his relations assemble and cut it down; and however large it may be, they reduce it to chips, which they scatter in the winds, for having, as they say, been the cause of the death of their brother. They employ much of their time in the chace, and, having no prejudice of cast, or sect, to restrain them in the choice of their game, no animal comes amiss to them. An elephant is an immense prize for a whole parah. They do not remove their parahs so frequently as the Choomeeas do their chooms: the Choomeeas seldom remain longer than two years on the same spot, whereas the Kookies are usually four or five; and when they migrate they burn their parah, lest the gyals should return to it, as they are frequently known to do if the huts are left standing. The Kookies never go to a greater distance from their old ground than a journey of twelve hours, unless compelled to proceed further from some particular cause, such as the fear of an enemy, or the want of a proper spot to fix upon.

Their great object in selecting a place to settle on, is natural strength of situation, with a sufficiency of good ground near the parah on which to rear the different grains, roots, and vegetables they wish to cultivate. They cultivate the ground as the Choomeeas do; and in this, as in every other domestic occupation, the female sex bears the weight

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of the labour, and no rank exempts them from it; the wife of the chief and the wife of his vassal work alike in the same field.

A proper spot being found on the declivity of some hill contiguous to the parah, the men cut down the jungle upon it in the month of March, and allow it to remain there until sufficiently decayed to burn freely; when they set it on fire, and thus at once perform the double purpose of clearing away the rubbish, and of manuring the ground with its ashes. The women now dig small holes, at certain distances, in the spot so cleared, and into each hole they throw a handful of different seeds they intend to rear, which are all jumbled together in a basket slung over the shoulder: the seeds are then covered with earth, and left to their fate; when in due time, according to their various natures, the plants spring up, ripen, and are reaped in succession: rice, Indian corn, and the mustard plant, are thus seen in the same field. Of rice they have a great variety, and two or three kinds peculiar to the hills: one of these, the *chereh*, is uncommonly fine, and has the peculiar quality of affecting, as a laxative, persons not in the habit of eating it. The other sorts are called *beh*, *deengkroo*, *roomkee*, *sepooee*, *bangsoo*, and *boulteh*; but it is not exactly ascertained, whether or not these are different species of grain, or the same kind receiving different names from the season of reaping it. The *beh* is reaped in July, the *chereh* in August, the *deengkroo* in September, the *roomkee* in October, and in November the *seepooee*, *bangsoo*, and *boulteh*. They have another small grain called *cutchoo*, and a variety of beans, as the *karass*, *burguddee*, and *tooraee*: the seed of the mustard plant they eat, but express no oil from it. Of the gourd and cucumber plants they have several kinds; and turmeric, yams, and tobacco, they cultivate; but the latter they have in small quantity, though very fond of it.

In their forests they have abundance of honey, but are ignorant of the method of separating it from the wax of the comb.

Their domestic animals are gyals, goats, hogs, dogs, and fowls; and of these the gyal is by much the most valued, both on account of its milk and its flesh. As already mentioned, it is a species of cow peculiar to these hills, where it is met in its wild state: in shape it resembles the heavy strong make of the wild buffalo, but has much shorter horns: its colour is brown, acquiring a lighter shade towards the belly, which, as well as the legs, is often white: its milk is nearly as rich as the cream of common cow milk, and its flesh constitutes the first luxury at a Kookie feast, and, except on very extraordinary occasions, is never given. The goats are larger and more hairy than those of the plains. In the other animals there is nothing peculiar. Notwithstanding that the Kookies have such a number of different articles of food, yet a scarcity of provisions frequently prevails among the tribes, when those upon a friendly footing always assist each other; and whatever may have been thus amicably given is rigidly repaid, in more favourable times, by the tribe which received it. A scarcity may be occasioned either by the irregularity of the season in a failure or excess of the periodical rains; or else by the incursions of enemies, who never fail to lay waste and destroy, if they can, every thing to be found without the parah. And the parah itself, in a fatally unguarded hour, is often destroyed also; when the helpless survivors, if any, of such a calamity are thrown upon the humanity of their neighbouring friends.

In the parahs they cook their victuals in earthen pots of their own manufacture resembling those of the Bengalees, but much stronger and thicker in substance. The hunter, however, in his excursions through the forests, boils his food in a particular kind of hollow bamboo. From the ashes of a different species of the same plant he extracts a substitute for salt to eat with his victuals; and with equal simplicity and readiness he kindles his fire by the friction of one piece of dried bamboo upon another. The Kookies have but one wife; they may, however, keep as many concubines as they please. Adultery may be punished with instant death by either of the injured parties, if the guilty are caught by them in the fact; it may otherwise be compromised by a fine of gyals, as the chief may determine. The frailty of a concubine is always compromised in this way, without disgrace to the parties. Fornication is punished in no other manner than by obliging the parties to marry, unless the man may have used violence; in which case he is punished, generally with death, either by the chief or by the relations of the injured female. Marriage is never consummated among them before the age of puberty. When a young man has fixed his affections upon a young woman either of his own or some neighbouring parah, his father visits her father, and demands her in marriage for his son: her father, on this, inquires what are the merits of the young man to entitle him to her favour, and how many he can afford to entertain at the wedding feast: to which the father of the young man replies, that his son is a brave warrior, a good hunter, and an expert thief; for that he can produce so many heads of the enemies he has slain, and of the game he has killed; that in his house are such and such stolen goods; and that he can feast so many (mentioning the number) at his marriage. On hearing this, the father of the girl either goes himself, or sends some confidential friend, to ascertain the facts; which if he finds to be as stated, he consents to the marriage, and it is celebrated by a feast given by him to the bridegroom and all their mutual friends. At night the bride is led by her husband from her father's house to his own, where he next day entertains the company of the preceding day, which is more or less numerous according to the connections and circumstances of the parties. When a chief marries, the whole parah is entertained by him; and should his bride be from another parah, as often happens, the two parahs feast and carouse with each other alternately. At these, and all their festivals, there is much drinking of a liquor made of the rice called *deengkroo*, of which the Kookies are very fond. There are two kinds of this liquor; the one pure and limpid, and the other of a red colour, from an infusion of the leaf of a particular tree called *bangmullah*, which renders it highly intoxicating. They indulge very freely in the use of both kinds, except when they go on hostile excursions: they then rigidly abstain from them. In January and February they usually marry, because they have provisions in the greatest plenty, and it is their most idle time.

When any person dies in a parah, the corpse is conveyed by the relations of the deceased, and deposited upon a stage raised under a shed erected for the purpose at some distance from the dwelling-house. While it remains there, it is carefully guarded day and night from the depredations of dogs and birds by some one of the family, and a regular supply of food and drink is daily brought and laid before it. Should more than one casualty occur in a family, the same ceremony is observed with respect to each corpse; and at whatever time of the year persons may happen to die in the parah, all the bodies must be kept in this manner until the 11th of April, called by the Bengalees *Beesoo*. On that day all the relations of the deceased assemble, and convey their remains from the sheds to different funeral piles prepared for them on a particular spot without the parah, where they are burnt; as are also the several sheds under which the bodies had lain from the period of their decease. After this melancholy ceremony is over, the whole party repairs to the house of him in whose family the first casualty occurred in that year, and partakes of an entertainment given by him in honour of the dead. On the following day a similar feast is given by him in whose family the next casualty of the season had happened; and thus the feast goes round in succession until one is given for each of the dead.

In this pious preservation of the dead till a certain day in the year, when only the last solemn funeral rites can be performed to their remains, there is a singular coincidence in the practice of the Kookies with that of some of the tribes of the North American Indians, as related in Bertram's Travels; and it must appear a curious fact, that in so very particular an instance there should be this similitude in the customs of two savage people placed in such opposite parts of the world; where the climate, and other peculiar local circumstances, are so totally different.

The Kookies have an idea of a future state, where they are rewarded or punished according to their merits in this world. They conceive that nothing is more pleasing to the Deity, or more certainly ensures future happiness, than destroying a number of their enemies. The Supreme Being they conceive to be omnipotent, and the Creator of the world and all that it contains. The term in their language for the Supreme Being is *Khogein Pootteeang*. They also worship an inferior deity under the name of *Sheem Sauk*, to whom they address their prayers, as a mediator with the Supreme Being, and as more immediately interesting himself in the concerns of individuals. To the Supreme Being they offer in sacrifice a gyal, as being their most valued animal; while to *Sheem Sauk* they sacrifice a goat only. In every parah they have a rudely formed figure of wood of the human shape representing *Sheem Sauk*; it is generally placed under a tree, and to it they offer up their prayers before they set out on any excursion or enterprise, as the deity that controls and directs their actions and destiny. Whenever, therefore, they return successful, whether from the chace or the attack of an enemy, they religiously place before *Sheem Sauk* all the heads of the slain, or of their game killed, as expressive of their devotion, and to record their exploits. Each warrior has his own particular pile of heads, and according to the number it consists of his character as a hunter and warrior is established in the tribe. These piles are sacred; and no man dares attempt to filch away his neighbour's fame, by stealing from them to add to his own. They likewise worship the moon, as conceiving it to influence their fortunes in some degree. And in every house there is a particular post consecrated to the deity, before which they always place a certain portion of whatever food they are about to eat. In the month of January they have a solemn sacrifice and festival in honour of the deity; when the inhabitants of several neighbouring parahs (if on friendly terms) often unite, and kill gyals and all kinds of animals, on which they feast, and dance and drink together for several days. They have no professed ministers of religion, but each adores the deity in such manner as he thinks proper. They have no emblem, as of *Sheem Sauk*, to represent the Supreme Being.

The Kookies having no coins among them, but such as find their way from the plains, for the few necessaries they want they barter their produce with the Choomeeas, who are the medium of commerce; and on these occasions the Choomeeas are never allowed to enter their parahs, but are obliged to remain at a certain distance, whither the articles of exchange are brought: such is their extreme jealousy of admitting any strangers within their parahs, as already noticed. They frequently visit a Mug chief, commonly known by the name of the *Comlahpore rajah*, who is settled among the hills in the southern parts of this district, and to whom they make themselves understood from the similarity of language. They can give no account of the country to the eastward of their hills; but they have a tradition that it is an open level country, like the plain of Chittagong. The Kookies are a great terror to the Bengalees settled on the borders of the jungles in the Runganeeah and Aurungabad districts; and a particular annoyance to the wood-cutters, whose business leads them far into the forests, and whom they have frequently surprised and cut off. Whenever an unfortunate event of this nature has occurred, it has always been remarked, that the Kookies carry nothing away from the slain but their heads, and such salt as they may have with them. They stand so greatly in awe of fire-arms, that the report of a single musket will put a whole party to flight: on this account the rajah of the Choomeeas, who is so immediately in their neighbourhood, keeps in his service a number of Pehluwans, or men with fire-arms: but, notwithstanding, his people have been obliged to abandon several places by the depredations committed by the Kookies. Though the rajah is upon terms of friendship with some of the tribes, yet, in the course of their migrations, these are succeeded by others that he knows nothing of, and of whose approach even he is ignorant until his people are cut off: he is therefore under the necessity of being constantly prepared to repel these attacks, which, from being always made in the night, it is impossible to guard against.

The following is a specimen of the Kookie language:

Meepa . . . . Man.

Noonaoo .... Woman.
Naoo .... A child.
Meepa Naoot'he ...... A male child.
Noonaoot'he .... A female child.
P'ha .... Father.
Noo .... Mother.
Chopooee .... Brother.
Charnoo .... Sister.
P'hoo .... Grandfather.
P'hee .... Grandmother.

Their numbers are reckoned thus:

Katka .... One.
Neeka .... Two.
Toomka .... Three.
Leeka .... Four.
Rungākā .... Five.
Rooka .... Six.
Sereeka .... Seven.
Rictka .... Eight.
Koaka .... Nine.
Soomka .... Ten.

By combining the first syllable of *soomka* with every intermediate number, as *soomkatka, soomneka, soomtoomka,* and so on, they reckon to twenty, which is *roboka.* The same combination now takes place with *roboka,* the final syllable *ka* being struck off; it goes on *robokātkā, roboneeka,* &c., to thirty, which is expressed by *soomtoomka,* or three tens. Forty is *soomleeka,* or four tens; fifty *soomrungaka,* or five tens; and so on to a hundred, which is expressed by *rezāka.* From *rezāka* the final syllable *ka* being struck off, a similar combination, as above, takes place with *neeka, toomka,* &c., to one thousand, called *saungka.* The preceding rule of striking off the final *ka* is observed with *saungka;* and thus they go on to hundreds of thousands, beyond which their ideas of numbers do not extend, as far as could be understood, from their having no terms to express them.

III. *An Essay on the Fecula of Green Plants.* By Professor Proust.

[Concluded from our last volume, p. 128.]

VI. *On Putrefaction.*

But what then is putrefaction? A change respecting which we have very few correct ideas.

When

When fecula, curd, flesh, or organized matters in general have passed a certain period of that change which we are accustomed to call putrefaction, they suddenly stop at a permanent state, where unknown combinations seem to wait for them, as if to salt and embalm them, as if to ensure their duration in this new state, and to secure them from further destruction.

When, for example, curd, fecula, gluten, flesh, have passed through the stages of an infection often destructive, and those derangements of colour and form which disfigure them, and have at length attained, some to the caseous state, vegetables and dunghills to that of mold, turf, poudrette, and meat to such a state as not to be annihilated after fifteen years of an ichorous stagnation, they all stop at that point without being able to pass beyond it, and without ever reaching, at least in our observation, that final solution which ought to terminate their existence, or reduce them to an earthy inert matter,—*non absimile cineribus*, as Stahl expresses it; in a word, to a state where no trace is observed of the radicals which organized them.

A putrefaction of this kind, strictly speaking, no where takes place. But we no sooner perceive derangements in the organization of an animal or vegetable matter, lividity and bad smell, than we immediately imagine it is commencing; and we confound, without perceiving that we do so, these appearances or phænomena which belong to a kind of fermentation little known, with the effects of that decomposition which alone ought to be accounted putrefaction,—if its end accords with the ideas we entertain of it, and if it be really that operation which nature has established to analyse, or resolve into their ultimate elements, those beings subjected to it.

Let us thence conclude that absolute putrefaction is a thing with which we are entirely unacquainted. But let us return to fecula: it is time to review that which is sufficiently divided to pass through the filter.

VII. We shall take, for example, the filtered juice of cabbage, one of those which furnish fecula in the greatest abundance; and the better to show the difference which there is between this second fecula and albumen, we shall subject the latter to the same tests. The white of an egg beat up in a pound of water, and filtered, will furnish the liquor of comparison we require.

1st. Immerse into water heated to 145 degrees two matrasses, one with filtered juice and the other with albumen. The juice a moment after becomes turbid, by caseous flakes which fall to the bottom. Albumen at that temperature does not experience the slightest change.

2d. Place over a furnace two matrasses, one with juice diluted in twenty parts of water, and the other with albumen. But the fecula, however much diluted it may be, will still be entirely separated by the heat. It is here that it clearly shows its insolubility. In regard to the water of the albumen, in proportion as it is heated it becomes opalised without ceasing to be transparent: it boils and is concentrated, without depositing flakes or any thing that has a resemblance to fecula. And if the evaporation be then completed in an open vessel, it leaves nothing but a varnish of white of egg. Darcet had before informed us that albumen diluted with a large quantity of water is no longer separable by heat. Albumen is a soluble mucilage, fecula is not; and the temperature which coagulates the latter makes no change in the state of the former.

3d. Water of albumen may be kept several days without alteration: on the other hand, the juice of plants is in a continual state of change, which always disturbs its transparency. When a juice is filtered it becomes turbid, and it does not cease to deposit white fecula.

4th. Albumen makes the juice of violets incline to a green colour, and reddens turnsole to blue. White fecula when washed produces none of these changes: and how should it? The juice of cabbages, hemlock, and many other plants, makes turnsole red. Albumen however has not the property of communicating a green of itself: we know that it is indebted for it to a mixture of alkali.

5th. Alcohol separates from the water of albumen light transparent shining flakes, which on the filter retain the appearance of baked white of egg. The juice of plants with alcohol gives only an opake whitish powder, which speedily falls to the bottom of the vessel.

6th. All acids, hydro-sulphurated water, and ammonia, precipitate the fecula dissolved in juices; but these re-agents make no change in water of albumen.

Oxygenated muriatic acid precipitates and oxidates white fecula. The same acid first oxidates and then precipitates albumen.

7th. Crystallized carbonate of potash, magnesia, muriate of soda, muriate of potash, muriate of ammonia, nitrate of potash, &c. when thrown into filtered juice force the fecula, which is naturally very little soluble, to be precipitated as it is dissolved. Water of albumen is not rendered turbid by any of these salts.

Conse-

Consequences.

White fecula deposited spontaneously, or by alcohol, by acids, salts, &c. is insoluble in water: on the other hand, acids which precipitate fecula do not alter solution of albumen.

No salt is capable of separating albumen from water; but the contrary is the case with fecula: it adheres so weakly to water that there is not one of them which does not separate it, and consequently oblige it to be deposited.

White of egg dried and left to soften returns to the same volume, opacity and whiteness, as baked albumen. The case with white feculæ is different: they acquire a strong brown colour. The greater part even become entirely black in drying, as those of cresses, cabbage, the *solanum licopersicum*, &c.; and if they become soft in water they never assume the appearances observed in white of egg. In a word, this fecula is nothing else than a part of the gluten which forms the base of green fecula. Thus, for example, if the fecula of white cabbage, separated by the filter, be compared with that which the juice of it gives by heat, both deprived of colouring matter, the smallest difference will not be found. But it is the white fecula in particular which dissolves easiest, because it is not, like green fecula, in a state of combination, which opposes its solution. All plants contain a portion of gluten, which not having been vivified by the light remains colourless.

Cabbage, succory, escarolle, and plants blanched by the art of the gardener, give also white fecula, but in much less quantity than when they remain green. The stem of the cabbage and that of hemlock give pale fecula in comparison of that produced by their leaves. But vegetables in general have not always need of being highly coloured externally to announce their abundance in gluten. The small joubarbe gives abundance of well coloured fecula, which is particularly rich in wax, as will be seen hereafter.

VIII. But it may be said, As albumen is the only product which has been remarked to possess the property of coagulating by heat, it seems natural thence to conclude, &c. But milk of almonds curdles also by heat, by alcohol, acids, &c. This is a fact well known in apothecaries' shops; and yet it has never been concluded from this appearance that emulsions contain white of egg; because, even if characters of animalization were observed in the principles of emulsion,

sion, it ought to exhibit other traits of a very striking nature before it could be treated as albuminous*.

It is under this point of view also that we ought to consider the gluten of fecula, since it is neither tenacious nor elastic, nor susceptible of fermentation like that of wheat†. Rouelle, in announcing it to chemists as a product analogous to that of wheat, wished only to exhibit a part of the characters which give them a similarity, those only which belong to the nature of their constituent principles, since external characters of resemblance do not exist: my object therefore, in defending the labours of that great master, is much rather to maintain in the catalogue of his discoveries that of an animalized matter found particularly in leaves, than gluten properly so called, because this indeed is the discovery which the author of the System of Chemical Knowledge has rendered problematical in his work. Destroy the aggregation in animalized matters; deprive silk, horn, wool, feathers, &c. of their form; it is evident then that, considered in their constituents alone, they will be albumen, gluten, febrine matter, any, every thing you please; because, if these constituents are every where the same, which has never yet been examined, and what would be the only means to establish the difference between them, would be to fix the proportions according to which nature has united them to give them existence.

But it may be added, If albumen does not issue from juices with characters so striking as you desire, we must pay attention to the extract, the salts and the acids, which are always found along with it, and which must disguise it a little: it is particularly in the water with which the farina has been washed that you ought to search for it, to find it in that state of purity which will leave no doubt in regard to its nature. Let us see then what the washing of the farina will exhibit.

* The comparison which Rouelle made of the green juice of plants to an emulsion rests on a much better foundation than he imagined. The cheese separated from the milk of almonds by one of these means, when washed and dried, gives oil by expression, and then all the products of caseum by distillation. This no doubt is the reason why almonds and all kinds of nuts give by nitric acid so large a quantity of azote.

The whey of almonds contains gum, a little extractive matter, and sugar, which is either of the kind obtained from the sugar cane, or of that which I discovered in grapes, and which I shall describe in speaking of fermentation.

† The gluten of wheat is susceptible of a fermentation peculiar to it. The gases thence disengaged in abundance are, the carbonic acid, and hydrogen pretty pure.

IX. Water employed in washing farina, like the juice recently filtered, is in a state of alteration, which continually increases, and which does not stop till the acid which arises from the fermentation of the saccharine principle has finished the precipitation of the gluten.

All the acids and all the salts which we have applied to juices operate in the same manner on the water of farina. Alcohol produces the same effect: but vinegar does not, because it dissolves the gluten. In a word, it is not by coagulation that acids separate gluten from juices and from the water of farina, since ammonia and salts do the same; but rather by seizing on the solvent of a substance which seems to derive its solubility from a pure and simple division, and not from an affinity comparable to that which unites gums, sugar, and albumen to water.

Water of farina exposed to a heat of 145 degrees abandons the gluten as it does the juice of plants. To dilute it in a very large quantity of water is not sufficient to give solubility to gluten: on the least exposure to heat it falls of itself.

I have collected so much as an ounce of gluten which heat separated from washings. Kept in its own moisture it fermented, produced vinegar and ammonia. It is now after two years an obscure cellular mass, odorous and savoury in the same degree as the cheese of gluten.

Let us then conclude that albumen has not yet appeared in vegetables. But we shall not therefore say that it cannot be formed there as well as in animals. The age in which we live, being more abundant than ever in observations, daily proves that there are but few products in either kingdom which can be considered as really exclusive. It will however be allowed, that to establish the existence of albumen by excluding the gluten of green plants, the learned author of the System of Chemical Knowledge has trusted too much to the slender support of mere appearance. Before he announced albumen he ought, in my opinion, to have strengthened his first observation by more conclusive facts than that of concrescibility alone. But let us not forget that, in so vast an enterprise as this, it is difficult for an author to cut out with equal precision all the materials of his edifice.

It will be with the same view that I shall extend these conclusions to other products which Fourcroy, without sufficient examination, has placed among the glutinous substances of vegetables.

“There

"There exists," says he, "an observation more exact and more positive than that of Rouelle in regard to the presence of this glutinous matter in the vegetable tissue which forms flax and paper," &c.* To call the author's attention to this passage is sufficient. More details on my part would have too much the appearance of censure. Fourcroy no doubt will suppress it in a new edition, as well as that of the paste of the mallows. If the paste of the mallows had a right to assume a place among the animalized products of vegetables, we ought to place there also the paste of almonds, paste of eggs, of marmalade, &c.

In regard to glue, which is found in the same chapter, every body knows that it is merely a kind of turpentine, an inflammable aromatic resin, soluble in alcohol, which vegetation forms in the filamentous tissue of the holly; in the fruit of the elder tree, its bark perhaps, and that of other individuals, but under no point of view a glutinous substance.

X. Potash readily dissolves green fecula and divides it into two parts: one attaches itself to the solvent, and the other separates itself under the form of a green powder which cannot be attacked by new potash. This powder, when washed and dried, gives by distillation the products of white wood and of flax: that is to say, nothing ammoniacal. This is the ligneous part, which is generally introduced into fecula by trituration.

This solution has all the characters of an animal solution: it exhales ammonia; it blackens the silver pan; and, by the action of acids, emits effluvia which darken traces made by white metals.

But here, as in soap from wool, a great part of the fecula experiences a degradation which deranges the mode and proportion of its radicals. Acids separate from it but very little fecula: the rest assumes an extractive character which disposes it to unite with water. Neither alcohol nor acids can separate this new extract from salts. It is of a fawn colour, and muriate of tin precipitates from it an obscure lake. In regard to the other, when collected and washed on a filter it exhibits this singularity, that it has not lost the property of crisping by the heat of boiling water.

Alcohol extracts from precipitated fecula a green colour more charged than from that which is fresh. This arises from the resin, which is not destructible like gluten, at-

* Vol. vii. p. 296.

taching

taching itself in greater quantity to that which has saved itself from destruction. In a word, this fecula gives by distillation ammoniacal products.

XI. An acid of eighteen or twenty degrees of the areometer disengages in abundance the azote from green fecula. A stronger acid dissolves it with facility, and separates from it a little of the powder, which is the ligneous remains of the plant. With whatever œconomy the nitric acid is managed, the oxalic acid is rarely obtained crystallized. It resolves itself into water and carbonic acid.

Solution of fecula always contains the bitter yellow of Welter, sulphuric acid, benzoic acid, oxalate of lime and tallow. If the solution of fecula charged with iron, that of *solanum licopersicon*, be precipitated with acetite of lead, a powder composed of oxalate and phosphate of lead and of oxide of iron is obtained. By heating it with the blowpipe the lead is burnt and even dissipated, and nothing remains but a globule of phosphate of iron.

When a vegetable product contains azote, sulphur, phosphorus, benzoic acid, tallow, bitter yellow and iron in abundance, one may rest assured that it belongs to the class of animalized substances.

Of Wax.

XII. Wax is the work of vegetation, and not of bees. It is, in my opinion, by nourishing themselves with the gluten, which accompanies it in the farina of the stamina, that they effect a separation of it. This farina gives abundance of ammonia, which induces me to believe that it contains gluten; and at present, since I have discovered wax in certain feculæ, I presume that if this farina were treated with nitric acid wax might be found in it.

Fecula of the small joubarbe gave me a quantity which surprised me. This wax is white, dry and brittle, and has no smell: it cannot be confounded with the sebaceous products given by other feculæ, those of hemlock and of the solanum. Messrs. Fernandez and Chabaneau, to assure themselves of it, examined it, chewed it, and were convinced that this product is nothing else than perfect wax.

The fecula of green cabbage gave me some of it also, but much less. Wax appears to me to be the varnish which vegetation extends over plants to secure them no doubt from the effects of mouldiness, which might injure their health. It is this varnish which divides rain and dew into pearly drops on the cabbage leaves, those of the poppy, and many others which exhibit to us that agreeable spectacle in our gardens. It is this wax that the curious gardener, when he presents a plum, a fig, or a bunch of grapes, is so desirous of preserving, that he avoids touching them as much as possible with his fingers.

At Paris, when an orange is taken from the paper covering in which it has been conveyed from Portugal, it is seen covered with a farinaceous coating, which may be removed by the blade of a knife, and applied to a taper to melt it and ascertain its nature.

The fecula of opium contains also a kind of tallow which approaches near to wax by its strong consistence, and which several apiologists have mentioned.

Raw silk also is covered with wax, which alcohol removes from it along with its colour, and which is separated from it by cooling.

Of some Feculæ less known.

XIII. When five or six pounds of saffron are treated together, to obtain from it the volatile oil and extract, there is observed in the decoction a fine dust which renders it turbid, deposits itself, and may be separated by straining through a cloth. This powder when washed shrinks on drying, and becomes grained like green fecula in summer: it speedily becomes putrid, and filled with worms, if not carefully preserved. This fecula by heat gives all the products of gluten. With alkalies and lemon juice it communicates to silk a very brilliant yellow dye.

Borage.

A plant may contain gluten in two states; one in the fecula, and the other dissolved in its juice by means of potash: of this kind is the juice of borage: when clarified it is thick and of a sea-green colour; some drops of acid separate from it a caseous curd, which is collected by the filter, and which is nothing else than gluten.

Elder.

Elder berries, amidst a juice strongly coloured, exceedingly gummy, and slightly saccharine, contain a fecula as green as that of spinach. When it has been well freed from the red colour, alcohol extracts from it a green tincture: the rest is gluten, which is in nothing different from that of fecula.

When these berries are bruised their glue adheres to the fingers: it has the same consistence as that of holly. Their juice left to ferment gives a very small quantity of spirit, which

which has a disagreeable odour. It is followed by an astonishing quantity of very good distilled vinegar.

Buck-thorn.

The juice of buck-thorn, which contains a bitter nauseous extract, gum, and a little sugar, is thickened by a greenish dirty matter, which is separated from it by heating it and leaving it to ferment. This pulp when well washed is of a bright green colour: it is gluten mixed with a little febrine matter: it gives carbonate of ammonia, &c.

Rose.

Its petals triturated furnish fine fecula slightly coloured, which gives the same products as gluten.

Grapes.

Fecula is found in great abundance in grapes: it forms the lees in wine: but to speak of this product would be anticipating what I have to say on fermentation. Gluten is found also in quinces, apples, and no doubt in other fruits; it is found in the acorn, chestnut, horse-chestnut, rice, barley, rye, pease and beans of all kinds. I shall resume the subject hereafter, on the difference between wheat which has germinated and that which has not undergone this operation.

IV. *Account of a Journey to the Summit of the Peak of Teneriffe: in a Letter from* L. Cordier, *Engineer of Mines, to* C. Devilliers *junior* *.

Santa-Cruz, in Teneriffe,
May 1, 1803.

MY DEAR FRIEND,

I have terminated my seventh geological campaign by a most interesting excursion. I had examined, with Neergard, the extinguished volcanoes in the centre of France. In the Pyrenees and Catalonia we discovered the immense remains of the antient strata of the globe, and the manner in which they have been covered by modern strata, which contain vestiges of an antique organization having no resemblance to that of the present age. I followed these observations in the interior of Spain, in the Sierra-Morena, as far as the famous Strait of Gibraltar, where my conjectures on the forces which determined the ultimate form of the continents received a new degree of probability. I had met

* From the *Journal de Physique*, Messidor, an. 11.

with

with almost all the species of strata which enter into the composition of the globe, including rock salt, bitumen, and sulphur. In the last place, I had conceived an idea of some of those memorable epochs when Nature exercised the energetic power she formerly possessed of creating and destroying, of raising or depressing, in order to bring our planet to its present state. It remained for me to go to one of those sanctuaries to which she in some measure retired after finishing her labour, where her activity is from time to time awakened, and gives proofs of existence which are sufficient to occasion terror and desolation among us. Do you not agree with me in opinion, that it is there only that one can be able to conceive by analogy the kind and the energy of the means which she must have displayed in the earliest periods? The hope of acquiring some ideas in regard to the Atlantide fixed my determination. And, indeed, could I venture to form conjectures respecting the existence of that country so celebrated and so problematical, but on the peak of Teneriffe?

We left Cadiz on the 4th of April, and had a pleasant passage: a shark, two tortoises, and a kind of spermaceti whale, were the only living objects we met with. I made some researches, but without success, in regard to those phosphorescent bubbles which appear in the sea water during the dark. On the 11th I traversed with eagerness a soil almost unknown to the naturalist. I beheld with pleasure the palm tree, the cotton shrub, the cactus, the coffee, and the banana tree, amidst a variety of others with which I was entirely unacquainted. The olive tree of Madeira, *olea madeirensis*; the tree which produces dragon's blood, *dracena draco*; the *lignum rhodium*, and *convolvulus floridus* which produces the rose wood so valuable, and an immense quantity of large euphorbias, among which were the *euphorbia canariensis* and the *euphorbia mauritanica*, attracted my attention as much as the broad triangular faces and yellow complexion of the inhabitants of the country. It is easily perceived that their blood is mixed with that of the antient islanders. I have since thought that it might be a punishment of nature, who took advantage of the incontinence of the conquerors to preserve the remembrance of their ferocity, by imprinting on the figure of their descendants the features of the Guanches, whom they cruelly destroyed, and with so little advantage.

On the 15th I was on the northern coast of the island: my instruments were repaired at nine in the morning, and I had removed the obstacles which ill-founded opinion had opposed

opposed to my enterprise of ascending the peak so early in the season. It is to be remembered that two gentlemen in the suite of lord Macartney were not able to succeed in the month of October 1792, on account of the cold and snow; and that at a later period captain Baudin was in danger of perishing there in the month of December. No person, therefore, was tempted to accompany me.

At six o'clock in the morning of the 16th I left the port of Orotava, trusting to the fine weather, and still more to my being accustomed to the snow and ice in the high mountains. I had with me a guide, a mule laden with water and provisions, and a mule driver. The peak stands in the southern part of the island, on an eminence which rises more than 1100 toises above the level of the sea. The day was employed in ascending to the bottom of this colossal peak.

Less time could not be employed in passing from the tropic to the polar ice. We travelled for five hours over gentle acclivities covered with the richest and most luxuriant vegetation. All the flowers in bloom exhaled the most delicious perfume, and the mildness of the temperature was equal to the sweetness of the air. On this occasion I could not help calling to mind Tasso, Armida, and the delights of the Fortunate Islands of antiquity. We were a long time in the middle of an immense wood of laurels, and a tall kind of heath, the elegant stems of which were covered with white blossom. Pines then announced to us a soil more ungrateful, because more elevated. The lava of currents, hitherto concealed by vegetation, began to appear in all their aridity and confusion. The pines were soon succeeded by a large species of broom, *spartium supranubium*, which extends to the eminence, where its dismal bushes, scattered over heaps of scoriæ or plains of volcanic sand, participate only with some lichens, the property of the driest and most arid desert that can be imagined.

We halted on a small sandy plain of pumice stone, bordered by two enormous currents of vitreous lava: some blocks of this lava, ranged in a semicircle, form here what is called *stanza de los Ingleses*, where we reposed for the night under a most beautiful sky. The barometer stood at 19 inches 9·5 lines, and the thermometer at 4·9 degrees. According to a corresponding observation made at the port, we were 1529 toises above the level of the sea. I was much astonished to see the broom, but indeed stunted, live at that elevation. A good fire which we made defended us from the intenseness of the cold.

The night was delightful, without a cloud, and scarcely a breath of air stirring. The colour of the sky appeared to be a very intense black: the stars sparkled with an exceeding bright light, by the help of which we faintly perceived the obscure vapours that veiled every thing below us. Every time I rose to observe the thermometer, I employed a considerable time in enjoying the charms of so rare and so beautiful a situation. Raised to that height in the atmosphere, seated quietly on that enormous mass of smoking ruins insulated in the ocean, being alone awake amidst the silence of nature, I admired with religious awe the majesty of its sleep; I recalled past events, and waited without impatience for the hour when I was going to satisfy the curiosity which had brought me so far to visit one of the oldest volcanoes of the earth.

At a quarter before five the thermometer fell to three degrees below zero. It was now day-light, and I set out with my guide. The acclivities are rapid, and formed by heaps of ruins which cover the currents. We had always to clamber up large masses of scoriæ and vitreous lava exceedingly sharp and rough. The snow retained in the furrows formed by the currents was fortunately solid. I took advantage of it to ascend from time to time in a less painful manner. Towards the summit we no longer found any thing but pumice stones, exceedingly fatiguing by their inclination and mobility. Without advancing too fast, we arrived at the end of three hours at the summit of the peak. To look to the bottom of the crater then behind me, and to survey the immensity of the horizon, was the affair of a moment; to enjoy the accomplishment of a project which I had long formed, was the affair of a second. The former, my dear Devilliers, was certainly worth the latter.

When my first eagerness was satisfied, I ensured my position on the most elevated edge. It is impossible to walk round the crater: it is necessary to remain on the northern part by which you have ascended. It appeared to me proper to place my instruments a little lower, to shelter them from the sulphureous vapours which the wind agitated above the crater before it carried them away. When I returned to my post I hoisted a flag, to announce my success to my good friends at the port of Oratava, and I quietly communicated to them the observations I had made. A line of vapour marked out on the horizon the separation of the sea and the air, forming an immense and perfect circle. On the smooth surface of this truly boundless plain arose the isles of Ferro, Canary, Gomera, and Palmo, which seemed to crowd around that

that awful mass which hangs over them. Each of them was ornamented with a band of light clouds, which extended several leagues in the north-east in a direction contrary to that of the trade wind. The sun, now near the tropic, diffused in tranquillity a most splendid light over the waters of the ocean. The atmosphere was as pure and as transparent as it was calm. My sight, however, was not sufficiently strong to distinguish the islands of Fuerte-Ventura and Lanzarotta, the profile of which was designed in the horizon at the moment of sun-rise: but I saw distinctly every thing around me; and, with the famous passage of Plato in my hand, I was able to examine whether I was standing on the remains of the Atlantide.

This research was naturally connected with the most general observations; but I soon found that it ought only to be a consequence of them. I obtained in succession all the proofs I could desire of the distinction which I had already made of two orders of volcanic matters. The modern lava has been thrown up amidst the ruins of an antient system of ejected matter much older, the immense fragments of which form the skeleton of the island, and sustain the eminence on which the peak is raised. Their greatest ridges, turned towards the summit, rise to more than 300 toises above all the new products. Their torn flanks exhibit a series of thick strata, almost all declining towards the sea, and composed alternately of ashes, volcanic sand, pumice stone, and compact lava often prismatic, porous lava and scoriæ. An innumerable quantity of new currents, which have flowed down from the peak, or which have issued from its sides, mark out a multitude of irregular furrows, which turn round or pass along the edges of these antique masses, and lose themselves in the sea on the western and northern side. More than eighty craters are dispersed throughout these currents, and increase with their remains the confusion which seems every where to prevail: in a word, the subterranean agents have not even respected the evidences and remains of their antient energy; they have pierced in many places the shreds of the antient strata, and new ejected matters have freely extended themselves over their declivities.

This antient volcanic system extended much further before its destruction: several of its enormous fragments insulated in the sea are a proof of it. It has been destroyed by forces similar to those which have opened the last valleys on the continents: this is proved by the form and respective position of the ruins. But is its destruction to be ascribed to one and the same period? I am inclined to think it is but in consequence of probabilities deduced from all the facts which relate to that grand epoch.

I shall not speak in detail of all those observations which cannot appear insulated; such as the existence of obsidian stone and petro-silex in currents, the incontestable transition of obsidian stone to pumice stone, &c. My position was too favourable not to take advantage of it in every manner possible. I rectified by the compass the large chart published by Lopes; and I several times repeated the only experiment I could make on the magnetic needle, namely, that on its inclination I always found it more than five degrees towards the south pole. At the height at which I was placed, the solar rays had not yet traversed two-thirds (in weight) of the atmosphere. I shall add some remarks to those I have already made on the origin and distribution of free heat in the atmosphere, in regard to the intensity of the rays, the density of the strata, and the height above the earth.

The puffs of vapour which warmed me from time to time, at length attracted me into the crater. One can descend into it only by three indentations: its edges are perfectly steep in the inside, and highest towards the north: it is of an elliptic form, and may be about 1200 feet in circumference and 110 in depth. Proceeding from the steep edges, the declivities consist of a snow-white earth, which forms a contrast with the beautiful orange colour and the bright splendour of the crystals of the sulphur which cover all the still solid masses. This earth results from the decomposition of the blackest and hardest vitreous and porphyritic lava: it is continually softened by a very hot moisture: one therefore glides rather than descends to the bottom of the crater. The whole, however, is solid; and the lowest part is occupied by blocks, which crumble down from the steep edges according as these matters are decomposed, and sink into the interior of the gulf.

The vapours, which issued in abundance from among these blocks and an infinite number of crevices, certainly came from the depth of several leagues, and retained a great intensity of heat. The thermometer exposed in a crevice speedily rose to 80 degrees, and no doubt would have risen higher had the tube been longer. To my great astonishment, I found that this scorching vapour was composed only of sulphur and water perfectly insipid. I searched, but in vain, for traces of sulphureous acid, soda, and hydrogen gas.

gas. What surprised me most, was to find close to the incrustations of sulphur, which it forms in a short time, real opal in thin mamellous plates.

Having ascertained the discovery of a formation so singular, I ascended, to terminate by barometric observations. I shall here mention only the first, because the rest gave me the same results in the calculation, a few differences more or less excepted. At eight o'clock, at the distance of a toise and a half from the summit, the barometer was at 18 inches 4 lines, and Reaumur's thermometer at 6·9 degrees. At the same hour, Mr. Little, an Englishman, who observed at the port with excellent instruments, the precision of which I had verified, found the barometer at 28 inches 5·6 lines, and the thermometer at 19·9 degrees: the station was seven toises above the level of the sea. The result of these data, corrected according to Deluc's method, and then increased by eight toises and a half, makes the height of the peak to be 1901·2 toises above the level of the sea.

This is far from the height of ten Italian miles, assigned to it by Ricciolo and Kircher; and the latter is nothing in comparison of the 15 marine leagues ascribed to it by Thomas Nicols. Why then should people convert into fabulous wonders every thing great and curious produced by nature? Do they imagine that by every thing they add in their extravagant accounts they increase the feeble merit of having seen them?

What has been said in regard to the intensity of the cold, the weakness of spirituous liquors, and the difficulty of respiration on the peak, is not more correct. In a word, I have several times found by experience that the opinion generally received in this respect is more than exaggerated. I assure you that the cold was very supportable; that liquors had lost none of their force; that the hydro-sulphureous vapours* were not injurious to respiration; and that we suffered no inconvenience from the rarity of the air, though it obliged us to make frequent pauses on approaching the summit. In the last place, what has been said, and often repeated, in very modern works respecting the appearance

* The author means *aquoso-sulphureous*, since he says that the vapours are composed only of pure water and sulphur. This proves, as I have already observed in the preliminary discourse in the *Journal de Physique*, year 9, that when we wish to express the combinations of inflammable gas with sulphur and other substances, we ought not to say *hydro-sulphureous* but *hydrogeno-sulphureous*, according to the principles of the new nomenclature.—*Note of Delametherie.*

of the sun's disk as seen from the summit of the peak, is absolutely false.

The enjoyment of three hours and a half soon elapsed. This was little, no doubt, in comparison of the eight hundred leagues which I had travelled to procure it: but these hours, such as I spent them, were and always will be to me of infinite value. I had scarcely time to arrive at the port of Orotàva with day-light; and I had still to make specimens of all the different kinds of lava. I was obliged to quit for ever one of the most beautiful scenes in nature; and I quitted this famous summit, bidding it, with regret, an eternal farewell.

We descended very speedily: the lava, which had rendered our efforts exceedingly laborious, crumbled to pieces under our feet. We therefore soon passed *las norices del pico*, two small spiracles at the bottom of the pap, which continually throw up water and vapour. The snow softened by the sun was less dangerous, but I often sunk into it up to the knees; which was not very tempting to my guide, who had not ventured to trust himself to it in ascending, and who was afraid of sinking into it altogether. We stopped for a moment near *la cueva del gelo*. This is one of those wonders to the vulgar, respecting which so many fables are told by travellers. You will have an idea of it, if you imagine one of those vaults which the liquid lava forms above itself to have burst exactly over a large cavity, the bottom of which is filled with snow abundantly impregnated with water: in summer it is sometimes dry. At a quarter before one we arrived at La Stauze, somewhat fatigued with the carriage of my valuable and heavy collection.

Our small caravan soon set out, but at a slower pace. Till that moment, the rapidity of our march and the multitude of observations had scarcely permitted me to breathe. In descending I had time to reflect on every thing by which I had been most interested, and it was then only that I began to enjoy what I had seen. In this satisfactory account which I gave to myself, I soon discovered an error, which was, that I had not attempted to ascertain whether there existed any thing remarkable at the bottom of the peak towards the south-west. This fault could not be remedied. You will soon see that it was a great one, and whether it was properly repaired eight days after.

The state of the atmosphere had changed since the morning. The clouds, now united, formed only a moveable stratum on a level with the heights, and which the trade-wind carried before it without breaking: we had not time to traverse it before sun-set. The declivity of the ground, and the darkness, rendered our march exceedingly painful till we reached the first habitations; where our guide soon kindled some pieces of split fir-wood, by the light of which we continued our route; and arrived at the port of Orotava at nine in the evening. I found my friends uneasy at my long delay: they had distinctly observed the flag which I hoisted in the morning.

I have not time to add any thing further to this sketch of one of the most interesting journeys that those who occupy themselves with the structure of the globe can undertake. Since that time I have not neglected any opportunity of multiplying or verifying my observations. I have collected the most singular notions in regard to the internal composition of more than 600 modern currents of lava. What would become of our numerous systems in regard to volcanoes, if it be true that we have hitherto been acquainted only with the superficial part of their productions, scoriæ and porous lava? This is as if we were to judge of different liquors without seeing any part of them but the foam.

The eruption which choked up the port of Guarachico in 1706 was attended with this peculiarity, that the current traversed sixteen leagues in five hours: the extremity of it has been carried away by the sea. One may observe that it is composed of prismatic basaltes, black and somewhat porous, with large crystals of augite and olivin.

The last eruption took place in 1798. New mouths, three in number, were opened on the declivity of an enormous prolongation of the base of the peak towards the south-west, 1270 toises above the level of the sea. As the form of the mountains on this side justified my regret, I made every effort to repair my fault; and I can now say, that of all the travellers who preceded me, I ascended quietly for three hours along the declivities of the prolongation. When I reached the height of 1600 toises I found myself on the edges of a vast crater, to which none of those we are acquainted with can be compared: it is nearly a league and a half in circumference. Though very old, it is exceedingly steep in the inside, and still exhibits the image of the most dreadful violence of the subterranean fires. The peak has been raised on the edges of this immense mouth. The impossibility of walking round the summit of the peak, or rather the custom which travellers have of exactly following the traces of their predecessors, is no doubt the cause of this curious fact having hitherto remained unknown.

My second ascent of the peak was not only a lesson: it furnished me, as well as my researches respecting an eruption which took place in 1705 at Guimar, with a number of facts, of which I wish I were able to give you an account. But I must be contented with assuring you that few of my journeys have afforded me so much satisfaction as the present. I had every assistance and aid I could desire, both from individuals and from the Spanish government. I shall never forget the reception I met with from the marquis de Perlasca, the governor-general of the islands; and from the marquis de Casa Cajigal, who commands under him.

V. *On Mr.* Arthur Woolf's *improved Apparatus, applicable to Steam Engines and other Purposes of Art and Manufacture: including a Description of two Boilers now erecting at Messrs.* Meux's *Brewery.*

Mr. Woolf's improved apparatus consists, First, of two or more cylindrical vessels properly connected together, and so disposed as to constitute a strong and fit receptacle for water, or any other fluid intended to be converted into steam, whether at the usual heats or at temperatures and under pressures uncommonly high; and also to present an extensive portion of convex surface to the current of flame, or heated air or vapour from a fire: Secondly, of other cylindrical receptacles placed above these cylinders, and properly connected with them, for the purpose of containing water and steam, and for the reception, transmission, and useful application of the steam generated from the heated water or other fluid: and, Thirdly, of a furnace so adapted to the cylindrical parts just mentioned, as to cause the greater part of the surface of all and each of them, or as much of the said surface as may be convenient or desirable, to receive the direct action of the fire, or heated air and vapour.

That our readers may be able fully to comprehend the way in which Mr. Woolf constructs his apparatus, we shall present some plans and views, with such a description as will, we hope, convey a pretty correct idea of their nature.

Fig. 1. (Plate I.) represents one of his boilers in its most simple form. It consists of eight tubes marked *a*, made of cast iron or any other fit metal, which are each connected with the cylinder A placed above them, as shown in the side view fig. 2, in which the same letters refer to the same parts

parts as in fig. 1. In fig. 2. is also shown the way in which the fire is made to act. The fuel rests on the bars at B, and the flame, heated air and vapour, being reverberated from the part above the two first smaller cylinders, goes under the third, over the fourth, under the fifth, over the sixth, under the seventh, and partly over partly under the eighth small cylindric tube. The direction of the flame, till it reaches the last-mentioned tube, is shown by the dotted curved line and arrows. When it has reached that end of the furnace it is carried by the flue C to the other side of a wall, built under and in the direction of the main cylinder A, and then returns under the seventh smaller cylinder, over the sixth, under the fifth, over the fourth, under the third, over the second, and partly over partly under the first; when it passes into the chimney. The wall before mentioned, which divides the furnace longitudinally, answers the double purpose of lengthening the course which the flame and heated air have to traverse, giving off heat to the boiler in their passage, and of securing from being destroyed by the fire the flanges or other joinings employed to unite the smaller tubes to the main cylinder. The ends of the smaller cylindric tubes rest on the brick-work which forms the sides of the furnace, and one end of each of them is furnished with a cover, secured in its place by screws or any other adequate means, but which can be taken off at pleasure, to allow the tubes to be freed, from time to time, from any incrustation or sediment which may be deposited in them. To any convenient part of the main cylinder A, a tube is affixed, to convey the steam to the steam-engine, or to any vessel intended to be heated by means of steam.

When very high temperatures are not to be employed, the kind of boiler just described is found to answer very well; but where the utmost force of the fire is desirable, Mr. Woolf, for a reason which shall be afterwards mentioned, combines the parts in a manner somewhat different, though the same in principle. Having been permitted to inspect two boilers of this kind which he is now erecting in Messrs. Meux's brewery, and even to take copies of such parts of the plans as were necessary for our present purpose, we persuade ourselves a short description of an apparatus so curious, and at the same time so useful, will prove highly acceptable to our readers.

In fig. 3, A is the main cylinder crossing the smaller cylinders *a*,*a*,*a*, half way between their middles and ends, but not joined to them at the points at which it crosses them. It is put in this place that it may come over that part of the furnace

furnace S,S,S, through which the flame first passes, and receive its direct action, which it does over nearly a half of its surface, as may be seen by looking at the vertical section A SS, fig. 6. The smaller cylinders have a communication with the main cylinder in the following manner:—Three cylinders, C C C, are placed parallel to the main cylinder A, over the part of the furnace by which the flame returns, in such a manner that each of the cylinders C C C takes in three of the smaller cylinders *a a a*, being united to and connected with them as shown in fig. 4, which is a longitudinal vertical section of that part of the apparatus. The cylinders C C C have a direct communication with the main cylinder A by the pipes or tubes P P P, as may be better seen by the cross vertical section, fig. 6, in which the same parts are marked with the same letters as in figures 3 and 4. The three tubes C C C are preferred to one long tube, to prevent any derangement taking place in the furnace or in the tubes, by the expansion and contraction, occasioned by changes of temperature, which is more considerable in one tube of the whole length of the furnace than when divided into three portions; and it is for the same reason that the tube A is not made to communicate directly with the smaller tubes *a a a*, but mediately by means of the tubes marked C and P.—N. B. The two outermost of the tubes marked P, instead of going parallel to the middle tube P, may both be inclined towards it, as one of them is from *m*, so as to join the cylinder A near the middle; or any other direction may be given to them, to prevent derangement by expansion.

The tubes C and *a* are kept from separating by bolts from the inside of *a* passing through the top of C, where they are secured by nuts screwed on to them (see fig. 5.); and these parts of C are so contrived, that by taking off any of the nuts a cover may be removed, and a hole presented large enough to admit a man's hand into C to clean it out.

Fig. 5 is a longitudinal vertical section of the boiler and furnace, through the centre of the axis of the main cylinder A, showing the course which the flame and heated air are forced to take. The first three small cylinders are completely surrounded with flame, being directly over the fire; the flame is stopped by the brick-work W over the fifth, and forced to pass under it, and then over the sixth, where it again meets with an interruption, which forces it to go under the seventh, over the eighth, and partly over partly under the ninth. It then turns round the end of the longitudinal wall which divides the furnace, and passes over the eighth smaller cylinder, under the seventh, and so on alternately over

over and under the other tubes, till it reaches the chimney B, fig. 4. The wall that divides the furnace may be seen in fig. 3, N, N, and in fig. 6, at N.

To secure a free communication between the different parts of the boiler, the three tubes of the middle cylinder C are connected with those of the two exterior C's by two pipes *o o*. The other ends of the tubes *a a a* are each fitted with a cover properly secured and bolted, but which can be taken off occasionally to clean out the boiler.

In working with such boilers, the water carried off by evaporation is replaced by water forced in by the usual means; and the steam generated is carried to the place intended, by means of tubes connected with the upper part of the cylinder A.

Mr. Woolf has taken out a patent for this very valuable contrivance. In the specification he has lodged of his invention, means are pointed out for applying it to the boilers of steam-engines already in use, by ranging a row of cylinders below the present boiler, and connecting them with each other and with the boiler. Directions are also given for constructing boilers composed of cylinders disposed vertically; but as we consider such an arrangement inferior to the horizontal, and as being introduced, perhaps, chiefly for the purpose of preventing his patent from being infringed by evasion, we shall not give any further description of it. We cannot, however, dismiss this article without quoting some of Mr. Woolf's remarks, which may prove very useful.

"It may not be improper (says he) to call the attention of those who may hereafter wish to construct such apparatus to one circumstance, namely, that in every case the tubes composing the boiler should be so combined and arranged, and the furnace so constructed, as to make the fire, the flame and heated air to act around, over and among the tubes, embracing the largest possible quantity of their surface. It must be obvious to any one that the tubes may be made of any kind of metal; but I prefer cast iron as the most convenient. The size of the tubes may be varied: but in every case care should be taken not to make their diameter too great; and it must be remembered, that the larger the diameter of any single tube in such a boiler the stronger must it be made in proportion, to enable it to bear the same expansive force as the smaller cylinders. It is not essential, however, to my invention that the tubes should be of different sizes; but I prefer that the upper cylinders, especially the one which I call the main cylinder, should be larger than

than the lower ones, it being the reservoir as it were into which the lower ones send the steam, to be thence conveyed away by the steam pipe or pipes. The following general direction may be given respecting the quantity of water to be kept in a boiler on my construction:—it ought always to fill not only the lower tubes, but the main cylinder A and the cylinder C to about half their diameter; that is, as high as the fire is allowed to reach—and in no case ought it to be allowed to get so low as not to keep full the necks or branches which join the smaller cylinders, marked with the letter *a*, to the cylinders A or C; for the fire is only beneficially employed when applied, through the medium of the interposed metal, to water, to convert it into steam: that is, the purpose of my boiler would in some measure be defeated, if any of the parts of the tubes exposed to the direct action of the fire should present in their interior a surface of steam instead of water, to receive the transmitted heat, which must more or less be the case if the lower tubes, and even a part of the upper, be not kept filled with the liquid.

"As to the construction of the furnaces, though that must be obvious from the drawings, it may not be improper here to remark that they should always be so built as to give a long and waving course to the flame and heated air, or vapour, forcing them the more effectually to strike against the sides of the tubes which compose the boiler, and so to give out a large portion of their heat before they reach the chimney: unless this be attended to, there will be a much greater waste of fuel than necessary; and the heat communicated to the contents of the boiler will be less from a given quantity of fuel.

"My invention is not only applicable to all the uses to which the boilers in common use are generally applied, but to all of them with much better effects than the latter, and can besides be applied to purposes in which boilers, constructed as they have hitherto been, would be of little or no use. The working of all kinds of steam engines is one important application of my invention; for the steam may be raised, in a boiler constructed in the manner before described, to such a temperature, and consequently to such an expansive force, as to work an engine even without condensing the steam, by simply allowing it to escape into the atmosphere after it has done its office, as proposed by Mr. James Watt, in the specification of his patent, dated January 5, 1769: where he says, engines may be worked by the force of steam only, by discharging the steam into the

the open air. In all cases where it is desirable to heat or boil water, or other fluids and substances, without the direct application of fire to the vessel or vessels containing them, which in such cases become secondary boilers, the use of my apparatus will produce effects superior to any obtainable by other means,—no more being necessary than to make the vessel, or secondary boiler, containing the water or other fluids, and the substances immersed or dissolved in, or blended or mixed with the water or other fluid, to communicate, by means of a tube or tubes, with the prime boiler, constructed in the manner before described. In such cases, as in making extracts of every kind for the various purposes of arts and manufactures, and for the simple boiling of water or watery fluids, the steam should go directly into the vessel, or secondary boiler, whose contents are to be heated or boiled; and the orifice or orifices of the pipe or pipes through which the steam is conveyed should go to a considerable depth in the fluid, that the steam may be the better able to give off its heat and be condensed before it can reach the surface: and in every such case, an allowance should be made for the increase which will be made to the quantity of liquid in the vessel to be heated, by the quantity of steam which will be condensed in the same before the process be ended. The vessels into which the steam is thrown may be either open or close, as the nature of circumstances may require: but where extracts are to be made from vegetable or other matters from which extracts are or may be made, as from hops, bark, drugs and dye-stuffs, for brewing, tanning, dyeing and other processes, the materials will be much more completely exhausted of all their valuable parts; and in many instances they will be completely dissolved by employing close vessels, which in that case must be made very strong,—a thing not difficult to be accomplished, when it is recollected that they may be at a distance from, and consequently out of the power of being deranged by, the fire, and that they may be surrounded with, and as it were buried in, massy stone or brick-work, in addition to other and obvious means of securing them. My apparatus so employed becomes, in fact, an improved Papin's digester on a large scale. I do not wish to be understood as claiming the merit of having been the first who applied steam in the manner just described to boil water and other fluids, but merely as pointing out an important use to which my apparatus is applicable, and in which the effect obtained will be much greater than by any other means.

"Another important use to which my invention can be applied with better effect than the means now in use, is that

that of distillation on the large scale, and that by either sending the steam directly into and among the contents of the still or alembic, or by inclosing the still in another vessel, and making the steam of a high temperature, to circulate in and to occupy the space between the exterior surface of the still and the interior surface of the containing vessel. In either case, all danger of burning or singeing the materials operated upon is done away, and a much more pleasant and pure spirit will be obtained than by the methods now in common use. I need not stop here to show the reason why, even in the case of throwing the steam directly into the still, the spirituous part will be the first to rise and pass over into the receiver.

"I might mention many other useful applications that may be made of my invention; but I shall only state one more, namely, to the drying of gunpowder, and lessening the danger of explosions in the manufacture of that article. By means of my invention, any desired temperature, necessary for that purpose, may be produced where the powder is to be dried, without the necessity of having fire in, or so near the place as to endanger its safety; for by employing steam only, conveyed through pipes, and properly applied and directed, without allowing any of it to escape into the room or apartment where the powder is, any competent workman can produce a heat equal to that found necessary for drying gunpowder, or much higher if required. Nor is the lessening of the danger of explosions the only advantage which this way of drying gunpowder holds out—it presents another and an essential one for the goodness of the article—the heat can be completely regulated so as to prevent, or at least lessen, the partial decomposition of the powder by the sublimation of the sulphur, which is found to take place by the methods at present in use."

In every case Mr. Woolf uses two safety valves, at least, in his apparatus, to prevent accidents: a precaution which cannot be too strongly enforced; as it may happen, when but one is employed, it may by some accident get locked, and the works and people about them be exposed to the danger of an explosion.

Besides the common safety valves, Mr. Woolf has also introduced a valve, of a new construction, into the steam-pipe itself, to regulate the quantity that shall pass from the boiler. In fact, it is a self-acting regulator; and being extremely ingenious, we think we shall be gratifying our readers by laying a description of it before them, which we shall in our next, with an accurate engraving.

The two boilers now constructing for Messrs. Meux will not

not be the least curious part of the immense collection of ingenious mechanism of which their premises can boast. They are not intended for the steam engine, but to supersede the necessity of applying fire directly to their two large boilers, each of which are of the contents of about 800 barrels. They are in future to be heated by steam, sent into them from these new boilers; which will not only prevent the wear to which the coppers are exposed by the usual practice, which costs a large sum of money yearly, but, it is expected, will produce a large saving in fuel.

We understand also, that when these boilers are finished Messrs. Meux mean to have one constructed for their steam engine. Indeed, if these boilers shall be found to answer the purposes expected from them, and we can see no reason to induce us to doubt of their success, it will occasion a complete change in numerous departments of arts and manufactures, in which steam and the heat that may be obtained from it are, or may be, advantageously employed*.

VI. *On the Motion of Bodies affected by Friction. By the Rev.* Samuel Vince, *A. M. of Cambridge. Communicated by* Anthony Shepherd, *D. D. F. R. S. Plumian Professor of Astronomy and Experimental Philosophy at Cambridge*†. *Read November* 25, 1784.

The subject of the paper which I have now the honour of presenting to the Royal Society, seems to be of a very considerable importance both to the practical mechanic and to the speculative philosopher; to the former, as a knowledge of the laws and quantity of the friction of bodies in motion upon each other will enable him at first to render his machines more perfect, and save him in a great measure the trouble of correcting them by trials; and to the latter, as those laws will furnish him with principles for his theory, which when established by experiments will render his conclusions applicable to the real motion of bodies upon each other. But, however important a part of mechanics this subject may constitute, and however, from its obvious uses, it might have been expected to have claimed a very considerable attention both from the mechanic and philosopher, yet it has, of all the other parts of this branch of natural philosophy, been the most neglected. The law by

* Mr. Woolf has adopted for the door of his furnace Mr. Roberton's invention for consuming smoke, which we have therefore not described, having given a full account of it in our eleventh volume.

† From the Philosophical Transactions, vol. lxxv.

which

which the motions of bodies are retarded by friction has never, that I know of, been truly established. Musschenbroek says that in small velocities the friction varies very nearly as the velocity, but that in great velocities the friction increases: he has also attempted to prove that, by increasing the weight of a body the friction does not always increase exactly in the same ratio; and that the same body, if by changing its position you change the magnitude of the surface on which it moves, will have its quantity of friction also changed. Helsham and Ferguson, from the same kind of experiments, have endeavoured to prove that the friction does *not* vary by changing the quantity of surface on which the body moves; and the latter of these asserts that the friction increases very nearly as the velocity; and that by increasing the weight, the friction is increased in the *same* ratio. These different conclusions induced me to repeat their experiments, in order to see how far they were conclusive in respect to the principles deduced from them: when it appeared that there was another cause operating besides friction, which they had not attended to, and which rendered all their deductions totally inconclusive. Of those who have written on the theory, no one has established it altogether on true principles. Euler (whose theory is extremely elegant, and which, as he has so fully considered the subject, would have precluded the necessity of offering any thing further, had its principles been founded on experiments) supposes the friction to vary in proportion to the velocity of the body, and its pressure upon the plane, neither of which are true: and others, who have imagined that friction is a uniformly retarding force (and which conjecture will be confirmed by our experiments), have still retained the other supposition, and therefore rendered their solutions not at all applicable to the cases for which they were intended. I therefore endeavoured by a set of experiments to determine,

1st. *Whether friction be a uniformly retarding force.*

2dly, *The quantity of friction.*

3dly, *Whether the friction varies in proportion to the pressure or weight.*

4thly, *Whether the friction be the same, on whichever of its surfaces a body moves.*

The experiments, in which I was assisted by my ingenious friend the Rev. Mr. Jones, Fellow of Trinity college, were made with the utmost care and attention; and the several results agreed so very exactly with each other, that I do not scruple to pronounce them to be conclusive.

2. A plane was adjusted parallel to the horizon, at the extremity

extremity of which was placed a pulley, which could be elevated or depressed in order to render the string which connected the body and the moving force parallel to the plane. A scale accurately divided was placed by the side of the pulley, perpendicular to the horizon, by the side of which the moving force descended; upon the scale was placed a moveable stage, which could be adjusted to the space through which the moving force descended in any given time, which time was measured by a well regulated pendulum clock vibrating seconds. Every thing being thus prepared, the following experiments were made to ascertain the law of friction. But let me first observe, that if friction be an uniform force, the difference between it and the given force of the moving power must be also uniform; and therefore the moving body must descend with an uniformly accelerated velocity, and consequently the spaces described from the beginning of the motion must be as the squares of the times, just as when there was no friction, only they will be diminished on account of the friction.

3. Exp. 1. A body was placed upon the horizontal plane, and a moving force applied, which from repeated trials was found to descend $52\frac{1}{2}$ inches in 4″, for by the beat of the clock and the sound of the moving force when it arrived at the stage, the space could be very accurately adjusted to the time: the stage was then removed to that point to which the moving force would descend in 3″, upon supposition that the spaces described by the moving power were as the squares of the times; and the space was found to agree very accurately with the time: the stage was then removed to that point to which the moving force ought to descend in 2″, upon the same supposition; and the descent was found to agree exactly with the time: lastly, the stage was adjusted to that point to which the moving force ought to descend in 1″, upon the same supposition; and the space was observed to agree with the time. Now in order to find whether a difference in the time of descent could be observed, by removing the stage a little above and below the positions which corresponded to the above times, the experiment was tried, and the descent was always found too soon in the former, and too late in the latter case; by which I was assured that the spaces first mentioned corresponded exactly to the times. And, for the greater certainty, each descent was repeated eight or ten times; and every caution used in this experiment was also made use of in all the following.

Exp. 2. A second body was laid upon the horizontal plane, and a moving force applied which descended $41\frac{1}{4}$ inches in 3″:

3″: the stage was then adjusted to the space corresponding to 2″, upon supposition that the spaces descended through were as the squares of the times; and it was found to agree accurately with the time: the stage was then adjusted to the space corresponding to 1″, upon the same supposition; and it was found to agree with the time.

Exp. 3. A third body was laid upon the horizontal plane, and a moving force applied, which descended $59\frac{1}{8}$ inches in 4″: the stage was then adjusted to the space corresponding to 3″, upon supposition that the spaces descended through were as the squares of the times, and it was found to agree with the time: the stage was then adjusted to the space corresponding to 2″, upon the same supposition, and it was found to agree with the time: the stage was then adjusted to the space corresponding to 1″, and was found to agree with the time.

Exp. 4. A fourth body was then taken and laid upon the horizontal plane, and a moving force applied, which descended 55 inches in 4″: the stage was then adjusted to the space through which it ought to descend in 3″, upon supposition that the spaces descended through were as the squares of the times, and it was found to agree with the time: the stage was then adjusted to the space corresponding to 2″, upon the same supposition, and was found to agree with the time: lastly, the stage was adjusted to the space corresponding to 1″, and it was found to agree exactly with the time.

Besides these experiments, a great number of others were made with hard bodies, or those whose parts so firmly cohered as not to be moved *inter se* by the friction; and in each experiment bodies of very different degrees of friction were chosen, and the results all agreed with those related above: we may therefore conclude that *the friction of hard bodies in motion is an uniformly retarding force.*

But to determine whether the same was true for bodies when covered with cloth, woollen, &c. experiments were made in order to ascertain it; when it was found in all cases, that the retarding force increased with the velocity; but, upon covering bodies with paper, the consequences were found to agree with those related above.

4. Having proved that the retarding force of all hard bodies arising from friction is uniform, the quantity of friction, considered as equivalent to a weight without inertia drawing the body on the horizontal plane backwards, or acting contrary to the moving force, may be immediately deduced from the foregoing experiments. For let M = the moving

moving force expressed by its weight; F = the friction; W = the weight of the body upon the horizontal plane; S = the space through which the moving force descended in the time t expressed in seconds; $r = 16\frac{1}{12}$ feet; then the whole accelerative force (the force of gravity being unity), will be $\frac{M-F}{M+W}$; hence, by the laws of uniformly accelerated motions, $\frac{M-F}{M+W} \times r\,t^2 = S$, consequently $F = M - \frac{\overline{M+W} \times S}{r\,t^2}$. To exemplify this, let us take the case of the last experiment, where $M = 7$, $W = 25\frac{3}{4}$, $S = 4\frac{7}{12}$ feet, $t = 4''$;

hence

$$- 7 - \frac{32\frac{3}{4} \times 4\frac{7}{12}}{16\frac{1}{12} \times 16} = 6.417$$; consequently the friction

was to the weig[illegible]

And the great accurac[illegible] rubbing body as 6.4167 to 25.75. method is manifest from hen[illegible]ermining the friction by this had been made in the descent (an[illegible]if an error of one inch made may always determine the space [illegible]iments carefully exactness), it would not have affected the conclu[illegible]h greater part of the whole. [illegible]dth

5. We come in the next place to determine whether friction, *cæteris paribus*, varies in proportion to the weight or pressure. Now if the whole quantity of the friction of a body, measured by a weight without inertia equivalent to the friction drawing the body backwards, increases in proportion to its weight, it is manifest that the retardation of the velocity of the body arising from the friction will not be altered; for the retardation varies as $\frac{\text{Quantity of friction}}{\text{Quantity of matter}}$; hence, if a body be put in motion upon the horizontal plane by any moving force, if both the weight of the body and the moving force be increased in the same ratio, the acceleration arising from that moving force will remain the same; because the accelerative force varies as the moving force divided by the whole quantity of matter, and both are increased in the same ratio; and if the quantity of friction increases also as the weight, then the retardation arising from the friction will, from what has been said, remain the same; and therefore the whole acceleration of the body will not be altered: consequently the body ought, upon this supposition, still to describe the same space in the same time. Hence, by observing the spaces described in the same time, when both the body and the moving force are increased in the same ratio, we may determine whether the friction increases in proportion to the weight. The following ex-

 periments

periments were therefore made in order to ascertain this matter.

Exp. 1. A body weighing 10 oz. by a moving force of 4 oz. described in 2″ a space of 51 inches; by loading the body with 10 oz. and the moving force with 4 oz. it described 56 inches in 2″; and by loading the body again with 10 oz. and the moving force with 4 oz. it described 63 inches in 2″.

Exp. 2. A body, whose weight was 16 oz. by a moving force of 5 oz. described a space of 49 inches in 3″; and by loading the body with 64 oz. and the moving force with 20 oz. the space described in the same time was 64,orce of

Exp. 3. A body weighing 6 oz. by a moving the body 2½ oz. described 28 inches in 2″; an 10 oz. the space de-
with 24 oz. and the moving fo4 inches.
scribed in the same ing 8 oz. by a moving force of 4

Exp. 4. A bo inches in 2″; and by loading the body oz. describaid the moving force with 4 oz. the space de-
with in the same time was 47 inches.

Exp. 5. A body whose weight was 9 oz. by a moving force of 4½ oz. described 48 inches in 2″; and by loading the body with 9 oz. and the moving force with 4½ oz. the space described in the same time was 60 inches.

Exp. 6. A body weighing 10 oz. by a moving force of 3 oz. described 20 inches in 2″; by loading the body with 10 oz. and the moving force with 3 oz. the space described in the same time was 31 inches; and by loading the body again with 30 oz. and the moving force with 9 oz. the space described was 34 inches in 2″.

From these experiments, and many others which it is not necessary here to relate, it appears that the space described is always increased by increasing the weight of the body and the accelerative force in the same ratio: and as the acceleration arising from the moving force continued the same, it is manifest that the retardation arising from the friction must have been diminished; for the whole accelerative force must have been increased on account of the increase of the space described in the same time; and hence, (as the retardation from friction varies as $\frac{\text{Quantity of friction}}{\text{Quantity of matter}}$) *the quantity of friction increases in a less ratio than the quantity of matter or weight of the body.*

6. We come now to the last thing which it was proposed to determine, that is, whether the friction varies by varying the surface on which the body moves. Let us call two of the

the surfaces A and a, the former being the greater, and the latter the less. Now the weight on every given part of a is as much greater than the weight on an equal part of A, as A is greater than a; if therefore the friction was in proportion to the weight, *cæteris paribus*, it is manifest that the friction on a would be equal to the friction on A, the whole friction being, upon such a supposition, as the weight on any given part of each surface multiplied into the number of such parts, or into the whole area; which products, from the proportion above, are equal. But from the last experiments it has been proved that the friction on any given surface increases in a less ratio than the weight; consequently the friction on any given part of a has a less ratio to the friction on an equal part of A than A has to a; and hence the friction on a is less than the friction on A, that is, the smallest surface has always the least friction. But as this conclusion is contrary to the generally received opinion, I have thought it proper to confirm the same by a set of experiments. But before I proceed to relate them, I will beg leave to recommend to those, who may afterwards be induced to repeat them, the following cautions, which are extremely necessary to be attended to. Great care must be taken that the two surfaces have exactly the same degree of roughness; in order to be certain of which, such bodies must be chosen as have no knots in them, and whose grain is so very regular, that when the two surfaces are planed with a fine rough plane their roughness may be the same, which will not be the case if the body be knotty, or the grain irregular, or if it happens not to run in the same direction on both surfaces. When you cannot depend on the surfaces having the same degree of roughness, the best way will be to paste some fine rough paper on each surface, which perhaps will give a more equal degree of roughness than can be obtained by any other method. Now as the proof which I have already given depends only on the motion of the body upon the *same* surface, it is not liable to any inaccuracy of the kind which the preceding cautions have been given to avoid, nor indeed to any other, and therefore it must be perfectly conclusive. In the following experiments the cautions mentioned above were carefully attended to.

Exp. 1. A body was taken whose flat surface was to its edge as 22 : 9, and with the same moving force the body described on its flat side $33\frac{1}{2}$ inches in 2″, and on its edge 47 inches in the same time.

Exp. 2. A second body was taken whose flat surface was to its edge as 32 : 3, and with the same moving force it described on its flat side 32 inches in 2″, and on its edge it described $37\frac{1}{2}$ inches in the same time.

Exp. 3. I took another body and covered one of its surfaces, whose length was 9 inches, with a fine rough paper, and by applying a moving force, it described 25 inches in 2″; I then took off some paper from the middle, leaving only three-eighths of an inch at the two ends, and with the same moving force it described 40 inches in the same time.

Exp. 4. Another body was taken which had one of its surfaces, whose length was 9 inches, covered with a fine rough paper, and by applying a moving force it described 42 inches in 2″; some of the paper was then taken off from the middle, leaving only $1\frac{3}{4}$ inches at the two ends, and with the same moving force it described 54 inches in 2″; I then took off more paper, leaving only one-fourth of an inch at the two ends, and the body then described, by the same moving force, 60 inches in the same time.

In the two last experiments the paper which was taken off the surface was laid on the body, that its weight might not be altered.

Exp. 5. A body was taken whose flat surface was to its edge as 30 : 17; the *flat* side was laid upon the horizontal plane, a moving force was applied, and the stage was fixed in order to stop the moving force, in consequence of which the body would then go on with the velocity acquired until the friction had destroyed all its motion; when it appeared from a mean of 12 trials that the whole body moved, after its acceleration ceased, $5\frac{2}{5}$ inches before it stopped. The *edge* was then applied, and the moving force descended through the same space, and it was found, from a mean of the same number of trials, that the space described was $7\frac{3}{4}$ inches before the body lost all its motion, after it ceased to be accelerated.

Exp. 6. Another body was then taken whose flat surface was to its edge as 60 : 19, and, by proceeding as before, on the flat surface it described, at a mean of 12 trials, $5\frac{1}{8}$ inches, and on the edge $6\frac{11}{24}$ inches, before it stopped, after the acceleration ceased.

Exp. 7. Another body was taken whose flat surface was to its edge as 26 : 3, and the spaces described on these two surfaces, after the acceleration ended, were, at a mean of 10 trials, $4\frac{1}{5}$ and $7\frac{7}{8}$ inches respectively.

From all these different experiments it appears that the smallest surface had always the least friction, which agrees with the consequence deduced from the consideration that the

the friction does not increase in so great a ratio as the weight: we may therefore conclude that *the friction of a body does not continue the same when it has different surfaces applied to the plane on which it moves, but that the smallest surface will have the least friction.*

7. Having thus established, from the most decisive experiments, all that I proposed relative to friction, I think it proper, before I conclude, to give the result of my examination into the nature of the experiments which have been made by others; which were repeated in order to see how far they were conclusive in respect to the principles which have been deduced from them. The experiments which have been made by all the authors that I have seen have been thus instituted.—To find what moving force would *just* put a body at rest in motion: and they concluded from thence, that the accelerative force was then equal to the friction; but it is manifest that any force which will put a body in motion must be *greater* than the force which opposes its motion, otherwise it could not overcome it; and hence, if there were no other objection than this, it is evident that the friction could not be very accurately obtained: but there is another objection which totally destroys the experiment so far as it tends to show the quantity of friction, which is the strong cohesion of the body to the plane when it lies at rest; and this is confirmed by the following experiments. 1st, A body of $12\frac{1}{4}$ oz. was laid upon an horizontal plane, and then loaded with a weight of 8 lb. and such a moving force was applied as would, when the body was just *put* in motion, continue that motion without any acceleration, in which case the friction must be just equal to the accelerative force. The body was then stopped; when it appeared that the same moving force which had *kept* the body in motion before would not *put* it in motion, and it was found necessary to take off $4\frac{1}{2}$ oz. from the body before the same moving force *would* put it in motion: it appears, therefore, that this body, when laid upon the plane at rest, acquired a very strong cohesion to it. 2dly, A body whose weight was 16 oz. was laid at rest upon the horizontal plane, and it was found that a moving force of 6 oz. would just *put* it in motion; but that a moving force of 4 oz. *would*, when it was just put in motion, *continue* that motion without any acceleration, and therefore the accelerative force must *then* have been equal to the friction, and not when the moving force of 6 oz. was applied.

From these experiments therefore it appears, how very con-

considerable the cohesion was in proportion to the friction, when the body was in motion; it being, in the latter case, almost one-third, and in the former it was found to be very nearly equal to the whole friction. All the conclusions, therefore, deduced from the experiments which have been instituted to determine the friction from the force necessary to *put* a body in motion (and I have never seen any described but upon such a principle), have manifestly been totally false; as such experiments only show the resistance which arises from the cohesion and friction conjointly.

8. I shall conclude this part of the subject with a remark upon Art. 5. It appears from all the experiments which I have made, that the proportion of the increase of the friction to the increase of the weight was different in all the different bodies which were made use of: no general rule therefore can be established to determine this for *all* bodies; and the experiments which I have hitherto made have not been sufficient to determine it for the *same* body. At some future opportunity, when I have more leisure, I intend to repeat the experiments in order to establish, in some particular cases, the law by which the quantity of friction increases by increasing the weight. Leaving this subject, therefore, for the present, I shall proceed to establish a theory upon the principles which we have already deduced from our experiments.

PROPOSITION I.

Let e, f, g, (fig. 1. Plate II.) *represent either a cylinder, or that circular section of a body on which it rolls down the inclined plane* CA, *in consequence of its friction, to find the time of descent and the number of revolutions.*

As it has been proved in Art. 5. that the friction of a body does not increase in proportion to its weight or pressure, we cannot, therefore, by knowing the friction on any other plane, determine the friction on CA; the friction therefore on CA can only be determined by experiments made upon *that* plane, that is, by letting the body descend from rest, and observing the space described in the first second of time: call that space a, and then, as by Art. 3. friction is an uniformly retarding force, the body must be uniformly accelerated, and consequently the whole time of descent in seconds will be $= \sqrt{\frac{AC}{a}}$. Now to determine the number of revolutions, let s be the center of oscillation

to

to the point of suspension a*; then, because no force acting at a can affect the motion of the point s, that point, notwithstanding the action of the friction at a, will always have a motion parallel to CA uniformly accelerated by a force equal to that with which the body would be accelerated if it had no friction; hence, if $2m = 32\frac{1}{6}$ feet, the velocity acquired by the point s in the first second will be $= \frac{2m \times CB}{CA}$; now the excess of the velocity of the point s above that of r (r being the center) is manifestly the velocity with which s is carried about r; hence the velocity of s about the center $= \frac{2m \times CB}{CA} - 2a = \frac{2m \times CB - 2a \times CA}{CA}$, consequently $rs : ra :: \frac{2m \times CB - 2a \times CA}{CA} : \frac{2m \times ra \times CB - 2a \times ra \times CA}{rs \times CA}$ = the velocity with which a point of the circumference is carried about the center, and which therefore expresses the force which accelerates the rotation; now as $2a$ expresses the accelerative force of the body down the plane, and the spaces described in the same time are in proportion to those forces, we have $2a : CA :: \frac{2m \times ra \times CB - 2a \times ra \times CA}{rs \times CA} : \frac{m \times ra \times CB - a \times ra \times CA}{a \times rs}$ the space which any point of the circumference describes about the center in the whole time of the body's descent down CA; which being divided by the circumference $p \times ra$ (where $p = 6.283$, &c.) will give $\frac{m \times BC - a \times AC}{p \times a \times rs}$ for the whole number of revolutions required.

Cor. 1. If $a \times CA = m \times BC$, the number of revolutions $= 0$, and therefore the body will then only slide; consequently the friction vanishes.

Cor. 2. Let $a' r' s'$ (fig. 2.) be the next position of $a r s$, and draw $t r' b$ parallel to $s a$, then will $s' t$ represent the retardation of the center r arising from friction, and $a' b$ will represent the acceleration of a point of the circumference about its center; hence the retardation of the center : acceleration of the circumference about the center :: $s' t$: $a' b$ :: (by sim. $\triangle$'s) $t r' : b r' :: rs : ra$.

Cor. 3. If a' coincides with a, the body does not *slide*, but only *roll*; now in this case $s s' : r r' :: a s : a r$; but

* a and s are not fixed points in the body, but the former always represents that point of the body in contact with the plane, and the latter the corresponding center of oscillation.

as

as $s\,s'$ and $r\,r'$ represent the ratio of the velocities of the points s and r, they will be to each other as $\frac{2 \times BC}{CA} : 2\,a$ or as $m \times CB : a \times CA$; hence, when the body *rolls* without *sliding*, $a\,s : a\,r :: m \times CB : a \times CA$.

Cor. 4. The time of descent down CA is $= \sqrt{\frac{A}{\ }}$; but by the last Cor. when the body *rolls* without *sliding*, $a = \frac{m \times r\,a \times BC}{s\,a \times AC}$, hence the time of descent in that case $= AC \sqrt{\frac{s\,a}{m \times r\,a \times BC}}$; now the time of descent, if there were no friction, would be $= \frac{AC}{\sqrt{\ \times BC}}$, hence the time of descent, when the body *rolls* without *sliding* : time of free descent $:: \sqrt{s\,a} : \sqrt{r\,a}$.

Cor. 5. By the last Cor. it appears, that when the body just *rolls* without *sliding*, or when the friction is just equal to the accelerative force, the time of descent $= AC \sqrt{\frac{s\,a}{\times\, m\, a \times BC}}$: now it is manifest that the time of descent will continue the same, if the friction be increased; for the body will still freely roll, as no increase of the friction acting at a can affect the motion of the point s.

If the body be projected from C with a velocity, and at the same time have a rotatory motion, the time of descent and the number of revolutions may be determined from the common principles of uniformly accelerated motions. As we have already investigated the accelerative force of the body down the plane, and of its rotation about its axis, it seems therefore unnecessary to lengthen out this paper with the investigations.

[To be continued.]

VII. *Observations on the Processes of Tanning.* By HUMPHRY DAVY, *Esq., Professor of Chemistry in the Royal Institution.*

[Concluded from our last volume, p. 85.]

II. *On the Impregnation of Skin with the Tanning Principle.*

THE tanning lixivium or ooze is generally made in this country, by infusing bruised or coarsely powdered oak bark in water.

Skins are tanned by being successively immersed in lixiviums,

viums, saturated in different degrees with the astringent principles of the bark. The lixiviums first employed are usually weak; but for the completion of the process they are made as strong as possible.

In the process of tanning, the skin gains new chemical properties; it increases in weight, and becomes insoluble in boiling water.

The infusions of oak bark, when chemically examined, are found to contain two principal substances; one is precipitable by solution of gelatine, made from glue or isinglass; and gives a dense black with solution of common sulphate of iron. The other is not thrown down by solution of gelatine; but it precipitates the salts of iron of a brownish black, and the salts of tin of a fawn colour.

The substance precipitable by solution of gelatine is the tanning principle, or the tannin of Seguin. It is essential to the conversion of skin into leather, and in the process of tanning it enters into chemical union with the matter of skin, so as to form with it an insoluble compound. The other substance, the substance not precipitable by gelatine, is the colouring or extractive matter; it is capable of entering into union with skin, and it gives to it a brown colour; but it does not render it insoluble in boiling water.

It has been usually supposed that the infusion of oak bark contains a peculiar acid, called gallic acid; but some late experiments render this opinion doubtful: and this principle, if it exists in oak bark, is in intimate combination with the extractive or colouring matter.

In the common process of tanning, the skin, which is chiefly composed of gelatine, slowly combines in its organized form with the tannin and extractive matter of the infusions of bark; the greater proportion of its increase of weight is however owing to tannin, and it is from this substance the leather derives its characteristic properties; but its colour, and the degree of its flexibility, appear to be influenced by the quantity of colouring matter that it contains.

When skin, in large quantity, is suffered to exert its full action upon a small portion of infusion of bark, containing tannin and extractive matter, the fluid is found colourless. It gives no precipitate to solution of glue, and produces very little effect upon the salts of iron, or of tin.

The tanning principle of oak bark is more soluble in water than the extractive matter: and the relative proportion of tannin to extractive matter is much greater in strong infusions of oak bark than in weak ones; and when strong infusions

infusions are used for tanning, a larger proportion of tannin is combined with the matter of skin.

For calf skins, and light cow skins, which are usually prepared in the grainer, weak lixiviums are used in the first part of the process; but thick ox hides, for the purpose of stout sole leather, are generally kept in a strong ooze, preserved constantly in a state approaching to saturation, by means of strata of bark.

Calf skins, and light cow skins, in the usual process, require for their full impregnation with tannin from two to four months; but thick ox hides demand from ten to eighteen months.

In any case the state of the skin with regard to impregnation with tannin may be easily judged of, if it be cut transversely with a sharp knife: in this case the tanned part appears of a nutmeg colour; but the unimpregnated skin retains its whiteness.

The tanned hides designed for sole leather, are, while drying, generally smoothed with a stout steel pin, and beat with a mallet. By this process they are rendered denser, firmer, and less permeable to water: calf skins are not subjected to the operation of beating; and they are treated in different ways by the currier, according as they are needed for different purposes.

III. *General Remarks relating to the Processes of Tanning.*

A very great number of vegetable productions, besides oak bark, contain the principle essential to the conversion of skin into leather: galls, sumach, the bark of the Spanish chesnut, of the elm, of the common willow, and of the Leicester willow, the branches of the myrtle, tormentil, and heath, have all been used in the processes of tanning.

Different methods have been proposed for estimating the quantity of tannin in different vegetable productions. Tannin, by being dissolved in water, increases its specific gravity, and the hydrometer has been used for estimating the strength of the tanning ooze. The results given by this instrument are, however, often fallacious in comparative experiments, in consequence of the presence of extractive matter, and of saline substances; and the action of the solution of gelatine affords the best indication of the quantity of the tanning principle.

The solution of gelatine most proper for the general purposes of experiments, is made by dissolving an ounce of glue, or of isinglass, in three pints of boiling water.

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The substance to be examined as to its tanning power may be used in the quantity of two ounces; it should be in a state of coarse powder, or in small fragments. A quart of boiling water will be sufficient to dissolve its astringent principles.

The solution of glue, or gelatine, must be poured into the astringent infusion, till the effect of precipitation is at an end. The turbid liquor must then be passed through a piece of blotting-paper, which has been before weighed.

When the precipitate has been collected, and the paper dried, the increase of its weight is determined; and about $\frac{2}{5}$ of this increase of weight may be taken as the quantity of tannin in the ounce of the substance examined.

When solution of gelatine cannot be obtained, a solution of albumen may be used. It is made by agitating the white of an egg in a pint of cold water. It does not putrefy nearly so readily as the solution of glue, and it may be employed with equal advantage in experiments of comparison; but the composition of the precipitates it forms with tannin, has not as yet been ascertained.

The tanning principle in different vegetables is possessed of the same general characters; but it often exists in them in states of combination with other substances.

In galls it is in union with the gallic acid. In sumach it is mixed with saline matter, particularly sulphate of lime; and in the greater number of barks it is in combination with mucilage, and different extractive and colouring matters.

Leather tanned by means of different astringent infusions, differs considerably in its composition; but it seldom contains more than 1-3d of its weight of vegetable matter.

Gallic acid, and saline matters in general, in cases when they are combined with tannin, are not absorbed with it by skin; but they remain in their primitive forms.

The leather made from infusions of Aleppo galls, and of sumach, is composed probably of pure tannin and the matter of skin. Its colour is very pale, and the increase of weight is greater than in most other cases.

Extractive, or colouring matters, in cases when they exist in astringent infusions, as in the instance of oak bark already mentioned, are wholly or partly absorbed with the tannin by the skin. The leather from barks in general is coloured, and contains different proportions of extractive matter.

Of all the substances that have been examined as to their tanning properties, catechu or terra japonica, is that which is richest in the tanning principle. This substance is the

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extract of the wood of a species of the mimosa, which grows abundantly in India; and calculating on its price, and on the quantities in which it may be procured, there is great reason to believe that it may be made a valuable article of commerce.

In a paper published in the Philosophical Transactions, for 1803*, a statement is given of the comparative value of different astringent substances, oak bark being considered as the standard.

The attraction of tannin for water is much stronger than that of any other of the principles usually found in astringent vegetables; and the saturated infusions obtained from substances containing very different proportions of astringent matters, are usually possessed of the same degree of strength with regard to their tanning powers.

When saturated solutions of the tanning principle are used in the process of manufacture, the leather is tanned in a much shorter time than in the common operation with weaker infusions. The rapid method of tanning has been recommended by Mr. Seguin; and is ably described in a pamphlet published by Mr. Desmond.

It has however been generally observed, that leather too quickly tanned is more rigid, and more liable to crack than leather slowly tanned. And there is every reason to believe that its texture must be less equable, as the exterior strata of skin would be perfectly combined with tannin before the interior strata were materially acted upon; and the want of colouring or extractive matter in the strongest lixivium, in many cases must affect the nature of the leather.

The substances used for tanning should, in all cases, be preserved in as dry a state as possible before they are used. When they are exposed to moisture and air, the tanning principle by degrees is destroyed in them, and for the most part converted into insoluble matter.

The process of drying bark by heat, when carefully conducted, must, as there is great reason to believe, on the whole be advantageous. The tanning principle is not decomposed at a temperature below 400°. And in fresh vegetable substances, tannin appears to be sometimes developed or formed by the long application of a low heat: this fact I observed with my friend Mr. Poole in September 1802, with regard to acorns; and I have since made the same remark upon the horse chesnut.

* See our next article.

VIII. *An*

VIII. *An Account of some Experiments and Observations on the constituent Parts of certain astringent Vegetables; and on their Operation in Tanning. By* Humphry Davy, *Esq., Professor of Chemistry in the Royal Institution.**

The discovery made by M. Seguin, of a peculiar vegetable matter which is essential to the tanning of skin, and which is possessed of the property of precipitating gelatine from its solutions, has added considerably to our knowledge of the constituent parts of astringent vegetables.

Mr. Proust has investigated many of the properties of this substance; but though his labours, and those of other chemists, have led to various interesting observations, yet they are far from having exhausted the subject. The affinities of tannin have been hitherto very little examined; and the manner in which its action upon animal matters is modified by combination with other substances, has been scarcely at all studied.

At the desire of the managers of the Royal Institution, I began, in September 1801, a series of experiments on the substances employed in the process of tanning, and on the chemical agencies concerned in it. These experiments have occupied, ever since, a considerable portion of my leisure hours; and I now presume to lay before the Royal Society an account of their general results. My chief design was, to attempt to elucidate the practical part of the art: but in pursuing it, I was necessarily led to general chemical inquiries, concerning the analysis of the different vegetable substances containing tannin, and their peculiar properties.

I. *Observations on the Analysis of astringent Vegetable Infusions.*

The substances that have been supposed to exist most generally in astringent infusions are, tannin, gallic acid, and extractive matter.

The presence of tannin in an infusion, is denoted by the precipitate it forms with the solution of glue or of isinglass. And, when this principle is wholly separated, if the remaining liquor gives a dark colour with the oxygenated salts of iron, and an immediate precipitate with the solutions of alum and of muriate of tin, it is believed to contain gallic acid and extractive matter.

The experiments of MM. Fourcroy, Vauquelin, and Seguin,

* From Philosophical Transactions for 1803.]

guin, have shown that many astringent solutions undergo a change by exposure to the atmosphere; an insoluble matter being precipitated from them. A precipitation is likewise occasioned in them by the action of heat; and these circumstances render it extremely difficult to ascertain, with any degree of precision, the quantities of their constituent parts, as they exist in the primitive combination.

After trying several experiments on different methods of ascertaining the quantity of tannin in astringent infusions, I was induced to employ the common process of precipitation by gelatine, as being the most accurate.

This process, however, requires many precautions. The tanning principle in different vegetables, as will be seen hereafter, demands for its saturation different proportions of gelatine; and the quantity of the precipitate obtained by filtration is not always exactly proportional to the quantities of tannin and gelatine in solutions, but is influenced by the degree of their concentration. Thus I found that 10 grains of dry isinglass, dissolved in two ounces of distilled water, gave, with solution of galls in excess, a precipitate weighing, when dry, 17 grains; whilst the same quantity, dissolved in six ounces of water, produced, all other circumstances being similar, not quite 15 grains. With more diluted solutions, the loss was still greater; and analogous effects took place, when equal portions of the same solution of isinglass were acted on by equal portions of the same infusion of galls diluted in different degrees with water; the least quantity of precipitate being always produced by the least concentrated liquor. In all cases, when the weak solutions were used, it was observed that the residual fluid, though passed two or three times through the filter, still remained more or less turbid and opaque; so that it is most likely that the deficiency arose from the continued suspension of some of the minutely divided solid matter in the liquid mass.

The solutions of gelatine, for the purposes of analysis, should be employed only when quite fresh, and in as high a state of saturation as is compatible with their perfect fluidity. I have observed that, in cases when they approach towards the state of jelly, their power of acting upon tannin is materially altered, and they produce only a very slight precipitation. As the degree of fluidity of solutions of gelatine is influenced by their temperature, I have found it expedient, in all comparative experiments, to bring them, and the astringent infusions on which they are designed to act, as nearly as possible to a common degree of heat. My

standard

standard temperature has been between 60° and 70° Fahrenheit; and the solutions of gelatine that I have used were made by dissolving 120 grains of isinglass in 20 ounces of water.

In ascertaining the proportions of tannin in astringent infusions, great care must be taken to prevent the presence of any excess of gelatine; for when this excess exists, I have found that a small portion of the solid compound formed is redissolved, and the results of the experiment otherwise affected. It is not difficult to discover the precise point of saturation, if the solution of isinglass be added only in small quantities at a time, and if portions of the clear liquor be passed through a filter at different periods of the process. The properties of these portions will indicate the quantities of the solution of gelatine required for the completion of the experiment.

That the composition of any precipitate containing tannin and gelatine may be known with a tolerable degree of precision, it is necessary that the isinglass employed in the solution, and the new compound formed, be brought as nearly as possible to the same degree of dryness. For this purpose I have generally exposed them, for an equal time, upon the lower plate of a sand-bath, which was seldom heated to more than 150°. This method I have found much better than that of drying at the temperatures of the atmosphere, as the different states of the air, with regard to moisture, materially influence the results.

Mr. Hatchett has noticed, in his excellent paper on Zoophytes, &c.*, that isinglass is almost wholly composed of gelatine. I have found that 100 grains of good and dry isinglass contain rather more than 98 grains of matter soluble in water. So that when the quantity of isinglass, in any solution employed for acting upon an astringent infusion, is compared with the quantity of the precipitate obtained, the difference between them will indicate the proportion of tannin, as it exists in the combination.

After the tannin has been separated from an astringent infusion, for the purpose of ascertaining its other component parts, I have been accustomed to evaporate the residual liquor very slowly, at a temperature below 200°†. In this

* Philosophical Transactions for 1800, p. 327.

† M. Deyeux has shown (*Annales de Chimie*, tome xvii. p. 36), that in the process of evaporating solutions of galls, no gallic acid is carried over by the water at a temperature below that of ebullition. Many astringent infusions, however, lose a portion of their aromatic principle even in cases when they are not made to boil; but this substance, though evident

this process, if it contains extractive matter, that substance is in part rendered insoluble, so as to fall to the bottom of the vessel. When the fluid is reduced to a thick consistence, I pour alcohol upon it. If any gallic acid or soluble extractive matter be present, they will be dissolved, after a little agitation, in the alcohol; whilst the mucilage, if any exist, will remain unaltered, and may be separated from the insoluble extract by lixiviation with water.

I have made many experiments with the hope of discovering a method by which the respective quantities of gallic acid and extractive matter, when they exist in solution in the alcohol, may be ascertained, but without obtaining success in the results. It is impossible to render the whole of any quantity of extractive matter insoluble by exposure to heat and air, without at the same time decomposing a portion of the gallic acid. That acid cannot be sublimed without being in part destroyed; and, at the temperature of its sublimation, extractive matter is wholly converted into new products.

Ether dissolves gallic acid; but it has comparatively little action upon extractive matter. I have been able, in examining solutions of galls, to separate a portion of gallic acid by means of ether. But when the extractive matter is in large quantities, this method does not succeed, as, in consequence of that affinity which is connected with mass *, the greatest part of the acid continues to adhere to the extract.

Alumine has a strong attraction for extractive matter, but comparatively a weak one for gallic acid †. When carbonate of alumine is boiled for some time with a solution containing extractive matter, the extractive matter is wholly taken up by the earth, with which it forms an insoluble compound; but into this compound some of the gallic acid appears likewise to enter; and the portion remaining dissolved in the solution is always combined with alumine.

I have not, in any instance, been able to separate gallic acid and extractive matter perfectly from each other; but I have generally endeavoured to form some judgment concerning their relative proportions, by means of the action of the salts of alumine and the oxygenated salts of iron. Muriate of alumine precipitates much of the extractive

dent to the smell, in the water that comes over, cannot be detected by chemical reagents.

* See Berthollet, *Recherches sur les Lois de l'Affinité. Mem. de l'Institute National*, tome iii. p. [illegible].

† See Fiedler, *Journal de Chimie*, par J. B. Van Mons, tome i. p. 85.

 matter

matter from solutions, without acting materially upon gallic acid; and, after this precipitation, some idea may be formed concerning the quantity of the gallic acid by the colour it gives with the oxygenated sulphate of iron. In this process, however, great care must be taken not to add the solution of the sulphate of iron in excess; for in this case the black precipitate formed with the gallic acid will be redissolved, and a clear olive-coloured fluid only will be obtained.

The saline matters in astringent infusions adhere so strongly to the vegetable principles, that it is impossible to ascertain their nature, with any degree of accuracy, by means of common reagents. By incineration of the products obtained from the evaporation of astringent infusions, I have usually procured carbonate of lime and carbonate of potash.

In the different analyses, as will be seen from the results given in the following sections, I have attended chiefly to the proportions of the tanning principle, and of the principles precipitable by the salts of iron, as being most connected with practical applications.

With regard to the knowledge of the nature of the different substances, as they exist in the primitive astringent infusion, we can gain, by our artificial methods of examination, only very imperfect approximations. In acting upon them by reagents we probably, in many cases, alter their nature; and very few of them only can be obtained in an uncombined state. The comparison, however, of the products of different experiments with each other is always connected with some useful conclusions; and the accumulation of facts with regard to the subject must finally tend to elucidate this obscure but most interesting part of chemistry.

II. *Experiments on the Infusions of Galls.*

I have been very much assisted, in my inquiries concerning the properties of the infusions of galls, by the able memoir of M. Deyeux on Galls*.

The strongest infusion of galls that I could obtain at 56° Fahrenheit, by repeatedly pouring distilled water upon the best Aleppo galls broken into small pieces, and suffering it to remain in contact with them till the saturation was complete, was of the specific gravity 1·068. Four hundred grains of it produced, by evaporation at a temperature be-

* *Annales de Chimie*, tome xvii. p. 1.

low 200°, fifty-three grains of solid matter; which, as well as I could estimate by the methods of analysis that have been just described, consisted of about nine-tenths of tannin, or matter precipitable by gelatine, and one-tenth of gallic acid, united to a minute portion of extractive matter.

100 grains of the solid matter obtained from the infusion left, after incineration, nearly $4\frac{3}{4}$ grains of ashes; which were chiefly calcareous matter, mixed with a small portion of fixed alkali. The infusion strongly reddened paper tinged with litmus. It was semitransparent, and of a yellowish-brown colour. Its taste was highly astringent.

When sulphuric acid was poured into the infusion a dense whitish precipitate was produced; and this effect was constant, whatever quantity of the acid was used. The residual liquor, when passed through the filter, was found of a shade of colour deeper than before. It precipitated gelatine, and gave a dark colour with the oxygenated sulphate of iron.

The solid matter remaining on the filter slightly reddened vegetable blues; and, when dissolved in warm water, copiously precipitated the solutions of isinglass. M. Proust*, who first paid attention to its properties, supposes that it is a compound of the acid with tannin: but I suspect that it also contains gallic acid, and probably a small portion of extractive matter. This last substance, as is well known, is thrown down from its solutions by sulphuric acid; and I found, in distilling the precipitate from galls by sulphuric acid, at a heat above 212°, that a fluid came over of a light-yellow colour, which was rendered black by oxygenated sulphate of iron, but which was not altered by gelatine.

Muriatic acid produced, in the infusion, effects analogous to those produced by sulphuric acid; and two compounds of the acid and the vegetable substances were formed: the one united to excess of acid, which remained in solution; the other containing a considerable quantity of tannin, which was precipitated in the solid form.

When concentrated nitric acid was made to act upon the infusion, it was rendered turbid; but the solid matter formed was immediately dissolved with effervescence, and the liquor then became clear, and of an orange colour. On examining it, it was found that both the tannin and the gallic acid were destroyed; for it gave no precipitate either with gelatine or the salts of iron, even after the residual nitric acid was saturated by an alkali. By evaporation of a portion of

* The fact of the precipitation of the solution of galls by acids was noticed by M. Dizé. See *Annales de Chimie*, tome xxxv. p. 37.

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the fluid a soft substance was obtained, of a yellowish-brown colour, and of a slightly sourish taste. It was soluble in water, and precipitated the nitro-muriate of tin, and the nitrate of alumine; so that its properties approached to those of extractive matter; and it probably contained oxalic acid, as it rendered turbid a solution of muriate of lime.

When a very weak solution of nitric acid was mixed with the infusion, a permanent precipitate was formed; and the residual liquor, examined by the solution of gelatine, was found to contain tannin.

A solution of pure potash was poured into a portion of the infusion. At first a faint turbid appearance was perceived; but by agitation the fluid became clear, and its colour changed from yellow-brown to brown-red; and this last tint was most vivid on the surface, where the solution was exposed to the atmosphere. The solution of isinglass did not act upon the infusion modified by the alkali till an acid was added in excess, when a copious precipitation was occasioned.

The compound of potash and solution of galls, when evaporated, appeared in the form of an olive-coloured mass, which had a faint alkaline taste, and which slowly deliquesced when exposed to the air.

Soda acted upon the infusion in the same manner as potash; and a fluid was formed of a red-brown colour, which gave no precipitate to gelatine.

Solution of ammonia produced the same colour as potash and soda, and formed so perfect an union with the tannin of the infusion that it was not acted upon by gelatine. When the compound liquor was exposed to the heat of boiling water, a part of the ammonia flew off, and another part reacted upon the infusion so as to effect a material change in its properties. A considerable quantity of insoluble matter was formed, and the remaining liquor contained little tannin and gallic acid, but a considerable portion of a substance that precipitated muriate of tin and the salts of alumine.

When the experiment on the ebullition of the compound of the infusion and ammonia was made in close vessels, the liquor that came over was strongly impregnated with ammonia; its colour was light yellow, and, when saturated with an acid, it was very little altered by the salts of iron. The residual fluid after the process had been continued for some time, as in the other case, precipitated gelatine slightly, but the salts of alumine copiously; and it gave a tinge of red to litmus paper.

When solution of lime, of strontia, or of barytes, was poured in excess into a portion of the infusion, a copious olive-coloured precipitate was formed, and the solution became almost clear, and of a reddish tint. In this case the tannin, the gallic acid, and the extractive matter, seemed to be almost wholly carried down in the precipitates; as the residual fluids, when saturated by an acid, gave no precipitate to gelatine, and only a very slight tint of purple to oxygenated sulphate of iron.

When the solutions of the alkaline earths were used only in small quantities, the infusion being in excess, a smaller quantity of precipitate was formed, and the residual liquor was of an olive-green colour; the tint being darkest in the experiment with the barytes, and lightest in that with the lime. This fluid, when examined, was found to hold in solution a compound of gallic acid and alkaline earth. It became turbid when acted on by a little sulphuric acid; and, after being filtrated, gave a black colour with the solutions of iron, but was not acted upon by gelatine.

When a large proportion of lime was heated for some time with the infusion, it combined with all its constituent principles, and gave, by washing, a fluid which had the taste of lime water, and which held in solution only a very small quantity of vegetable matter. Its colour was pale yellow; and, when saturated with muriatic acid, it did not precipitate gelatine, and gave only a slight purple tinge to the solutions of the salts of iron. The lime in combination with the solid matter of the infusion was of a fawn colour. It became green at its surface, where it was exposed to the air; and, when washed with large quanties of water, it continued to give, even to the last portions, a pale yellow tinge.

Magnesia was boiled in one portion of the infusion for a few hours; and mixed in excess with another portion, which was suffered to remain cold. In both cases a deep green fluid was obtained, which precipitated the salts of iron but not the solutions of gelatine; and the magnesia had acquired a grayish-green tint. Water poured upon it became green, and acquired the properties of the fluid at first obtained. After long washing the colour of the magnesia changed to dirty yellow; and the last portions of water made to act upon it were pale yellow, and altered very little the solutions of iron.

When the magnesia was dissolved in muriatic acid, a brownish and turbid fluid was obtained, which precipitated gelatine and the oxygenated salts of iron. So that there is every reason to believe that the earth, in acting on the

astringent

astringent infusion, had formed two combinations; one containing chiefly gallic acid, which was easily soluble in water; the other containing chiefly tannin, which was very difficultly soluble.

Alumine boiled with the infusion became yellowish-gray, and gave a clear white fluid, which produced only a tinge of light purple in the solutions of iron. When the earth * was employed in a very small quantity, however, it formed an insoluble compound only with the tannin and the extract, and the residual liquor was found to contain a gallate of alumine with excess of acid.

The oxides of tin and of zinc, obtained by nitric acid, were boiled with separate portions of the infusion for two hours. In both cases a clear fluid, which appeared to be pure water, was obtained; and the oxides gained a tint of dull yellow. A part of each of them was dissolved in muriatic acid. The solution obtained was yellow; it copiously precipitated gelatine, and gave a dense black with the salts of iron. Mr. Proust †, who first observed the action of oxide of tin upon astringent infusions, supposes that portions of tannin and gallic acid are decomposed in the process, or converted, by the oxygen of the oxide, into new substances. These experiments do not, however, appear to confirm the supposition.

M. Deyeux observed that a copious precipitation was occasioned in infusion of galls, by solutions of the alkalis combined with carbonic acid. Mr. Proust has supposed that the solid matter formed is pure tannin, separated from its solution by the stronger affinity of the alkali for water; and he recommends the process as a method of obtaining tannin.

In examining the precipitate obtained by carbonate of potash fully combined with carbonic acid, and used to saturation, I have not been able to recognise in it the properties which are usually ascribed to tannin: it is not possessed of the astringent taste, and it is but slightly soluble in cold water or in alcohol. Its solution acts very little upon gelatine, till it is saturated with an acid; and it is not possessed of the property of tanning skin.

In various cases in which the greatest care was taken to use no excess, either of the astringent infusion or of the alkaline solution, I have found the solid matter obtained possessed of analogous properties; and it has always given,

* Mr. Fiedler, I believe, first observed the action of alumine upon tannin.—Van Mon's Journal, vol. i. p. 86.

† *Annales de Chimie*, tome xlii. p. 69.

by incineration, a considerable portion of carbonate of potash, and a small quantity of carbonate of lime.

The fluid remaining after the separation of the precipitate was of a dark brown colour, and became green at the surface when it was exposed to the air. It gave no precipitate to solution of gelatine, and afforded only an olive-coloured precipitate with the salts of iron.

When muriatic acid was poured into the clear fluid, a violent effervescence was produced; the fluid became turbid; a precipitate was deposited; and the residual liquor acted upon gelatine and the salts of iron in a manner similar to the primitive infusion.

M. Deyeux, in distilling the precipitate from infusion of galls by carbonate of potash, obtained crystals of gallic acid. In following his process, I had similar results; and a fluid came over which reddened litmus paper, and precipitated the salts of iron black, but did not act upon gelatine.

When the precipitate by carbonate of potash was acted upon by warm water, applied in large quantities, a considerable portion of it was dissolved; but a part remained which could not in any way be made to enter into solution, and its properties were very different from those of the entire precipitate. It was not at all affected by alcohol: it was acted on by muriatic acid, and partially dissolved; and the solution precipitated gelatine and the salts of iron. It afforded, by incineration, a considerable portion of lime, but no alkali.

In comparing these facts it would seem that the precipitate from infusion of galls consists partly of tannin and gallic acid united to a small quantity of alkali, and partly of these vegetable matters combined with calcareous earth; and it will appear probable, when the facts hereafter detailed are examined, that both the potash and the lime are contained in these compounds in a state of union with carbonic acid.

The solutions of carbonate of soda and of carbonate of ammonia, both precipitated the infusion of galls in a manner similar to the carbonate of potash; and each of the precipitates, when acted on by boiling water, left a small quantity of insoluble matter, which seemed to consist chiefly of tannin and carbonate of lime.

The entire precipitate by carbonate of soda produced, when incinerated, carbonate of soda and carbonate of lime. The precipitate by carbonate of ammonia, when exposed to a heat sufficient to boil water, in a retort having a receiver attached

attached to it, gave out carbonate of ammonia, (which was condensed in small crystals in the neck of the retort,) and a yellowish fluid, which had the strong smell and taste of this volatile salt. After the process of distillation, the solid matter remaining was found of a dark brown colour; a part of it readily dissolved in cold water, and the solution acted on gelatine.

The residual fluid of the portions of the infusion which had been acted on by the carbonates of soda and of ammonia, as in the instance of the carbonate of potash, gave no precipitate with gelatine, till they were saturated with an acid; so that in all these cases the changes are strictly analogous.

The infusion of galls, as appears from the analysis, contains in its primitive state calcareous matter. By the action of the mild alkalis, this substance is preciptated in union with a portion of the vegetable matter, in the form of an insoluble compound. The alkalis themselves at the same time enter into actual combination with the remaining tannin and gallic acid; and a part of the compound formed is precipitated, whilst another part remains in solution.

When the artificial carbonates of lime, magnesia, and barytes, were separately boiled with the portions of infusion of galls for some hours, they combined with the tannin contained in it so as to form with it insoluble compounds; and in each case a deep green fluid was obtained, which gave no precipitate to gelatine even when an acid was added, but which produced a deep black colour in the solutions of the salts of iron.

Sulphate of lime, when finely divided, whether natural or artificial, after having been long heated with a small quantity of the infusion, was found to have combined with the tannin of it, and to have gained a faint tinge of light brown. The liquid became of a blue-green colour, and acted upon the salts of iron, but not upon gelatine; and there is every reason to suppose that it held in solution a triple compound, of gallic acid, sulphuric acid, and lime.

We owe to Mr. Proust the discovery that different solutions of the neutral salts precipitate the infusion of galls; and he supposes that the precipitation is owing to their combining with a portion of the water which held the vegetable matter in solution. In examining the solid matters thrown down from the infusion by sulphate of alumine, nitrate of potash, acetite of potash, muriate of soda, and muriate of barytes, I found them soluble, to a certain extent,

tent, in water, and possessed of the power of acting upon gelatine. From the products given by their incineration and by their distillation, I am, however, inclined to believe that they contain, besides tannin, a portion of gallic acid and extractive matter, and a quantity of the salt employed in the primitive solution.

It is well known that many of the metallic solutions occasion dense precipitates in the infusion of galls; and it has been generally supposed that these precipitates are composed of tannin and extractive matter, or of those two substances and gallic acid united to the metallic oxide; but from the observation of different processes of this kind, in which the salts of iron and of tin were employed, I am inclined to believe that they contain also a portion of the acid of the saline compound.

When the muriate of tin was made to act upon a portion of the infusion, till no more precipitation could be produced in it, the fluid that passed through the filter still acted upon gelatine, and seemed to contain no excess of acid; for it gave a precipitate to carbonate of potash without producing effervescence. The solid compound, when decomposed by sulphuretted hydrogen, after the manner recommended by Mr. Proust, was found strongly to redden litmus paper, and it copiously precipitated nitrate of silver; whereas the primitive infusion only rendered it slightly turbid; so that there is every reason to believe that the precipitate contained muriatic acid.

By passing the black and turbid fluid, procured by the action of solution of oxygenated sulphate of iron in excess upon a portion of the infusion, through finely-divided pure flint, contained in four folds of filtrating paper, I obtained a light olive-green fluid, in which there was no excess of sulphuric acid, and which I am inclined to suppose was a solution of the compound of gallic acid and sulphate of iron, with superabundance of metallic salt. I have already mentioned that gallic acid, when in very small proportion, does not precipitate the oxygenated salts of iron; and Mr. Proust, in his ingenious paper upon the Difference of the Salts of Iron, has supposed that, in the formation of ink, a portion of the oxide of iron in union with gallic acid is dissolved by the sulphuric acid of the sulphate. This comes near to the opinion that they form a triple compound; and, in reasoning upon the general phænomena, it seems fair to conclude that, in the case of the precipitation of tannin by the salts of tin and of iron, compounds are formed of tannin

and

and the salts; and that, of these compounds, such as contain tin are slightly soluble in water, whilst those that contain iron are almost wholly insoluble.

In examining the action of animal substances upon the infusion of galls, with the view of ascertaining the composition of the compounds of gelatine and of skin with tannin, I found that a saturated solution of gelatine, which contained the soluble matter of 50 grains of dry isinglass, produced from the infusion a precipitate that weighed nearly 91 grains; and in another instance, a solution containing 30 grains of isinglass gave about 56 grains; so that, taking the mean of the two experiments, and allowing for the small quantity of insoluble matter in isinglass, we may conclude that 100 grains of the compound gelatine and tannin, formed by precipitation from saturated solutions, contain about 54 grains of gelatine, and 46 of tannin.

A piece of dry calf-skin, perfectly free from extraneous matter, that weighed 180 grains, after being prepared for tanning by long immersion in water, was tanned in a portion of the infusion, being exposed to it for three weeks. When dry, the leather weighed 295 grains; so that, considering this experiment as accurate, leather quickly tanned by means of an infusion of galls consists of about 61 grains of skin, and 39 of vegetable matter, in 100 grains.

After depriving a portion of the infusion of all its tanning matter, by repeatedly exposing it to the action of pieces of skin, I found that it gave a much slighter colour to oxygenated sulphate of iron than an equal portion of a similar infusion which had been immediately precipitated by solution of isinglass; but I am inclined to attribute this effect, not to any absorption of gallic acid by the skin, but rather to the decomposition of it by the long continued action of the atmosphere; for much insoluble matter had been precipitated during the process of tanning, and the residuum contained a small portion of acetous acid.

In ascertaining the quantity of tannin in galls, I found that 500 grains of good Aleppo galls gave, by lixiviation with pure water till their soluble parts were taken up, and subsequent slow evaporation, 185 grains of solid matter. And this matter, examined by analysis, appeared to consist

Of tannin - - - - -	130 grs.
Of mucilage, and matter rendered insoluble by evaporation - - - -	12
Of gallic acid, with a little extractive matter -	31
Remainder, calcareous earth and saline matter	12

The fluid obtained by the last lixiviation of galls, as M. Deyeux

M. Deyeux observed, is pale green; and I am inclined to believe that it is chiefly a weak solution of gallate of lime. The ashes of galls, deprived of soluble matter, furnish a very considerable quantity of calcareous earth. And the property which M. Deyeux discovered in the liquor of the last lixiviations, of becoming red by the action of acids, and of regaining the green colour by means of alkalis, I have observed, more or less, in all the soluble compounds containing gallic acid and the alkaline earths.

[To be continued.]

IX. *Extract from the third Volume of the Analyses of M. Klaproth.*

[Continued from our last volume, p. 344.]

Analysis of the natural Muriate of Ammonia of Vesuvius.

After the eruption of Vesuvius in the year 1794, which continued several weeks, the vapours of the burning lava became in part condensed into concrete salts, which were found under different forms in the crevices and hollows of the upper scoriæ of the lava after it had cooled. The principal products of this natural sublimation are sal ammoniac and muriate of soda.

The sal ammoniac is sometimes pure, sometimes coloured yellow, and for the most part crystallised in prisms of four planes a little inclined, exceedingly brilliant and transparent.

Muriate of soda forms almost always shapeless strata of salt fibrous in their fracture: it is rarely pure, and for the most part mixed with an oxide of copper which communicates to it a green colour more or less intense, and besprinkled in many places with small brilliant leaves of sparry iron.

The sublimated sal ammoniac ought, without doubt, to be considered as a product of the decomposition of water and atmospheric air in this grand chemical operation of nature.

It is not necessary to make a similar supposition to explain the formation of the muriate of soda. The sea water which penetrates to the focus of the volcano and concurs to its eruption contains it ready formed, while the decomposition of a part of this salt furnishes the free muriatic acid which forms muriate of ammonia.

M. Klaproth found in his analysis that this muriate is perfectly

perfectly pure, and that it contains only one-half per cent. of muriate of soda. He found a little more in that of a variety the crystallisation of which was less regular.

The yellow variety has crystals of the same form: they have a beautiful topaz colour which arises from the combination of one-eighth per cent. at most of iron.

M. Klaproth was the more surprised at not finding sulphate of ammonia, as the muriate of that base was formed in an atmosphere impregnated with sulphureous vapours.

Analysis of the Sal Ammoniac of Bucharia.

Bucharian Tartary furnishes an ammoniacal salt which differs in its external characters from that of the lava of Vesuvius. We have not yet obtained sufficient ideas respecting its formation and natural history.

M. Model is the first person who made mention of it: he assures us that several quintals of it are annually transported to Russia and Siberia, which gives reason to presume that it is very abundant in Bucharia. The opinion he forms, in regard to the rocks, is the more probable, as the fragments of rock, which seem to be composed of argillaceous schist or compact argil, are very often covered with sal ammoniac. It is to be remarked, that among the grains of this salt there are found also small insulated fragments of yellow sulphur. M. Karsten has described it under the name of conchoid sal ammoniac.

It is grayish white, has a rough surface, is not very brilliant on the outside, and has a vitreous splendour on its fracture, which is perfectly conchoid. Its fragments are irregularly angular; it varies from semi-transparency to opacity; it is pliant, tender, light, of a pungent taste of urine, and contains

Muriate of ammonia - -	97·50
Sulphate of ammonia - -	2·50
	100

Analysis of Sassolin.

Natural sedative salt, known under the name of sassolin, is a white salt interspersed with some spots of an isabella colour, grouped in stalactites, soft and saponaceous to the touch, easily pulverised, and composed, in a great measure, of free boracic acid.

M. Hoefer first made known at Florence the boracic acid, which he found in the waters of the lake Cherchiaso and in those of the lake of Castel-Nuovo.

Pro-

Professor Mascagni found it concrete on the borders of the warm spring of Sasso near Sienna, and gave it the name of sassolin.

A hundred parts of sassolin, dissolved in boiling water and spirit of wine, gave in their analysis

Boracic acid - - - - - -	86
Sulphate of magnesia, containing a little iron	11
Sulphate of lime - - - - -	3
	100

Supplement to the Article on Sassolin.

M. Klaproth joins to this analysis of natural boracic acid that of a gray sandy powder mixed with fragments of mica, which are collected in the lagunas, and which was sent to him under the name of *loto*.

1st. A small quantity of that powder communicated a slight redness to water coloured by tincture of turnsole.

2d. Four ounces of alcohol put to digest over 100 grains of this powder, and filtered, gave no indications of boracic acid: on the contrary, they gave reason to suspect sulphate of lime.

3d. Water boiled with this powder acquires a taste of sulphurated hydrogen, and strongly blackens a silver spoon. It gave, by evaporation, sulphate of lime in fine needles which, joined to that dissolved by the alcohol, weighed 5 grains.

4th. The powder, dried in a gentle heat, weighed 84 grains. Being spread out on a small capsule, and gently heated, sulphur was dissipated: it lost eight grains of its weight.

5th. The residuum roasted, with double the quantity of potash, saturated afterwards with muriatic acid, evaporated to dryness, redissolved in water and filtered, gave silex which, when dried, weighed 54.

6th. The solution well neutralized was precipitated by the succinate of soda; the roasted precipitate contained three grains of oxide of iron.

7th. The remaining liquor then gave a precipitate by caustic potash, which, added in excess, redissolved it. Being saturated by an acid, and precipitated by carbonate of soda, it deposited alumine which, when calcined, weighed 16 grains.

The

The sandy substance, or loto, contained then in 100 parts

Silex - - - - - -	54
Alumine - - - - -	16
Oxide of iron - - -	3
Sulphur - - - -	8
Sulphate of lime - - -	5
	86

The quantity of sulphurated hydrogen being very inconsiderable, the greater part of the loss arises, no doubt, from the water.

Analysis of the Salt of Idria with capillary Filaments.

The capillary salt of Idria (*Holotricum Scopopolii*) which is found in fissures of the argillaceous scheeferthon schist, mixed with the aluminous schist of the mines of Idria, is of a silver-white colour, and forms needle-like or capillary crystals, which sometimes are more than two inches in length. Hitherto they have been considered to be feathered alum, composed of sulphuric acid, alumine, lime, and iron, according to Scopoli. But the analysis of Klaproth has shown the falsity of this opinion.

The result of this analysis proves that the salt of Idria with capillary filaments contains neither alumine nor lime, but that it is a natural compound of sulphate of magnesia, containing a small quantity of the sulphate of iron.

Analysis of the Feathered Alum of Frayenwald.

The feathered alum, which is formed in part in the quarries of argillaceous schist of Frayenwald, and particularly by their decomposition in the open air, has a white colour inclining to gray. It is composed of capillary filaments often crooked, united sometimes in bundles not very close, and sometimes cemented, and forming a crust: it has a moderate silky splendour.

A hundred parts of this feather alum contain

Alumine - - - - - -	15·25
Oxidulous iron - - - - -	7·50
Potash, sulphuric acid, and water of crystallisation	75·00
	100

Analysis of Melilite.

It is to the celebrated mineralogist of Freiberg that we have been indebted upwards of ten years for the knowledge of this fossil. The constituent principles of it have been

100

too little known to enable us to assign to it, with precision, a place in the classification of minerals. On account of its colour, which resembles that of honey, M. Klaproth calls it melilite.

Melilite is found at Arten in Thuringia, but insulated and in small quantity in strata of turf.

The external characters by which it is known are as follows: It is generally of a honey colour, more or less dark, and sometimes of a straw yellow. It has always been found crystallised in octaëdra: it is however rare that the crystals are entire, and for the most part they have the form of pyramids with four faces more or less distinct. They are seldom found of a moderate size, being always for the most part small.

The surface of them is generally smooth and brilliant, sometimes rough and as if gnawed, but they have always internally a vitreous splendour; their fracture is conchoid, and the fragments are irregularly angular.

The crystals are rarely perfectly diaphanous: in general, they are semi-transparent, and in the variety, which is of a yellow colour, scarcely pellucid. Melilite is tender, fragile, and easily pulverized. Reduced to powder, it is of a grayish-yellow colour. Its specific gravity is 1550.

There are found also sometimes in the same coal mines small pale yellow crystals of native crystal, which have a resemblance to the straw coloured variety of melilite.

It was at first believed that melilite is a combustible fossil, similar to amber. Its exterior characters seemed also to confirm it. But if the character of a non-metallic combustible fossil is to feed the flame which consumes it, this is not the case with melilite: when burnt it simply becomes white without being able to maintain combustion of itself.

M. Gilet Lamont has besides proved, in the *Journal de Chimie* for 1791, that melilite is not crystallized amber as baron de Born supposed.

Other mineralogists have supposed that this fossil is sulphate of lime impregnated with oil of petroleum, from which its yellow colour arises. This opinion arose probably from the white colour which this fossil acquires by combustion. It is however possible, considering its rarity, that it has been imitated by selenite coloured and cut artificially into crystals of the same form.

It was only from chemical analysis that a more correct knowledge of this fossil could be obtained. Messrs. Lampadius and Abich undertook this labour and published an account

account of it almost at the same time. But their results exhibit very considerable differences :

For melilite, according to Mr. Lampadius, is composed of

Carbon - - - -	85·5
Oil of petroleum - -	13·5
Silex - - - -	2·0
Water of crystallization -	5·0
	96·0

According to Mr. Abich, it contains

Benzoic acid - - -	5
Carbon - - - -	40
Water of crystallization - -	28
Carbonate of alumine - -	16
Benzoate of alumine - -	5
Oxide of iron - - -	3
Resin - - - - -	2
	100

The striking difference between these two analyses induced M. Klaproth to repeat them. He made his experiments on a pretty large quantity of melilite. The details are as follows :

Preliminary Trials.

1st. Melilite placed on burning coals, or well exposed to the flame of a taper, loses its transparency and yellow colour. It becomes white, punctured with black, and at length altogether white, like chalk. In this operation neither smoke nor sensible light is perceived.

2d. If melilite, reduced to a powder, be boiled with a sufficient quantity of water, this fossil becomes decomposed; the water acquires the properties of an acid, and suffers to be deposited a gray flaky earth.

3d. The entire crystals of melilite immersed in nitric acid dissolve completely, without heat, in the course of a few minutes. The liquor always remains clear till they are entirely dissolved. This process exhibits a sure and easy means of distinguishing real melilite from adulterated substances with which it might be confounded.

4th. If the crystals be put into muriatic acid, the acid does not remain clear like the nitric acid; it becomes whitish and nebulous : the crystals even are not entirely dissolved at the end of some days.

5th. In concentrated sulphuric acid, fragments of mililite do not fall to the bottom but float at the surface. They are gradually converted into white flakes, without giving clear solutions : this, however, takes place when the acid is diluted with water.

6th. Acetic acid exercises no action on melilite.

7th. Solution of caustic soda converted fragments of this fossil into white flakes, and dissolved them almost entirely.

8th. Solution of caustic ammonia changed them also at length into white flakes, but without dissolving them.

Melilite thrown on saltpetre in a state of fusion, produced no real detonation. The morsels of this fossil burn merely with a faint and transient light, and become mixed with the fused saltpetre under the form of a white earth.

M. Klaproth then analyzed them in the dry and in the moist way.

1st. Fifty grains of pulverized melilite, mixed with 75 grains of crystallized carbonate of soda, were boiled in a phial with a sufficient quantity of water. There was a reciprocal action between these two substances, with a disengagement of the carbonic acid of the soda. After the decomposition of the melilite effected by the soda, the earthy part deposited on the filter, when washed and dried, weighed 8¾ grains, and was found to be alumine.

The soda in solution was in a great measure neutralized : Mr. Klaproth completed the saturation of it with acetous acid, and evaporated the liquor gently to dryness. The acetite of soda thence resulting was separated from the saline mass by small quantities of alcohol poured over it at several times. The residuum was then dissolved in water, from which were precipitated crystals of a neutral salt, the acid of which had consequently been furnished by the melilite.

It results from this analysis that melilite is composed of alumine and an acid.

2d. Fifty grains of pulverized melilite put into a stopped flask, containing a cold solution of caustic ammonia, and frequently stirred, were decomposed; and twenty-four hours after the bottom of the glass was lined with a multitude of small crystals of a neutral salt, formed by the acid of the melilite and ammonia : they were covered with a slight brown stratum of alumine, arising from the decomposition of that fossil. The liquor was heated, and diluted with a sufficient

sufficient quantity of water to dissolve the crystals, after which it was filtered: it then deposited, by evaporation, small prismatic crystals with six planes.

3d. Fifty grains of melilite coarsely pulverized, and on which weak sulphuric acid was poured, were soon completely dissolved, without heat, except some carbonaceous parts and a few grains of quartz accidentally adherent. The solution filtered, and then concentrated, coagulated into a soft mass, ramified by small crystals in needles, without giving any appearance of real crystals of alum, which proves that melilite contains no potash.

In the decomposition of 100 parts of melilite in the dry way, a great deal of carbonic acid and hydrogen gas, &c. was disengaged.—These Mr. Klaproth collected under bells filled with mercury, and prove that the acid of melilite is analogous to vegetable acids; that it is composed of carbon, hydrogen, and oxygen, and consequently decomposable by fire. The residuum in the retort was black and brilliant. The fragments had lost nothing of their form or volume. They weighed 5 grains. When calcined in the open air, they gradually lost their black colour and their carbon: they became yellowish-blue: they weighed 16 grains. When dissolved in sulphuric acid they gave, by the addition of acetite of potash, crystals of alum.

A hundred parts of melilite, analyzed in the dry way, gave

34 inches in a line of carbonic acid gas
25 ——————— of hydrogen gas
38 grains of acidulous and aromatic water
2 of aromatic oil
9 of pure carbon
16 of alumine, combined with a little silex.

Decomposition of Melilite by Water.

Four hundred grains of melilite boiled for two hours with 60 ounces of water were decomposed: the decomposition when filtered to separate the alumine gave, by evaporation, crystals in needles, and an acid mass of small balls formed of diverging radii proceeding from one center. It remained to be known whether this acid of two radicals could belong to any of the known vegetable acids, or whether it had characteristic properties which ought to make it be considered as a particular acid.

The properties by which it is distinguished from all the other vegetable acids are as follows:

1st. Melitic acid crystallizes into fine needles, or globules, formed by the union of its needles, or in small hard prisms. This acid, however, does not seem at first to possess the property of crystallizing. It is probable that it gradually acquires it by the absorption of the oxygen of the atmosphere.

2d. This acid, when put upon the tongue, has at first a sweetish-sour taste, and then leaves a bitter savour.

3d. If put upon a warm plate of metal it is readily decomposed: it is dissipated in abundant gray fumes which, however, do not affect the smell. There remains a small quantity of ashes, which produce no change in red or blue tincture of turnsole.

4th. When neutralized by potash it crystallizes into long prisms grouped together.

5th. When saturated by soda it crystallizes into cubes or triangular plates, sometimes single, and sometimes in groupes.

6th. When saturated by ammonia it crystallizes in beautiful prisms with six planes, which soon lose their transparency in the air: they have then a silvery-white colour.

7th. Melitic acid dissolved in lime water, into which a solution of barytes or of calcined strontian is poured, drop by drop, produces a white precipitate; but which, if muratic acid be poured into it, becomes redissolved.

8th. When poured into a solution of acetite of barytes it produces, in like manner, a white precipitate capable of being redissolved by the addition of nitric acid.

9th. It produces no cloud, or precipitate, in solution of muriate of barytes; but some time after very fine crystals in transparent needles are deposited.

10th. Solution of nitrate of silver remains clear, and experiences no change by the addition of melitic acid.

11th. Melitic acid poured into a solution of nitrate of mercury, prepared either hot or cold, produces in it a very abundant white precipitate, which is immediately redissolved by the addition of a new quantity of nitric acid.

12th. When poured into a solution of nitrate of iron it gives a very abundant precipitate of an isabella colour, capable of being redissolved by the addition of muriatic acid.

13th. Poured into a solution of acetite of lead it gives, in like manner, a very abundant precipitate, which is immediately redissolved by the addition of nitric acid.

14th. Poured into a solution of acetite of copper, it gives a grayish-green precipitate.

15th. But a solution of muriate of copper experiences no change.

16th. It

16th. It has never yet been possible to convert it into oxalic acid by means of nitric acid. The only change which M. Klaproth remarked was, that its brownish colour became a straw-yellow.

The precipitate of lime water by this acid immediately redissolves by the addition of nitric acid.

These first trials, in regard to the affinities of melitic acid, are sufficient, however, to prove that it is susceptible of combining with several earths and metallic oxides; and that its affinity is stronger than that of the acetic acid and less than that of the mineral acids. This acid, composed of carbon, hydrogen, and oxygen, which is susceptible of decomposition by heat like the vegetable acids, participates then in their nature; but differs from them by its properties as well as by the proportion of its principles. This induced M. Klaproth to consider it as a particular vegetable acid, to which he has given the name of melitic acid. *Acidum melilithicum.*

What place will be now assigned in the methodical classification of fossils to that which affords the first instance of alumine, combined with a vegetable acid? Melilite belongs to the mineral kingdom by its base, and to the vegetable by the constituent principles of its acid, and by the origin of its formation amidst beds of coal: but coals being considered as fossils, though they arise from vegetable remains, mineralogists will have a right to class melilite among the fossils with a base of alumine.

The following is the proportion of the principles of which it is composed:

Melitic acid - - -	46
Alumine - - -	16
Water of crystallization -	38
	100

Analysis of the muriated Lead Ore of Derbyshire.

The regular crystals of this muriate of lead, already decribed by Mr. Karsten in his mineralogical tables, are formed of cubes of from four to six lines, with blunted edges; the decrements on the edges produce a great many varieties in their exterior form. Muriate of lead exposed on charcoal, at the extremity of the flame of the blow-pipe, immediately fuses into an opake globule of a beautiful orange-colour, which becomes lemon-yellow, and then white, by cooling; and the surface of the button seems to be slightly striated.

striated. When the charcoal inflames at the place where the globule adheres to it, the latter breaks in pieces, the muriatic acid escapes in white vapours, and the charcoal is covered with grains of metallic lead.

M. Klaproth has found in the crystals of muriate of lead treated by potash in a platine crucible, and by nitric acid,

Oxide of lead - - -	85·50
Muriatic acid - - -	8·50
Carbonic acid, with a little water	6
	100

Artificial muriate of lead contains 13 or 14 per cent. of concrete muriatic acid, while natural muriate of lead is not completely saturated; which explains why the carbonic acid may be found there at the same time as muriatic acid.

Analyses of the Green Phosphate of Lead of Zschopan.

This ore is composed of hexaëdral prismatic crystals, terminated by planes perpendicular to the axis. They are sometimes single, and sometimes formed into groupes; some of them are two inches in length. They are of an olive or green, sometimes inclining to meadow-green, and often to pale yellow; when pounded, they give a straw-coloured powder. The crystals, when very pure, have a smooth surface and a greasy polish; they are generally covered with a stratum of ochre which renders them rugged. The matrix from which they are extracted is white sulphate of barytes. The specific gravity of this substance is 6·270.

This phosphate of lead, when exposed on charcoal to the flame of the blow-pipe, fuses into an almost transparent globule; but it becomes opake by cooling, and soon crystallizes under the form of a polygonal garnet, with brilliant facets on the side which touches the charcoal. There are generally found small grains of lead reduced to the metallic state, but it is never entirely reduced without a flux. It participates in this property of crystallizing, by cooling, with all the ores of phosphate of lead hitherto known, as well as with artificial phosphate of lead. This observation had before been made by Cronstedt.

To fuse this ore a very strong heat is required; for M. Klaproth extracted it without its having experienced any alteration except at its edges, which were a little blunted by the muffle of a cupelling furnace, in which he had effected exceedingly well the separation of gold; but it fused completely in a blast-furnace, and crystallized in radii by cooling,

cooling, nearly in the same manner as sulphur of which its crystals assume also the colour.

The phosphate of lead of Zschopan reduced by black flux, and treated by the nitric and sulphuric acids to obtain phosphoric acid, is composed of

Oxide of lead - - -	78·40
Phosphoric acid - -	18·37
Muriatic acid - - -	1·70
Oxide of iron - - -	0·10
	98·57

That of Hoffsguind, near Fribourg, in the Brisgaw, contains

Oxide of lead - - -	77·10
Phosphoric acid - -	19
Muriatic acid - - -	1·54
Oxide of iron - - -	0·10
	97·74

The brown ore of phosphate of lead of Huelgoet in Brittany contains

Oxide of lead - - -	78·58
Phosphoric acid - -	19·73
Muriatic acid - - -	1·65
	99·96

The crystals subjected to this analysis were composed of hexaëdral prisms agglutinated together, of the size of a goose's quill, and half-an-inch in length. Their specific gravity, according to M. Klaproth, is 6·600.

The lemon-coloured ore of phosphate of lead of Wanlochhead in Scotland fuses, on coals, into a whitish green opake globule with some large brilliant facets, or facets the surface of which is covered with radii that cross each other. It contains

Oxide of lead - - -	80
Phosphoric acid - -	18
Muriatic acid - - -	1.62
	99·62

The yellow colour of this ore seems to arise merely from a greater oxidation of the lead. If pulverized, and if a solution of muriate of tin be poured over it, in a close vessel, it loses its yellow colour and becomes white.

[To be continued.]

X. *Analysis of Ambergris.* *By* Bouillon-Lagrange*.

It is is now almost generally admitted that ambergris is found in the stomach of the cachelot, called by naturalists *Physeter macrocephalus*, and that it seems to be the product of its digestion.

Dr. Swediaur has proved in his Researches on the Nature and Origin of Ambergris, that the beaks of the sepia, with which large pieces of ambergris, both those found on the coasts or at the surface of the sea, and those taken from the bellies of these whales, are mixed, belong to that species to which Linnæus has given the name of *Sepia octopoda*. The existence of these beaks and of other foreign bodies in ambergris is a convincing proof that it has been once in a state of softness or liquidity. M. Swediaur says, that the kind of whale which contains ambergris in its belly is that species from which spermaceti is extracted, which seems to be the *Physeter macrocephalus* of Linnæus, and which feeds chiefly on the large species of sepia. It is in the intestinal canal of this whale that the ambergris is found: to the animal it is a source of disease: this matter when it issues from the bag which contains it gradually acquires that solidity which it is observed to possess.

Ambergris is found in the Indian seas, near the Moluccas, the Maldives, and Madagascar, and on the coasts of China and Japan, and from Iolo to the Manillas. It is often picked up on the coasts of Maragnon, or of Brasil, but more commonly on those of Africa towards Cape Blanc, the Gulf of Arguin, the Bay of Portendia, and in some other islands which extend from that of Mosambique to the Red Sea.

According to the accounts of several travellers the inhabitants of the isles of Sanballat search for it in a very singular manner. After storms they proceed along the shore, and if there be ambergris on it they perceive it by the smell. There are certain birds and other animals on these shores which are fond of ambergris; and as they discover it at a

* From the *Annales de Chimie*, No. 139.

distance

distance by the smell, they go in search of it in order to eat it.

There can be no doubt that ambergris is an animal production. Several substances approach very near to it in smell, such as the excrements of some of the mammalia, and particularly those of oxen and pigs. I found that cows' dung dried in the sun has an odour very analogous to ambergris, and even to musk; and hence the name of *indigenous musk* given in some countries to this substance prepared in this manner.

Ambergris (*ambrea grisea*) is a light substance which floats on the water, solid, opake, of an ash colour, veined with white and yellowish-brown, slightly odoriferous, but the odour of which develops itself as it grows old, or when it is mixed with musk or other aromatous substances, as it is prepared for perfumes or smelling waters.

Good ambergris in its natural state may be known if when scraped with the blade of a knife it adheres to the knife like wax, if it retains the impression of the nails and that of the teeth, and if, when pricked with a hot needle, it emits a fat odoriferous juice. Though solid, and in general brittle, it is not sufficiently hard to bear polishing, but rubbed with the nail it becomes smooth like hard soap.

Geoffroy, Neumann, Grim, and Brow, have classed ambergris among the bitumens. The analysis made of it by chemists is not sufficient to determine the nature of this substance. Ambergris fuses in the fire, says Geoffroy, into a resin of a yellow or gold colour; when applied to a flame it kindles and burns; spirit of wine does not dissolve it entirely, there remains a black matter like pitch on which it has no action. When dissolved it leaves some time after a white nebulous sediment, which gradually coagulates and becomes thicker and thicker; this *coagulum* being dried changes into a brilliant foliated earth, and which is not different from spermaceti.

In distillation, according to the same chemist, ambergris gives first an insipid phlegm, then an acid liquor or spirit, and a highly odorous yellow oil, with some portion of acid and volatile dirty salt: in the last place there remains at the bottom of the retort a brilliant, black, and bituminous matter. It is here seen that this analysis, which does not differ from that given by all chemists, deserves to be re-examined in order to give us correct ideas respecting the nature of this singular substance.

I think it my duty to acquaint those who may be desirous of repeating these experiments, to be very careful in their

1 choice

choice of the ambergris. Several varieties are common in commerce, the price of which establishes different species. There is no doubt that this substance is fabricated, as *castorium* is made in some countries of Germany. Bayen assured me that he saw it made at Frankfort. This father of chemistry found that his memory did not deceive him; and, what is rare among travellers, he told the truth.

I have examined several kinds of ambergris used in commerce. Some of them vary in specific gravity, have a colour more or less dark, with very little odour, and are flexible; others are of an ash-gray colour, pretty hard: in the last place, others are almost stony, are scarcely soluble in alcohol, and have no odour.

The ambergris which I analysed was not purchased. I compared it with that in the cabinet of the Museum of Natural History, and found no difference either in the colour or odour.

Physical Properties.

It is of an ash-gray colour, interspersed in the inside with some yellow striæ; has a sweet mild odour, and grows soft between the fingers. When reduced to a fine powder it acquires a darker colour; pounded in a glass mortar it becomes agglutinated and adheres to the pestle.

Its taste is dull and almost insipid, and when put between the teeth it exhibits the same phænomena as wax.

Its specific gravity is from 844 to 849: that of water being 1000.

According to Brisson the specific gravity of ambergris is 9263. The weight of the cubic inch 4 gros 58 grains; that of the cubic foot 64 pounds 13 ounces 3 gros 47 grains.

The specific gravity of blackish ambergris is 7803. The weight of the cubic inch 4 gros 3 grains; that of the cubic foot 54 pounds 9 ounces 7 gros 35 grains.

Chemical Properties.

Exp. I. Ambergris, when placed on burning charcoal, burns, and becomes entirely volatilized: it then leaves an agreeable odour.

If this combustion is effected more slowly in a platina crucible it fuses, emitting the same odour; that of a fat body is also distinguished.

Nothing remains in the crucible but a black greasy spot.

Fifty degrees of heat (Reaumur's thermometer) are sufficient to fuse it A brown brilliant liquid is thus obtained.

At 80 degrees it is volatilized under the form of white vapours.

Exp.

Exp. II. The odour developed during its volatilization, having made me suspect the presence of an acid analogous to that of balsams, an experiment was made to ascertain it.

A bit of ambergris was placed in a porcelain capsule covered by a bell, in which was suspended a paper tinged with turnsole. The apparatus being placed on a sand-bath, the temperature was raised to the degree necessary to volatilize the ambergris: the paper speedily assumed a red colour. Nothing was now necessary but to discover the nature of this acid; and with this view Scheele's process for extracting acid of benjamin was employed.

The product was examined, and left no doubt in regard to its analogy.

Exp. III. The analysis with the retort added nothing to the knowledge already acquired in regard to the nature of ambergris.

A gentle temperature makes it fuse: in a more elevated one it is decomposed, and a whitish acid liquor and a light oil soluble in part in alcohol, which gives it a yellow colour, pass over into the receiver. There remains in the retort a light and very voluminous charcoal.

Exp. IV. Ambergris floats on water, and does not suffer itself to be penetrated by that liquid cold: it acquires neither odour nor savour. Boiling water produces no alteration on it. At that degree the ambergris dissolves and appears under the form of a brownish oily liquid: a small quantity of a black matter insoluble in alcohol is separated. The filtered liquor had neither odour nor colour, and only a slight bitter savour.

It is only in the ratio of the temperature, then, that ambergris dissolves, since in proportion as it is lowered it is found to have the same properties.

Exp. V. Acids in general have very little action on ambergris. It has not yet been possible by the aid of these agents to discover the constituent parts of this compound.

Weakened sulphuric acid makes it experience no change. If concentrated, it lays bare little of the oxide of carbon.

The same phænomena are exhibited by the muriatic and oxygenated muriatic acids.

Nitric acid raised to 18 degrees, and distilled from off that substance, in a pneumatic apparatus, gives for result nitrous gas, carbonic acid, and azotic gas.

The latter arises, no doubt, from the decomposition of some animal matters accidentally mixed with the ambergris, as as may be observed in the examination of some fragments of it.

There is found in the retort, after the elastic fluids are extracted, a thick liquid inclining to yellow: when brought to a soft consistence the matter swells up a little, and when evaporated to dryness in a porcelain capsule there remained a dry brittle matter of a golden-yellow colour, brilliant and transparent, which exhibited characters analogous to resins.

[To be continued.]

XI. *Proceedings of Learned and Œconomical Societies.*

ROYAL ACADEMY OF MADRID.

This learned body, in its sitting of August 19th, admitted among the number of its corresponding members John Baptiste Leonard Durand, author of a voyage to Senegal, and sent him a diploma. It transmitted to him also at the same time the following observations on the solar eclipse, made at Tangiers by Ali Beik Abdallah, a young Moor, educated in Europe, who has already distinguished himself by his talents, his love for science, and the service he endeavours to render to it.

Observations.

The sun appeared eclipsed above a hill which intersected the horizon at $17^h\ 24^m\ 13^s$. A large spot which was situated near the sun's centre emerged from the shadow at $18^h\ 28^m\ 25^s$. End of the eclipse, exterior contact $19^h\ 14^m\ 15^s$.

The observer employed a small telescope, by Dollond, which he calls a military one, of a foot focus, the eye-glass of which he smoked; the time was given by his chronometer, which he compared with the heavens, by the mean of 40 altitudes of the sun taken on the 16th and 17th with his pocket sextant and a glass horizon.

The part eclipsed seemed to be about eight digits, which shows the great influence of parallax.

He proposes to determine the longitude and latitude, of which, as yet, he has had only an approximation.

M. Delalande, who observed this eclipse at Paris, has deduced from it, that the difference of meridians between Tangiers and Paris is $33^m\ 12^s$ in time, which is only 32 seconds more than it was supposed to be before, but which stood in need of this confirmation.

SOCIETY

SOCIETY OF NATIONAL ŒCONOMY, HAARLEM.

This society has published the following

Prize Questions:

1. What species of nettle can be employed in making yarn? The memoir must state what country produces it; the proper season for gathering, and the manipulations necessary in preparing it for use. Twenty-five pounds of the yarn must be produced with the paper. The prize is 25 ducats, which will be augmented if 50 pounds be sent in.

2. Can the acorn be employed for making oil, as a substitute for coffee, or other purposes of domestic œconomy? and what are the best methods for doing so? The prize is six ducats.

3. What is the present state of public and private œconomy in Holland?

4. What is the best method of preventing or curing the rot in sheep? Fifty ducats to the person who shall point out the cause of the disease, and an effectual method of prevention; twenty-five ducats to the one who shall point out a cure.

The answers to the above questions must be sent to the secretary of the society before the 30th of September 1804.

5. Millet being little cultivated in Holland, and no good method known for separating it from the chaff, the society offers a premium of twenty-five ducats to the person who shall invent a machine by which that can be effected as completely as in the millet imported from other countries. The competition for this prize will be open till the 30th of September 1805.

ŒCONOMICAL SOCIETY, ST. PETERSBURGH.

This society has offered several premiums for encouraging industry among the peasants and the poor in hospitals; also for a good method, suited to the capacity of the Russian peasant, for the preservation of health, enabling him to apply remedies, especially from indigenous plants, with the manner of employing them. The prize for the latter is a gold medal of fifty ducats.

XII. *In-*

XII. *Intelligence and Miscellaneous Articles.*

VACCINATION A PREVENTATIVE OF THE PLAGUE.

Extract of a Letter from J. DE CARRO, *M. D. of Vienna, to Dr.* C. F. HAUG, *of Rastadt.*

August, 23, 1803.

WHAT will excite your admiration, as well as that of the whole world, is a new discovery made by two physicians, namely, Dr. Aubon, of Constantinople, and Dr. Lafond, of Salonica, in Macedonia. The experiments of these two physicians, who never have had any intercourse, confirm that the vaccine is a preservative against the plague. The proofs of the former are, that of 6,000 persons inoculated with the vaccine at Constantinople, not one of them was attacked by the plague; that children subjected to the vaccine inoculation were made to suck mothers attacked by the plague without any of them being infected; that an Italian physician, who devoted himself in Turkey to the study of the plague, being fully convinced of the property which the vaccine has of preserving from this malady, took every opportunity of coming into contact with persons infected by the plague, in an hospital destined for patients afflicted with that disease: that in consequence of accurate researches the vaccine pustules have been found on the teats of the cows, and the hands of those who milk them, in the villages around Constantinople: that it results from the account of persons worthy of credit, that in their country neither the plague nor the small-pox have ever prevailed epidemically, even when these scourges made the greatest ravages in the neighbourhood: that when an inhabitant of these villages has been infected with the plague in distant countries, and returns with that malady, he has either died or been cured without the disorder spreading: in the last place, that the confidence of several classes of men, and chiefly of the Armenians, in the preventive quality of the vaccine against the plague, is so great, that a number of people are inoculated every year with it to preserve them from this malady The physicians of Constantinople have begged me to contribute towards the promulgation of this new discovery, &c.

PRUSSIC ACID.

Dr. Schaub, of Cassel, in a letter to Mr. Parkinson, has given a new process for obtaining this acid in a state of ab-

solute

solute purity. It consists in pouring upon one part of Prussian blue half a part of sulphuric acid, diluted with an equal quantity of *water*, and subsequent distillation. The prussic acid passes over in the *alcohol**. Its odour greatly resembles the water of the Lauro-cerasus. It is a deadly poison to animals.

PHOSPHATE OF SODA.

M. Funcke, a German apothecary, gives the following as a more œconomical, expeditious, and easy process for preparing this substance than any in common use:

Saturate the excess of lime contained in calcined bones with dilute sulphuric acid, and dissolve the remaining phosphate of lime in nitric acid. To this solution add a like quantity of sulphate of soda, and then recover the nitric acid by distillation. The phosphate of soda is then to be separated from the sulphate of lime by affusion with water and crystallization in the usual manner.

SULPHATE OF SODA.

The same chemist has published a new method of preparing sulphate of soda from sulphate of lime. It consists in making into a paste, with a sufficient quantity of water, eight parts of burnt gypsum (sulphate of lime), five of clay, and five of common salt. This mixture is burnt in a kiln or oven, and then ground to powder, diffused in a sufficient quantity of water, which, after being strained and evaporated, is suffered to crystallize.

POTASH.

The ashes of vegetables in general contain only from 18 to 20 per cent.; those of buck-wheat, according to some experiments of Vauquelin, about 33 of this alkali.

GALVANISM.

Professor Tromsdorff has announced that metals may be deflagrated by means of the Galvanic fluid, in hydrogen, ammonia, nitrogen, nitrous and carbonic acid gases.

TITANIUM.

Professor Lampadius has succeeded in reducing to the metallic state, by means of charcoal only, the oxide of

* We have copied this from Mr. Nicholson's valuable Journal, but there is some inaccuracy in it. If water only was employed there could be no alcohol produced; if the latter was employed in place of water then either might pass into the receiver.

titanium

titanium, obtained by decomposing the gallate of that metal by potash or soda. The metallic titanium is of a dark copper colour, has much brilliancy, is brittle, but possesses, in small scales, a considerable degree of elasticity: it tarnishes on exposure to the air, and is easily oxided by heat, which gives it a blueish aspect: it detonates with nitrate of potash and is highly infusible. All the dense acids act upon it with considerable energy.

TUNGSTEN.

Richter, the German chemist, has published the following method of obtaining tungsten:

Expose equal parts of tungstic acid* and dried blood for some time to a red-heat in a crucible; put the black powder which is formed into a smaller crucible, and expose it again to a violent heat in a large fire for at least an hour. The result is tungsten in its metallic state.

STENCILLING.

On this process, which is employed in different manufactures, we have received a communication from Mr. T. Gill, which we think furnishes a very useful hint, and may possibly lead to an extension of the use of stencils:

"Wishing," says he, "to produce some copies of a miniature profile, lately taken by Mr. Hawkins's patent method (viz. by a machine, which being traced over the face itself, at the same time draws the outlines of the profile on a reduced scale), which was cut in thin wove post paper; I coated it pretty thick on both sides with the cement No. xvii. described in the Philosophical Magazine, vol. xiv. p. 122; which dried instantly, and rendered it perfectly impervious to oil and water, and sufficiently stiff. In short, the paper became a very excellent stencil, with which I was enabled to multiply the profiles with as much facility as if it had been a brass impression plate. I think the above information may be useful to manufacturers of paper hangings, cards, floor cloths, and in short to all who employ stencils, as a method of preparing them, far superior to that in general use; which consists in coating them with boiled linseed oil, as the oil requires much time to become dry, and, I believe, would never render the stencil so firm and durable, as by this new process."

* Or more properly tungstic oxide; tungsten, by some late experiments, appearing not to be acidifiable.

XIII. *Essay on the Franklinian Theory of Electricity. By* SAMUEL WOODS, *Esq. Read before the Askesian Society in the Session* 1802-3.*

THE science of electricity offers an extensive and interesting field of inquiry to the curious and speculative mind: the diligence of observation and experiment has collected an almost unlimited variety of facts, which it is often difficult to refer by any perspicuous classification to a few simple and general principles; and notwithstanding the endeavours of philosophers well qualified by their situation, talents and pursuits, to examine the effects, ascertain the properties, and investigate the laws of this singular fluid, it is still an arduous task to discover the connecting links which unite the numerous phænomena in one luminous and consistent system. Those striking appearances which arrest attention and create astonishment, are perhaps less calculated to convey substantial information than an accurate and repeated scrutiny into the minuter effects and operations. The recent and surprising discoveries in Galvanic electricity may convince us that our knowledge hardly penetrates beneath the surface. We know, indeed, that by rubbing a piece of glass or sealing-wax particular signs and actions are produced, which may be communicated to, and in certain circumstances retained by, other bodies: and we impute these signs and actions to the influence of a peculiar fluid, which we denominate electricity. But we are yet unable to conceive the reason or the means by which friction generates this power, or how its passage is obstructed or impeded by some particular substances: vapours, clouds, fogs, rain, and even the atmosphere, almost universally and uniformly indicate, when examined by delicate instruments, the presence of electricity; and though it is reasonable to conclude its agency of great extent and importance in our system, we are still ignorant what office is assigned to this subtile fluid in the œconomy of nature.

It has justly been observed that the effects of electricity are in many instances strictly mechanical, producing local motion like gravitation, and therefore a proper subject of mathematical investigation. The establishment of electrical science on such principles has been attempted by several: in the opinion of the ingenious editor of the Supplement to

* Copied by permission from the records of the society.

to the Encyclopædia Britannica, Mr. Æpinus and his followers, Messrs. Cavendish and Coulomb, have framed a perspicuous and demonstrable theory. The work of Æpinus I have not yet been able to procure; but, perhaps, at some future period I may be tempted to offer to the society a general view of the Æpinian theory, combined with the illustrations of his disciples.

I have undertaken on the present occasion to exhibit a succinct but, I trust, an intelligible view of that theory, respecting the operations of the electric fluid, which ascribes all electrical phænomena to the passage of this fluid from one body to another, disturbing from various causes that equilibrium which it is the constant tendency of nature to preserve, producing an increase or diminution of quantity, and a consequent effort to recover its original state: a theory which, though not originating with Dr. Franklin, owes its present adoption and celebrity to the discoveries and illustrations of that ingenious electrician. The redundancy and deficiency of the electric fluid form the corner stone of Dr. Franklin's theory; and the greatest part of what has been since added is a more distinct explanation of the mode of action by which such redundancy and deficiency produce the observed phænomena. I shall waive for the present any examination into the nature of electricity in the abstract, and assume its materiality as a subtile and most commonly an invisible fluid, which, in certain cases, becomes obvious to our senses; sometimes amusing us by the singularity of its action; at other times, by its stupendous effects, evincing itself one of the most powerful agents in nature.

In order to place the advantages and defects of this theory in the most perspicuous point of view, I shall endeavour to arrange the subject under a few general heads or propositions; by which means we shall be enabled to examine with more facility the dependence and connection of these propositions with each other, and the degree of proof by which they are individually and unitedly supported; but before we enter more particularly upon this examination it will be proper to premise a few observations respecting the terms in common use.

The term electricity is used too often in a vague and indefinite sense, sometimes for the fluid or cause of action, and at others for its perceptible effects: there is no single word yet introduced which bears the same relation to electricity as caloric to heat; and it appears, at present, most

 philo-

philosophical to apply the electric fluid as the cause or power, and electricity to the effect.

Electricity is found to be of two kinds; one produced by the excitation of glass, and formerly called vitreous: the other by the excitation of resin, and called resinous:—whether we impute these different phænomena to the action of one or of two fluids, it is convenient to adopt some terms which shall distinguish these different states, if of one fluid; or the different fluids if two; as a mean of such distinction, the terms positive and negative may be safely acquiesced in by all parties, without any precise definition of the sense in which they ought to be received. The adherents of Dr. Franklin consider positive as denoting redundancy,—and negative, deficiency.

When electrical appearances, viz. the attraction of light bodies or sparks, are induced by friction upon any body, such body is said to be excited.

Electricity may be produced four ways:—1. Friction; 2. Heating and cooling, as is particularly remarkable in the tourmalin; 3. Melting, or pouring one melted substance into another; 4. Evaporation: perhaps all these modes may be justly deemed mechanical, and resolve themselves into friction. When electricity is communicated from an excited electric to another body, that body is said to be electrified. I shall first state the series of propositions which I conceive comprises the most prominent and leading features of the Franklinian theory; and shall then consider them separately, adverting to the proofs by which they are supported.

Prop. 1. That the phænomena of electricity are imputable to the operations of one fluid, peculiar in its nature and properties; generally invisible; extremely subtile and elastic; universally and plentifully diffused through the atmosphere and other terrestrial substances.

Prop. 2. That the particles of which this fluid is composed have a strong attraction to other matter, and a strong repulsion between themselves.

Prop. 3. That this fluid, pursuant to the general law of hydrostatics, will, in a state of rest, be uniformly diffused in proportion to the capacity of bodies, and in this state of uniform distribution will produce no effect cognizable by our senses; but that this state of equilibrium is frequently, and may easily be, disturbed by natural or artificial causes.

Prop. 4. That this fluid moves with various degrees of facility through the pores of different kinds of matter in a certain class of bodies which are capable of transmitting this fluid with facility, and for that reason called conductors, such as metals, water, &c., it moves without any perceivable obstruction; but that in another class denominated electrics, such as glass, sealing-wax, &c. which on friction produce signs of electricity, it either moves with extreme difficulty, or is entirely immoveable.

Prop. 5. That though electrics are subdivided into two classes:—1. Glass, &c. which on excitation have a general tendency to emit the electric fluid by disturbing the equilibrium, collecting it, by means of the rubber, from the surrounding bodies and conveying it to some other body, producing the negative or minus state in those bodies, and the positive or plus state in the body to which it is so conveyed: 2. Resin, sulphur, &c. whose effects are precisely the reverse of the other class, having a general tendency on excitation to receive the electric fluid from any body with which it is immediately connected, producing a negative state in that body, and, by transmission through the rubber, a positive state in the surrounding bodies—yet that this affords no presumption of the existence of more than a single fluid.

Prop. 6. That any excited electric is capable of communicating, by contact with other bodies, an electricity similar to its own; and by proximity without contact, of inducing an opposite state of electricity without losing any part of its own possessions.

Prop. 7. That the two different states of positive and negative electricity may be easily and universally distinguished from each other by certain constant and invariable indications.

Prop. 8. That to electrify a body, the natural or proportionate quantity of this fluid must either be augmented or lessened in that body, and that the positive state consists in an accumulation or excess of electric fluid; and the negative state in a diminution or deficiency of natural quantity.

Let us now proceed to examine separately the different assertions comprehended in the above propositions.

The first proposition comprises three positions respecting the phænomena of electricity, which are not immediately obvious: that they are imputable to one fluid, elastic, and universally diffused. Besides the want of simplicity which characterizes the hypothesis of two fluids, it does not appear to me that any advantage is obtained by it, or that the most perplexing facts are more satisfactorily explained. Two fluids existing in chemical combination could not so easily be separated by causes strictly mechanical: the mere act

act of breaking a stick of sealing-wax will produce the two contrary electricities in the two contiguous extremities: if two different substances be rubbed together when insulated, unless the conducting powers of these substances be precisely similar, they will exhibit opposite signs of electricity: the mere contact between two bodies in different states produces an apparent equilibrium, and each ceases to be characterized by any peculiar properties.—Another circumstance which renders the theory of two fluids improbable is, that the quality produced depends not only on the nature of the electric, but on that of the rubber. Those electrics which with some rubbers produce positive, with others produce negative electricity; and almost every electric may be made to produce, at pleasure, either positive or negative electricity by the adaptation of proper rubbers. The visible electric atmosphere may be adduced, as another proof, in favour of the homogeneity of the electric fluid. If a ball, at the termination of a brass rod whose upper end is connected with the prime conductor, be inserted in an exhausted receiver at a sufficient distance from another ball to prevent a spark from passing between them, the upper ball will have a lucid atmosphere extending itself towards the lower ball, while the latter is destitute of any such appearance. If the upper ball be kept negatively electrified by connecting it with the rubber instead of the prime conductor, the effects will be reversed, and the lower ball distinguished by a lucid atmosphere: thus we have an ocular demonstration of the unity of the fluid; for, if there were two fluids, both should have atmospheres: under these various considerations I think we may be justified in ascribing all electrical appearances to the action of a single fluid.

With respect to the elasticity of this fluid, I much doubt whether it is susceptible of proof: as, however, its elasticity is inferred from its repulsive property, it will come under our notice in the next proposition.

The universal diffusion of this fluid may be presumed from our experience: no place has yet been found where, by the usual means of excitation, electricity cannot be obtained; and no reason can be assigned for any partial or local confinement when moisture and other conductors are at hand to convey it over the whole earth. It will on the present occasion be superfluous to examine the identity of lightning and electricity: it will be sufficient to observe that, by the proper management of the electrical kite, it may at all times be collected from the atmosphere.

The second proposition contains two positions: the attraction of this fluid to other matter, and the repulsive action between its particles. That excited electrics will influence light bodies at a considerable distance, by attracting such towards them, is a fact too common to be controverted: this property of attraction does not appear to be the result of any affinity between the electric fluid and matter in general, but to proceed from its tendency to equilibrium, and its disposition or power to make use of other substances as common carriers to restore it; for light substances insulated cannot act in this capacity, and will not be attracted by the conductor.

The repulsive action of the particles of the electric fluid between themselves is a question involved in considerable difficulty: the experiments in an exhausted receiver do not indicate any analogy to air or other elastic fluids; for, instead of spreading wider and evincing its elasticity in proportion as the resistance is diminished, the fluid passes in an uninterrupted stream. There are, however, other circumstances which favour a repulsive quality. Thus, light bodies after they become saturated are driven off: if a conductor be brought near an excited cylinder, yet too distant to receive a spark, and an index be placed at each end and in the middle, the near end will be found negative, the remote end positive, and the middle neuter,—proving that a portion of electric matter has been driven off, by the action of the excited cylinder, from the nearer to the remoter end; and if a conducting body be presented to the remoter end a spark may be obtained, and on removing the cylinder the whole conductor will be found in a minus or negative state: this repulsive quality is, too, much more subtile than the fluid, and can act like gravitation, through substances which the fluid itself is unable to penetrate.

The repulsion between two pith balls negatively electrified has received many mysterious solutions, none of which, as far as I am acquainted, are at all satisfactory. Without entering into any obscure inquiry about repulsive qualities, may we not refer the divergence of two pith balls, both in cases of positive and negative electricity, to one simple and general principle of attraction? When two pith balls are artificially surcharged with the electric fluid, its endeavour to escape, or its attraction to the surrounding particles floating in the atmosphere, would impel the balls to expose the utmost extent of their surface to discharge the superfluous quantity; and as the most contiguous particles become saturated,

turated, the balls will diverge, to find fresh particles capable of relieving them, in exact proportion to the degree of their charge. The same reasoning in an inverted order applies to the negative divergency: the particles immediately contiguous are deprived of their natural share of the electric fluid to restore the equilibrium; and in proportion as these are insufficient to supply the demand, the balls will diverge to obtain it from the next and succeeding ranges of particles. The air is probably a very good electric; and as no actual and continuous communication subsists between the heterogeneous conducting particles floating in the atmosphere, the transmission of the electric fluid to and from the balls, by a conveyance between such conducting but insulated substances, must be too slow and gradual to prevent the divergency alluded to. This hypothesis seems (I mean to myself) both simple and probable: I have endeavoured to illustrate by a figure the detail of this divergency.

Let A,B, (fig. 1. Plate III.) represent two pith balls suspended from a point C by the threads AFC, BGC, and let the semicircles concentric to each represent particles floating in the atmosphere: the mutual attraction between these particles and the electric fluid contained in the balls A,B, when positively electrified, will draw the ball A from the ball B towards *a* in the line AD; and, when *a* particles are saturated, to *b*, *c*, *d*, *e*, *f*, *g*, *h*, successively in the ratio of the charge till the redundant quantity is discharged, or, as may be supposed the common case, till the powers of attraction and gravitation are balanced, and the balls rest in equilibrio. In the same manner and upon the same principles B will recede to P, and both balls will cease to recede whenever their gravity balances the attractive power between the fluid and the atmosphere: in the same manner, in the case of negative electricity both balls require an additional portion, and, unable to obtain a sufficient quantity from *a*, *i*, traverse successively to *h*, *p*, till the equilibrium of the fluid is restored, or a balance produced between the attractive and gravitating powers.

The third proposition respects the inaction of the electric fluid in a state of uniform diffusion, and the facility with which its natural equilibrium is destroyed. The first position is supported by the general analogy of fluids; all of which have a tendency to diffuse themselves in conformity to some general laws, and at a certain period become stationary, producing no cognizable effects. We have every reason to believe that the electric fluid, as well as caloric, is always present in greater or smaller quantities in the composition of bodies, and we have a right to conclude that when its existence is not manifested by its action it must be in a comparative state, at least, of rest and uniform diffusion, since otherwise its passage would be indicated by external signs or sensations.

The facility with which the equilibrium is destroyed is very striking: the fracture of sealing-wax, the fall of metallic powders, the mere operation of pressure, are sufficient for this purpose. Mr. Æpinus pressed two plates of glass close together:—when separated and insulated, each acquired a strong electricity, one positive, the other negative; and upon reunion, the electricity of both disappeared: it is obvious that these modes are inferior sorts of excitation; but it is difficult, if not impossible, to offer any solution how excitation produces these effects: the means seem to point out a cause merely mechanical, but the presence of oxygen for some reason seems from experiment to be requisite for their production. It is remarkable that heat destroys the power of excitation, and dry cold augments it.

The fourth proposition is a very important one, and upon which a large proportion of electrical science depends—I mean the distinction between conductors and electrics—in which it is assumed, that in conducting substances the electric fluid moves without obstruction; and in electrics has a very slow and difficult, if any, passage. When we speak hypothetically of conductors and electrics, we suppose them to be perfect in their kind, but practically we are ignorant of any such perfection. In metals which approach the nearest to excellence, as conducting substances, there is often a very obvious resistance to the passage of the fluid, which is particularly remarkable in the destruction of small wires by the charge of a battery, and the heating of their substance even to redness and fusion; though the most accurate experiments have been hitherto insufficient to detect any delay of motion by such resistance, or to perceive the lapse of any the least time during its passage for several miles. It has been much controverted whether the fluid is conveyed along the surface or through the substance of conductors; but it does not appear to be a point of much consequence, or which at all affects the consistency of the theory. If a wire be coated with some electric substance, such as wax, resin, &c. it will be found to conduct a charge with as much facility as before; and hence it is inferred that the fluid must pass through the substance of the wire;

3 this

this proof can hardly be deemed conclusive, since it is, at least, doubtful whether the wire and its coating ought to be considered as in actual contact; and if not so, a fluid so extremely subtile might easily pass between them. That the fluid may be forced through the substance of wire is more susceptible of proof from the instances of fusion; but that its tendency is superficial may be inferred from the superior strength of sparks derived from conductors of large surface, extended in length in preference to breadth, when compared with solid conductors:—in short, it is found that the prime conductor of an electrical machine is equally, if not more, effectual when hollow than when solid. In some experiments made by Dr. Priestley, the excoriation of metallic chains resulting from a strong discharge also denotes some determination towards the surface.

If a perfect electric were in our possession, this hypothesis requires us to conceive of it as absolutely impermeable to the electric fluid: but as the qualities of conducting and non-conducting substances coalesce sometimes to a very extraordinary degree, even in glass, which we consider the best electric—I must state that I mean by impermeability, that power of preventing the escape of the fluid which is peculiar to electrics, which power is ascribed to the great difficulty experienced by the electric fluid in obtaining admission into the pores of such bodies, and the extreme slowness of its progressive motion over their surface or through their substance. This power of confining the fluid is proved by the charge of a Leyden phial, by the well-known instances of insulation, and by the durability of electrical properties. Mr. Henley (Phil. Trans. vol. lxvii.) mentions a small bottle which retained its electricity for seventy days after charging, and remained during that time in an open cupboard: he had a cylinder variable in the duration of its electricity: once, after excitation, it showed strong signs of electricity for thirty-three days: means were repeatedly and successfully resorted to, to remove these appearances; but after a short pause they constantly returned without fresh excitation, alternately became stronger and weaker, vanished and returned without any visible cause: he observed that the electricity was generally weak with a fire in the room, or the door open; during a northerly wind vigorous:—the cylinder did not uniformly retain this power; it would often lose all signs of electricity in 12 hours after excitation; at other times it would remain a fortnight.

The different results of communicating electricity to conductors, or electrics, afford another proof of the difficult

passage

passage the last-mentioned bodies afford to this fluid: in the first case, it finds an easy passage to any conducting substance presented at a convenient distance, and becomes immediately discharged; but in the latter case, it acquires any electricity with considerable difficulty, and, in order to induce it, must be touched several times and in different parts by an electrified body. A curious experiment of professor Lichtenberg, of Göttingen, deserves to be cited upon this occasion (Cavallo, 72): he first excited an electric plate, upon which he placed some metallic body of a convenient shape, and to this he communicated an electricity contrary to the one excited: then removing the metallic body by means of an electric, he shook some finely powdered resin over the electric plate, which fell over those parts only which had been in contact with the metallic body, forming radiated appearances. This description accords with a plate excited negatively, and a body positively electrified: but if the electricities are changed, the circumstances will be reversed also, and the powdered resin instead of seeking those parts touched by the metallic body will obviously avoid them.—At first sight, no reason appeared for this variation, since both electricities attract an unelectrified body; but, upon more accurate examination, Mr. Cavallo found that the mere action of falling produced a degree of excitation in the powdered resin, which of course became negatively electrified, and could in that state be attracted only by the contrary electricity. Thus, in the first instance, where the plate was negatively electrified and the parts in contact with the metal positive, the powder also in a negative state attached itself to the positive:—in the latter instance, the plate being positive, and the parts in contact negative, the powder also negative would attach itself to the plate, and avoid those parts endued with an electricity similar to its own.

Thus far the path we have trodden does not seem encumbered with any serious difficulties, but the observed phænomena require an addition to this hypothesis which is not very easily explicable: in charging a Leyden phial it is obvious, from various experiments, that while one side is receiving the other is emitting. Let a phial be insulated, and the knob of a second phial placed at a short distance from its external coating; every spark from the prime conductor to the knob of the first phial will be followed regularly by another spark from its outside coating to the knob of the second phial, having to the senses all the appearance of a free passage through the glass: but if there were a

free

free passage there could be no charge, and on the contrary, both phials are found charged; and upon this principle a battery is easily constructed: hence it becomes necessary to assume that electrics contain a large and equal quantity of the electric fluid at all times; that no real accumulation of quantity can take place; but that by affording an opportunity to one side for the escape of this fluid, it is possible to transfer an equal quantity to the other, while the deficiency is balanced by an occult principle of repulsion.

It is certainly very difficult to imagine the existence of a substance capable of yielding a large supply of a peculiar fluid, and into which an additional quantity may be poured on one side while it is abstracted from the other, when, at the same time, it refuses a passage to this fluid through its pores: this, however, is presumed to be the case in electricity. Dr. Franklin once imagined that, in the process of cooling, the middle of a glass plate or jar might become condensed, and its particles so much concentrated, that, while it admitted a circulation of electric fluid on its surface, it refused it through its substance. Dr. Franklin as usual reduced his conjecture to experiment, by grinding a thick glass plate away beyond the middle, and found that it received a charge with as much facility as before, and immediately acknowledged the fallacy of this opinion. I should feel exceedingly gratified to afford the society some light upon this curious circumstance; but as my own conceptions are involved in profound obscurity, it would be a vain and fruitless attempt to offer a fanciful solution unsupported by experiment or by probability.

The division between the two species of electrics is so fully detailed in the body of the fifth proposition, that it will be unnecessary to support it by any other consideration than an appeal to facts which are generally known. The construction of Mr. Nairne's machine is an ingenious exemplification of its truth; but with respect to the reason which determines these bodies in one instance to receive from, and in other circumstances to yield to, the rubber a supply of electric fluid, we pretend not to assign any. We have examined in the first proposition the presumption which these phænomena afford of the existence of two fluids, and endeavoured to show that such presumption was overthrown by the possibility of producing either negative or positive electricity by the adaptation of proper rubbers. The following table of excitation is extracted from *Encyclopædia Britannica.*

TABLE

TABLE OF EXCITATION.

Electrical Substances.	*Rubber.*	*Quality.*
Back of a cat	Every substance - -	pos.
Glass—smooth	Ditto - - - -	pos.
rough	Silk, sulphur, or metals -	pos.
ditto	Woollens, paper, wax, hand	neg.
Tourmalin -	Amber or air blown upon it	pos.
Ditto -	Hand - - - -	neg.
Hareskin -	Metals, silk, leather, hand -	pos.
Ditto -	Fine furs - - - -	neg.
Silk—black -	Sealing-wax - - -	pos.
	Skins, metals, hand - -	neg.
white -	Black silk or cloth, metals -	pos.
	Paper, skins, hand - -	neg.
Sealing-wax	Metals - - - -	pos.
	Skins, hand, woollens - -	neg.
Baked wood	Silk - - - -	pos.
	Flannel - - - -	neg.

The sixth proposition comprises another material source of electrical knowledge. It states, in the first place, that an excited electric is capable of communicating, by contact or by such proximity as shall permit the free passage of the electric fluid through the air, an electricity producing upon other bodies precisely the same effects as such excited electric. From this principle is derived the utility of what is called the prime conductor of an electrical machine. This conductor receives, and retains by its insulation, the electric fluid from the excited cylinder, which by this means we have the advantage of obtaining in a more powerful and concentrated state, since by its facility of transmission over the whole surface of such conductor the quantity collected from its various points, on presenting to it another conducting substance, passes off in a single spark, not in minute portions as it was received. This proposition states in the second place, that an excited electric, whose position is such with respect to another body that no spark or other passage of the fluid can take place, will induce upon that body an opposite state of electricity. If an excited tube be brought near any substance communicating with the ground (but prepared for insulation), this substance when insulated will be found to indicate the negative state of electricity: if, on the contrary, an excited stick of sealing-wax be presented, the positive state will be induced. This circumstance appears to be owing to the repulsive qualities imputed to the electric fluid, so often noticed in the course of our inquiry: the fluid in the excited tube is supposed to repel a quantity a quantity of the fluid residing in the substance to which it is presented, and to drive it off into the earth, in the same manner as the fluid in an insulated conductor is repelled from the nearest to the remotest end by the action of a machine, as we have attempted to prove under the second proposition: in this situation the substance mentioned will have less than its natural share, and of course indicate negative electricity. If we reverse the picture, the excited wax, by its opposite qualities, enables the substance to receive from the earth an additional quantity, which under insulation appears in the form of positive electricity.

The seventh proposition assumes an universal and uniform distinction between the two states of electricity. If no means are discoverable by which these states can be ascertained, it is sufficiently obvious that all reasoning respecting their particular situations and circumstances must be vague and nugatory: the certainty and facility of this distinction is an essential prop to the whole theory; let us therefore examine evidence. The proofs of this distinction are referable to two classes: one derived from the appearances of electric light; the other from the phænomena of attraction and repulsion. If a point be presented to the insulated rubber of a machine, which by Proposition 5. receives the fluid from such point, a diverging luminous stream will become apparent, which resembles a pencil of rays centring at the point, and darting through the air towards the rubber with a crackling noise, conformably to the expectations we should form of the emission of a fluid resisted equally in its motion by the surrounding atmosphere: but if the needle be transferred in contact with the rubber, its point outwards, which by Proposition 5. then becomes the recipient instead of emitting the electric fluid, the appearance will be changed: when the fluid is collected from the circumjacent air towards a point, it is natural to conceive it slowly and invisibly percolating from all parts in an equal proportion, till it approaches sufficiently near to break through the intermediate space; and as this space will be equal on every side, the negative electricity will become visible in the form of a steady, luminous globule on the point, accompanied with little noise: and this is consonant with experience. The different effects of the two electricities may be advantageously observed by receiving the stream upon the flat side of a piece of paper: a strong plus stream forms a beautiful star about four inches in diameter, consisting of very distinct radii not ramified; the minus stream forms no star, while many pointed brushes centre towards the paper (Cavallo).

vallo). The appearances in an exhausted receiver, mentioned under Proposition 1. may be adduced as additional proofs. Mr. Cavallo mentions a curious though delicate experiment as a further corroboration. After moistening the outside of a small phial he charged it at the prime conductor, and while the machine is acting a beautiful brush becomes visible, turning downwards towards the outside coating: if the outside be charged positive, the brush will appear directing its course inwards. The variation in the sensations of receiving a spark affords another collateral testimony to these distinctions, the negative sparks being much more pungent than the positive. The repulsion of two pith balls, or gold leaf, connected with the known property of certain substances to produce on excitation the same electrical quality, affords another and a more delicate and useful means of detecting minuter portions. If an electrometer be brought into contact with any electrified body, the balls or leaf will immediately separate; but we wish to ascertain with which electricity: upon exciting a piece of sealing-wax and presenting it to the instrument, its divergency will either increase or diminish: if it increases, it may be concluded similar to that of the excited substance; if it converges, the contrary. If you are desirous to obtain still more accuracy of examination to determine the quality, electrify two similar electrometers, one with some excited body, the other with the body you wish to examine, till the balls indicate equal degrees of divergency: then bring together the two electrometers: if they repel, their electricity may be deemed similar; if they attract, opposite.

The concurrence therefore of these two modes of examination by electric light and electric attraction and repulsion, if uniform and invariable, as they are asserted to be, affords a satisfactory criterion of the quality.

We are now arrived at the eighth and last proposition, which states in what the qualities of positive and negative electricity consist, viz. in accumulation and deficiency. It has been objected, and I think with some degree of justice, that this position is wholly hypothetical; that no direct and unequivocal proof can be adduced; and that the arguments commonly urged in its support are included in what logicians denominate a vicious circle. Thus it is said a body positively electrified will attract another body negatively electrified, because the one is redundant, the other is deficient. But how is this known? They attract each other. Again, in charging a phial, there is as constant a stream of electric fluid from the outside coating as from the conductor to the inside; whence it follows, that while the outside has too little, the inside has too much. Why so? Because the glass is impermeable. How is that proved? Because in the experiment above recited the fluid is accumulated on one side, while it is abstracted on the other. It is evident that under this representation every argument returns into itself, and is merely a play upon terms. I shall however endeavour to show that this statement is neither perfectly candid nor correct, and that the opinion alluded to is supported by more probability than these objectors are willing to admit.

In many instances we can form conclusions only from the effects. If two basons separated by a mound were filled with water, the pressure on all sides being equal, the mound would be likely to maintain its situation. If we suppose one full and the other empty, with a slight communication between them, the effort to restore the level would endanger the safety of the mound; and if such mound were destroyed, we should instantly conclude that it was occasioned by an accumulation of water on one side and a deficiency on the other. May we not extend the analogy to the electric fluid? It becomes visible only by the air's resistance to its passage; and if its effects are similar to those of water, may we not impute it to the same cause? By the impervious nature of those substances called electrics we are enabled to produce a change, which by effects similar to those above alluded to induces the conclusion, that they are occasioned by an accumulation of the fluid on one side, and its subsequent efforts to restore an equilibrium. If the fluid as it entered on one side passed through to the other, no change could be effected in the glass: if the glass plate be too thin, and the charge too high, the fluid will force a passage, leaving a small hole or bur in the glass, sometimes cracking the phial all round, and in either case incapacitating it from receiving another charge. It is singular, in the use of resin as a cement to unite the coating and the glass, the phial will not receive the least charge without forcing such a passage.

The easy solution of the phænomena of the Leyden phial on the Franklinian hypothesis has materially contributed to its reputation. Dr. Franklin proved experimentally that when a phial is charged, one side has lost exactly what the other has acquired: taking a charged phial, he observed, that when he afforded the fluid on the positive side an opportunity to escape, the other side became disposed to receive, and would attract any light body: by insulating his rubber he found that the phial would not receive a charge, because no fluid could be collected; and by insulating the phial he found the same result, because no opportunity of escape was afforded to the fluid on the outside; but by forming a communication between the inside and outside coatings the phial was charged with ease: in this case it appeared evident that the fluid residing in the outside had been transferred by the action of the machine to the inside: thus it appears that positive and negative electricity are inseparable, have a constant tendency to produce and preserve each other, and the increase or decrease of power on either surface of a plate of glass must be regulated by the increase or decrease of the contrary power on the opposite side. In charging positively no gradual addition of electric matter can be made to one side without a proper conveyance for an equal quantity to pass off on the other side, and in its gradual discharge none can be taken from the positive side without affording the negative side an opportunity of obtaining an equal quantity. The experiments of Mr. Brookes have been supposed to militate against this opinion; but they seem more properly to confirm it, allowing some degree of limitation to the general proposition: he found on charging an insulated phial, by means of a pointed wire, that in the act of charging both sides indicated positive electricity; by the theory the electric fluid is driven off from the external surface by the repulsive action of the positive electricity on the internal side of the phial, and by the confinement of insulation will be constrained to pass gradually through the point, of course producing the effect of accumulation. You will probably recollect, that during the last sessions your experimental committee repeated these experiments with some additional circumstances; and you will remember, that when the phial was not insulated the fluid seemed to pass off instantly; and the outside, even during the act of charging, always indicated the negative electricity. The most serious objection is derived from the difficulty of conceiving how a fluid incapable of percolating the pores of glass can act through the same pores by a peculiar occult repulsive quality: but when we consider the mysterious qualities of gravitation, of magnetism, and even of fluids, whose disposition to rise to the same level is equally unaccountable, we shall feel obliged to acknowledge that this quality affords no rational presumption against the truth of the theory. After all, whatever judgment we form of the general principle, its application in various instances will be insufficient to explain the observed phænomena.

Mr.

Mr. Cavallo has candidly acknowledged the difficulty of reconciling various properties of charged electrics with any received theory. Where, for instance, does the charge reside? Not in the coating, as may satisfactorily be shown: if in the glass, and the fluid can penetrate any the smallest portion, a glass might be made so thin that the fluid would freely pervade its substance; but a glass ball $\frac{1}{600}$th of an inch thick will receive a powerful charge. The hypothesis still remains incumbered with numerous difficulties; and it must be left to future investigation to determine whether it shall be wholly rejected, or whether subsequent discoveries may enable us to apply the foregoing principles with more certainty and success.

XIV. *On the Motion of Bodies affected by Friction. By the Rev.* Samuel Vince, *A. M. of Cambridge. Communicated by* Anthony Shepherd, *D. D. F. R. S. Plumian Professor of Astronomy and Experimental Philosophy at Cambridge. Read November* 25, 1784.

[Concluded from p. 58.]

PROPOSITION II.

Let the body be projected on an horizontal plane LM (fig. 3.) *with a given velocity, to determine the space through which the body will move before it stops, or before its motion becomes uniform.*

Case I.—1. Suppose the body to have no rotatory motion when it begins to move; and let a = the velocity of projection *per* second measured in feet, and let the retarding force of the friction of the body measured by the velocity of the body which it can destroy in one second of time, be determined by experiment and called F, and let x be the space through which the body would move by the time its motion was all destroyed when projected with the velocity a, and retarded by a force F; then, from the principles of uniformly retarded motion, $x = \frac{a^2}{2\,F}$, and if t = time of describing that space, we have $t = \frac{a}{F}$, and hence the space described in the first second of time $= \frac{2a - F}{2}$. Now it is manifest that when the rotatory motion of the body about its axis is equal to its progressive motion, the point a will be carried backwards by the *former* motion as much as it is carried forwards by the *latter*; consequently the point of contact of the body with the plane will then have no motion in the direction of the plane, and hence the friction will at that instant cease, and the body will continue to *roll* on uniformly without *sliding* with the velocity which it has at that point. Put therefore z = the space described from the commencement of the motion till it becomes uniform, then the body being uniformly retarded, the spaces from the end of the motion vary as the squares of the velocities, hence $\frac{a^2}{2F} : a^2$ $(:: 1 : 2F)$ $:: \frac{a^2}{2F} - z : a^2 - 2Fz =$ square of the progressive velocity when the motion becomes uniform; therefore the velocity destroyed by friction $= a - \sqrt{a^2 - 2Fz}$; hence, as the velocity generated or destroyed in the same time is in proportion to the force, we have by Cor. 2. Prop. 1. $rs : ra :: a - \sqrt{a^2 - 2Fz} : \frac{ra}{rs} \times \overline{a - \sqrt{a^2 - 2Fz}}$ the velocity of the circumference efg generated about the center, consequently $\sqrt{a^2 - 2Fz} = \frac{ra}{rs} \times \overline{a - \sqrt{a^2 - 2Fz}}$, and hence $z = \frac{\overline{rs^2 + 2rs \times ra} \times a^2}{\overline{as^2} \times 2F}$ the space which the body describes before the motion becomes uniform.

2. If we substitute this value of z into the expression for the velocity, we shall have $a \times \frac{ra}{rs}$ for the velocity of the body when its motion becomes uniform; hence therefore it appears that the velocity of the body, when the friction ceases, will be the same whatever be the quantity of the friction. If the body be the circumference of a circle, it will always lose half the velocity before its motion becomes uniform.

Case II.—1. Let the body, besides having a progressive velocity in the direction LM (fig. 3.) have also a rotatory motion about its center in the direction gfe, and let v represent the initial velocity of any point of the circumference about the center, and suppose it first to be less than a; then friction being a uniformly retarding force, no alteration of the velocity of the point of contact of the body upon the plane can affect the quantity of friction; hence the progressive velocity of the body will be the same as before, and consequently the rotatory velocity generated by friction will also be the same; to which if we add the velocity about the center

center at the beginning of the motion, we shall have the whole rotatory motion; hence, therefore, $v + \frac{ra}{rs} \times \overline{a - \sqrt{a^2 - 2Fz}} = \sqrt{a^2 - 2Fz}$, consequently $z = \frac{a^2 \times as^2 - \overline{v \times rs + a \times ra}^2}{2F \times as^2}$ the space described before the motion becomes uniform.

2. If this value of z be substituted into the expression for the velocity, we shall have $\frac{v \times rs + a \times ra}{as}$ for the velocity when the friction ceases.

3. If $v = a$, then $z = o$, and hence the body will continue to move uniformly with the first velocity.

4. If v be greater than a, then the rotatory motion of the point a on the plane being greater than its progressive motion and in a contrary direction, the absolute motion of the point a upon the plane will be in the direction ML, and consequently friction will now act in the direction LM in which the body moves, and therefore will accelerate the *progressive* and retard the *rotatory* motion; hence it appears that *the progressive motion of a body may be* ACCELERATED *by friction.* Now to determine the space described before the motion becomes uniform, we may observe that as the progressive motion of the body is now accelerated, the velocity after it has described any space z will be $= \sqrt{a^2 + 2Fz}$, hence the velocity acquired $= \sqrt{a^2 + 2Fz} - a$, and consequently the rotatory velocity destroyed $\frac{ra}{rs} \times \overline{\sqrt{a^2 + 2Fz} - a}$, hence $v - \frac{ra}{rs} \times \overline{\sqrt{a^2 + 2Fz} - a} = \sqrt{a^2 + 2Fz}$, therefore $z = \frac{\overline{rs \times v + ra \times a}^2 - a^2 \times as^2}{2F \times as^2}$ the space required.

5. If $a = o$. or the body be placed upon the plane without any progressive velocity, then $z = \frac{rs^2 \times v^2}{2F \times as^2}$.

CASE III.—1. Let the given rotatory motion be in the direction gef; then as the friction must in this case always act in the direction ML, it must continually tend to destroy both the progressive and rotatory motion. Now as the velocity destroyed in the same time is in proportion to the retarding force, and the force which retards the *rotatory* is to the force which retards the *progressive* velocity by Cor. 2. Prop. I. as $ra : rs$, therefore if v be to a as ra is to rs,

 then

then the retarding forces being in proportion to the velocities, both motions will be destroyed together, and consequently the body, after describing a certain space, will rest; which space, being that described by the body uniformly retarded by the force F, will, from what was proved in Case I. be equal to $\frac{a^2}{2F}$.

2. If v bears a greater proportion to a than ra does to rs, it is manifest that the rotatory motion will not be all destroyed when the progressive is; consequently the body, after it has described the space $\frac{a^2}{2F}$, will return back in the direction ML; for the progressive motion being then destroyed, and the rotatory motion still continuing in the direction gef, will cause the body to return with an accelerative velocity until the friction ceases by the body's beginning to roll, after which it will move on uniformly. Now to determine the space described before this happens, we have $rs : ra :: a : \frac{ra \times a}{rs}$ the rotatory velocity destroyed when the progressive is all lost; hence $v - \frac{ra \times a}{rs} = \frac{\overline{v \times rs - a \times ra}}{rs}$ = the rotatory velocity at that time, which being substituted for v in the last article of Case II. gives $\frac{\overline{v + rs - a \times ra}^{\,2}}{2F \times as^2}$ for the space described before the motion becomes uniform.

3. If v has a less proportion to a than ra has to rs, it is manifest that the *rotatory* motion will be destroyed before the *progressive*; in which case a rotatory motion will be generated in a contrary direction until the two motions become equal, when the friction will instantly cease, and the body will then move on uniformly. Now $ra : rs :: v : \frac{v \times rs}{ra}$ the progressive velocity destroyed when the rotatory velocity ceases, hence $a - \frac{v \times rs}{ra} = \frac{\overline{a \times ra - v \times rs}}{ra}$ = progressive velocity when it begins its rotatory motion in a contrary direction: substitute therefore this quantity for a in the expression for z in Case I. and we have $\frac{\overline{rs^2 + 2rs \times ra} \times \overline{a \times ra - v \times rs}^{\,2}}{as^2 \times ar^2 \times 2F}$ for the space described after the rotatory motion ceases before the motion of the body becomes uniform. Now to determine the space described

scribed before the rotatory motion was all destroyed, we have (as the space from the end of a uniformly retarded motion varies as the square of the velocity) $a^2 : \frac{a^2}{2F} ::$ $\frac{\overline{a \times ra - v \times rs}^2}{ra^2} : \frac{\overline{a \times ra - v \times rs}^2}{2F \times ra^2}$ the space that could have been described from the time that the rotatory velocity was destroyed, until the progressive motion would have been destroyed had the friction continued to act; hence $\frac{a^2}{2F} - \frac{\overline{a \times ra - v \times rs}^2}{2F \times ra^2} = \frac{2av \times ra \times rs - v^2 \times rs^2}{2F \times ra^2} =$ the space described when the rotatory motion was all destroyed, hence $\frac{\overline{rs^2 + 2rs \times ra} \times \overline{a \times ar - v \times sr}^2}{as^2 \times ar^2 \times 2F} + \frac{2av \times ra \times rs - v^2 \times rs^2}{2F \times ra^2}$ = the whole space described by the body before its motion becomes uniform.

DEFINITION.

The CENTER *of* FRICTION *is that point in the base of a body on which it revolves, into which if the whole surface of the base, and the mass of the body were collected, and made to revolve about the center of the base of the given body, the angular velocity destroyed by its friction would be equal to the angular velocity destroyed in the given body by its friction in the same time.*

PROPOSITION III.

To find the center of friction.

Let FGH (fig. 4.) be the base of a body revolving about its center C, and suppose about a, b, c, &c. to be indefinitely small parts of the base, and let A, B, C, &c. be the corresponding parts of the solid, or the prismatic parts having a, b, c, &c. for their bases; and P the center of friction. Now it is manifest that the decrement of the angular velocity must vary as the whole diminution of the momentum of rotation caused by the friction *directly*, and as the whole momentum of rotation or effect of the inertia of all the particles of the solid *inversely*; the *former* being employed in diminishing the angular velocity, and the *latter* in opposing that diminution by the endeavour of the particles to persevere in their motion. Hence, if the effect of the friction varies as the effect of the inertia, the decrements of the angular velocity in a given time will be equal. Now as the quantity of friction (as has been proved from experiments) does not depend on the velocity, the effect of

 the

the friction of the elementary parts of the base a, b, c, &c. will be as $a \times aC$, $b \times bC$, $c \times cC$, &c. also the effect of the inertia of the corresponding parts of the body will be as $A \times aC^2$, $B \times bC^2$, $C \times cC^2$, &c. Now when the whole surface of the base and mass of the body are concentrated in P, the effect of the friction will be as $\overline{a+b+c+\&c.} \times CP$, and of the inertia as $\overline{A+B+C+\&c.} \times CP^2$; consequently $a \times aC + b \times bC + c \times cC + \&c. : \overline{a+b+c+\&c.} \times CP :: A \times aC^2 + B \times bC^2 + C \times cC^2 + \&c. : \overline{A+B+C+\&c.} \times CP^2$; and hence

$$CP = \frac{\overline{A \times aC^2 + B \times bC^2 + C \times cC^2 + \&c.} \times \overline{a+b+c+\&c.}}{\overline{a \times aC + b \times bC + c \times cC + \&c.} \times \overline{A+B+C+\&c.}}$$

$=$ (if $S =$ the sum of the products of each particle into the square of its distance from the axis of motion, $T =$ the sum of the products of each part of the base into its distance from the center, $s =$ the area of the base, $t =$ the solid content of the body) $\frac{S \times s}{T \times t}$.

PROPOSITION IV.

Given the velocity with which a body begins to revolve about the center of its base, to determine the number of revolutions which the body will make before all its motion be destroyed.

Let the friction, expressed by the velocity which it is able to destroy in the body if it were projected in a right line horizontally in one second, be determined by experiment, and called F; and suppose the initial velocity of the center of friction P about C to be a. Then conceiving the whole surface of the base and mass of the body to be collected into the point P, and (as has been proved in Prop. II.) $\frac{a^2}{2F}$ will be the space which the body so concentrated will describe before all its motion be destroyed; hence if we put $z = PC$, $p =$ the circumference of a circle whose radius is unity, then will $pz =$ circumference described by the point P; consequently $\frac{a^2}{2pzF} =$ the number of revolutions required.

Cor. If the solid be a cylinder and r be the radius of its base, then $z = \frac{3r}{4}$, and therefore the number of revolutions $= \frac{2a^2}{3prF}$.

PROPOSITION

PROPOSITION V.

To find the nature of the curve described by any point of a body affected by friction, when it descends down any inclined plane.

Let efg (fig. 5.) be the body, the points a, r, s, as in Prop. I. and conceive st, rn, to be two indefinitely small spaces described by the points s and r in the same time, and which therefore will represent the velocities of those points; but from Prop. I. the ratio of these velocities is expressed by $m \times CB : a \times CA$, hence $st : rn :: m \times CB : a \times CA$. With the center r let a circle vw be described touching the plane LM which is parallel to AC at the point b, and let the radius of this circle be such that, conceiving it to descend upon the plane LM along with the body descending on CA, the point b may be at rest, or the circle may roll without sliding. To determine which radius, produce rs to x, parallel to which draw ndy, and produce nt to z; now it is manifest, that in order to answer the conditions above mentioned, the velocity of the point x must be to the velocity of the point r as $2 : 1$, that is, $zx : yx :: 2 : 1$, hence $zy = yx = nr$. Now $zy : dt$ ($:: ny : nd$) $:: rx : rs$; therefore $dt = \frac{rs}{rx} \times zy = \frac{rs}{rx} \times nr$, hence ts ($= td + ds = td + nr = \frac{rs}{rx} \times nr + nr$) $= \frac{rs + rx}{rx} \times nr$, consequently $\frac{rs + rx}{rx} : 1 :: ts : nr ::$ (from what is proved above) $m \times CB : a \times CA$; therefore $a \times CA \times rs + a \times CA \times rx = m \times CB \times rx$, hence $rx = \frac{a \times CA \times rs}{m \times CB - a \times CA}$ the radius of the circle which rolling down the inclined plane LM, and carrying the body with it, will give the true ratio of its progressive to its rotatory motion, and consequently that point of the circle which coincides with any given point of the body will, as the circle revolves upon the line LM, describe the same curve as the corresponding point of the body; but as the nature of the curve described by any point of a circle revolving upon a straight line is already very well known, it seems unnecessary to give the investigation.

By a method of reasoning, not very different, may the nature of the curve, which is described by any point of a body moving upon an horizontal plane, and affected by friction, be determined.

XV. *Copy of a Letter to the Rev.* SAMUEL VINCE, *Plumian Professor of Astronomy, &c. &c., Cambridge, from* JOHN SOUTHERN, *Engineer, dated Birmingham, January* 19, 1801.*

SIR,

HAVING read with much pleasure your paper on Friction, published in the Philosophical Transactions, vol. lxxv.† I am induced to trouble you with this letter, containing an account of a few experiments made by me some years since on the same subject, which were suggested by your elegant proposition, in terms equivalent to the following: that if friction be an uniform force, a body falling by its own weight, but resisted by friction, would nevertheless be uniformly accelerated. If you think the account is worthy the attention of the Royal Society, you will, perhaps, do me the favour of presenting it to that learned body‡.

ACCOUNT OF SOME EXPERIMENTS ON FRICTION.

In the neighbourhood of this place there are many mills used for turning grindstones which have a very great velocity, and which, from the facility of being detached in that state from the mill, are peculiarly adapted to ascertain, or rather to corroborate, your proposition, and also to determine in such cases the real quantum of friction; and I therefore availed myself of the liberty, which I readily acquired, to make experiments at one of them. Before I give an account of these, it will be useful to give a description of the apparatus employed in making them. (See Plate II.) §

A, (Fig. 6.) the grindstone $52\frac{1}{2}$ inches diameter, and $20\frac{1}{4}$ inches thick.

B, its spindle (of iron).

CC, the pivots or cylindric parts of the spindle, upon which it and the stone turned, exactly $3\frac{1}{6}$ inches diameter.

D, the pulley (of wood) upon the edge of which a leather strap went round, or rather half round, by which the stone was put in motion and continued so during pleasure, and by slipping off which the stone was detached from the mill, and suffered to turn freely till the resistance of friction on the pivots of the spindle and of the air stopped it.

* Communicated by the Author.

† See the preceding article, continued from our last number.

‡ Mr. Vince, approving it, did present it to the Royal Society.

§ Inserted in our last Number.

E, a

E, a slight axis made of a wire, perhaps the tenth of an inch diameter, turning with the spindle, and attached by a socket to the arbor of the seconds-hand of a common clock movement (not shown in the figure), so that every turn of the stone corresponded to a minute on the dial-plate, which was so situated as to be easily observed.

The experiments were conducted as follows: By a very excellent watch (having a detached scapement) I was enabled to call out at the expiration of every minute, and my assistant being at his post, opposite the dial-plate of the clock, noted the hour and minute pointed out by it at the instant of my calling; and, that as little time might be lost as possible, we were both ready to observe as soon as the stone was detached from the mill.

Below are stated the particulars of three experiments, being all that were made.

First Experiment.

Time in minutes.	Hour and minute pointed out by the clock.	Difference, being the number of turns made by the stone in each successive minute.	Second differences.
	h. m.		
0	12 50		
		250	
1	5 0		30
		220	
2	8 40		34
		186	
3	11 46		29
		157	
4	2 23		30
		127	
5	4 30		26
		101	
6	6 11		25
		76	
7	7 27		24
		52	
8	8 19		
		25	
8′36½″	8 44	at rest	
Whole No. of turns 1194			

Second Experiment.

Time in minutes.	Hour and minute by the clock.	Difference or number of turns.	Second differences.
	h. m.		
0	3 25		
		254	
1	7 39		28
		226	
2	11 25		28
		198	
3	2 43		26
		172	
4	5 35		28
		144	
5	7 59		24
		120	
6	9 59		26
		94	
7	11 33		26
		68	
8	12 41		25
		43	
9	1 24		
		10½	
9′36″	1 34½	at rest	
No. of turns 1329½			

Third Experiment.

Time in minutes.	Hour and minute by the clock.	Difference or number of turns.	Second differences.
	h. m.		
0	11 54		
		257	
1	4 11		33
		224	
2	7 55		30
		194	
3	11 9		31
		163	
4	1 52		27
		136	
5	4 8		28
		108	
6	5 56		28
		80	
7	7 16		29
		51	
8	8 7		
		17½	
8′55″	8 21½	at rest	
No. of turns 1230½			

It

It is well known to mathematicians, that had the resistances which opposed the motion of the stone been uniform, and the observations correct, the second differences, or those contained in the fourth column of each experiment, would have been the same, or a constant quantity. This it appears was not so, and several causes can be assigned why they might not be so, though friction itself be an uniform resistance: First, when the stone was making 260 or 270 turns per minute, as it was at the beginning of each experiment, the minute-hand would be passing over $4\frac{1}{2}$ minutes on the dial-plate per second of time, and consequently it was difficult to observe the precise place of the hand. Hence it is easy to see that a variation might arise on this account, especially when it is considered that the moment of calling by one person, and of attention of a second, might not be simultaneous. Secondly, as the circumference of the stone at the beginning of the experiments was moving with a velocity of upwards of 60 feet per second, some resistance from the air would necessarily arise, which would diminish as the stone revolved more slowly, and this would create a difference in the uniformity of resistance, and consequently in the second differences. Thirdly, the mill being used for grinding, the principal part of the apparatus was covered with siliceous dust; and though the rubbing parts were protected from it as much as possible, some particles of it might, by the shaking of the machine, fall between the rubbing surfaces, and thus occasion a variation in the resisting force at different instants. I am the more inclined to believe this was actually the case, from observing in the table the variation of mean resistance in the three experiments, notwithstanding they were made under circumstances as precisely the same as possibly could be: for in the second experiment the stone made 135 more turns before it came to rest than it did in the first, although the initial velocities were not materially different; and in the third experiment, notwithstanding the initial velocity was greater than in the second, the whole number of revolutions was 99 less.

If the second differences for each corresponding minute of time in the three experiments be added together, and divided by 3, the numbers $30\frac{1}{3}$, $30\frac{1}{3}$, $28\frac{2}{3}$, $28\frac{1}{3}$, 26, $26\frac{1}{3}$, $26\frac{1}{3}$ will be obtained for mean second differences; and had the experiments been very numerous, I think the probability is great that a set of means would have arisen which would have shown a more steadily decreasing series. From these few experiments, however, it seems fair to infer, that the resistance

resistance is greater when the velocity is greater: but it will shortly be seen whether this increase of resistance may not be attributed to the air.

I will now proceed to estimate the intensity of these resistances from the facts related:

The grindstone being $52\frac{1}{2}$ inches diameter and $20\frac{1}{4}$ inches thick, its solid contents were consequently $25\frac{3}{8}$ cubic feet: the specific gravity of a piece of stone of the same kind was accurately taken, and found to be 2.208 : a cubic foot of it would therefore weigh 138lb., and the whole grindstone 3501lb. The iron spindle and wooden pulley were by calculation 200lb., making the whole weight that was supported by the pivots of the spindle in round numbers 3700lb.

The resistance which a particle of matter at the distance x from its centre of motion opposes to a change of angular motion is as x^2, the resistance being measured by a power applied at a constant distance from the centre. In order to find the sum of resistances of all the matter in the stone, it is to be considered that the number of particles at the distance x is $tmx\dot{x}$ (t being = the thickness of the stone, and $m = 6{,}283$ &c = the circumference of a circle whose radius is 1); and as the resistance of every one of these particles is, as before said, x^2 the fluxion of the sum of all the resistances $= tmx^3\dot{x}$ whose fluent, or sum of resistances $= \frac{tmx^4}{4} =$ when $x = r$, (the radius of the stone) $\frac{mtr^4}{4}$.

If all the particles of the stone had been at the distance r from the centre, the sum of resistances would have been as the solid content $\times r^2 = \frac{mtr^4}{2}$; it is therefore evident that the sum of resistances of all the particles of the stone is *half* what it would be if every particle were at the circumference, and had the same angular velocity: for $\frac{mtr^4}{4} : \frac{mtr^4}{2} :: \frac{1}{2} : 1$.

By the experiments it appeared that when the resistance of the air might be esteemed inconsiderable (the velocity of the stone being comparatively small), the retardation of the velocity was about 26 turns per minute attributable to the friction on the pivots. It may therefore be asked, What power acting uniformly would give to *half* the quantity of matter in the stone (= 1750lb.) a velocity equal to 26 times its circumference? Twenty-six times the circumference of the stone is about $357\frac{1}{2}$ feet. Gravity would give a velocity a velocity = $32\frac{1}{6} \times 60 = 1950$ feet per second at the end of one minute to a body falling freely, or 117000 *feet per minute*; and the accelerating or retarding power being as the velocity acquired or destroyed in a given time, we have $117000 : 357\frac{1}{2} :: 1750 : 5{,}35$ = the power in pounds applied at the circumference of the stone that would generate or destroy the velocity of 26 turns per *minute*.

The resistance arising from friction is not, in the experiments, applied at the circumference of the stone, but at that of the rubbing parts of the spindle, which, as before stated, was $3\frac{1}{8}$ inches diameter; therefore to find the actual resistance caused by friction, 5,35lb. is to be increased in the inverse ratio of the diameter of the stone to that of the pivots: hence, $3{,}125 : 52{,}5 :: 5{,}35 : 90$lb. nearly, the resistance arising from the friction of 3700lb. of matter, or *less than one-fortieth part of the weight*.

I purposely omit to take into account the resistances of inertiæ of the iron spindle and wooden pulley, because the former from its centric situation, and the latter from its lightness, would not materially affect the conclusion.

It may now be judged of in some degree, whether the greater resistance which appeared to retard the stone under greater velocities might not arise from the air. It has been shown that the mean least and mean greatest retardations per minute were 26 and $30\frac{2}{3}$ revolutions; if 26 turns be equivalent, as shown above, to 5,35lb., at the circumference, $30\frac{2}{3}$ are equivalent to 6,31lb. and the difference 96lb. would cause this extra resistance. That a stone of the diameter specified, whose sides were very roughly hewn, and which moved in a trough nearly half its depth with a velocity of upwards of 60 feet per second, should meet with a resistance from the air equal to not quite one pound weight at its circumference, is not with me a matter of surprise, and I have no hesitation in attributing the variations in the mean second differences to this cause.

It will be evident, on due consideration of the facts which occurred at the end of each experiment, that the resistance was much greater in the last portion of time of each than in the previous ones; and though part of this might arise from the small velocity of the rubbing surfaces at that period of the experiments, part might also arise from a circumstance which was obvious enough, viz. the stone being heavier on one side of the centre than on the other, so that the motion in the latter seconds of time was considerably irregular.

On the whole, I conclude that these experiments confirm yours in relation to the induction that friction is an uniform resistance, at least where the rubbing surface moves with a velocity of from 9 inches to 4 feet per second, and that in favourable cases it does not exceed *the fortieth part of the pressure or weight which occasions it.*

The pivots of the spindles were steeled, ran in brasses, which together might be seven or eight inches long (say 3½ or 4 inches each), and were lubricated with mutton suet laid against the pivots; and as a very gentle heat was excited by the friction the suet was softened, but by no means in a fluid or even semi-fluid state. The necks of the spindle had this kind of temperature when I made the experiments, the stone having been at its usual work several hours before I began them; and I, being desirous of taking them in their common state of work, made no alteration whatever in this respect.

When these experiments were made (June 1797) I hoped that some opportunity would soon occur of making further ones on the same subject in the same manner, in which I might balance the stone and prepare every circumstance with due care: but as no such opportunity has since occurred, I am induced to present this account to you, sir, grounded on the few experiments as they *were* made.

I am, sir, with great respect,

Your most obliged servant,

JOHN SOUTHERN.

These experiments are the more worthy of notice, as they were made on actual and heavy machinery, with considerable variation of velocity of the rubbing surface, and great spaces were rubbed over: the weight which caused the friction being upwards of 33cwt., the velocity of the rubbing surfaces 4 feet per second at the greatest, and the length of surface rubbed over more than 1000 feet in each of two experiments, and not much short of that in the other. J. S.

August 4, 1803.

XVI. *On the Bite of a Snake cured by Volatile Alkali.* By DAVID RAMSAY, *M. D.*

A NUMBER of extraordinary cures performed within the last twenty years, in the East Indies, on persons bitten by snakes, have been communicated to the public in Jones's Asiatic Researches. These were effected by eau de luce, or by by volatile caustic alkali. Similar cures are recorded in Anderson's Recreations, as having taken place in Pondicherry in 1798 and 1799. About the same time my much esteemed friend Mr. Peale, of Philadelphia, added a living rattlesnake to his valuable museum, and invited physicians and others to subject animals to its bite, with a view of determining, by subsequent experiments, the comparative merits of the different remedies commonly recommended for obviating the effects of the bites of venomous animals. The result proved, that the volatile alkali was entitled to a decided preference. Possessed of these facts, I have for some years past embraced every opportunity for ascertaining, by experiment, how far the bites of snakes, or the stings or bites of other venomous animals, might be alleviated by this powerful remedy. A few cases have occurred in my practice, both from the bites of snakes and from the stings of spiders, in each of which the result equalled the recorded beneficial effects of similar applications on the other side of our globe. The last was the case of a negro fellow, by name Stepney, who on the 3d instant was bitten by a rattlesnake at Health Farm, on Charleston Neck. I was not present; but my provisional directions were so punctually carried into effect as to save a valuable life, that in all probability would otherwise have been lost. The experiment was decisive; for though no other application than the volatile alkali was used, the most excruciating agonies of the patient were speedily relieved, and a complete cure obtained in a few days. From full conviction of the efficacy of the remedy, I recommend to planters, and others exposed to the bites of snakes, to have always at hand six or eight ounces of the strongest spirits of hartshorn, well secured; and in case of a person being bitten by a snake, to give him 60 drops thereof in water, every six or eight minutes, till his pains begin to abate, and then to lengthen the interval between the doses in proportion to the abatement of the pain. The wounded part should also be frequently washed with the same medicine. The spirit of hartshorn is particularly designated, because the planters are acquainted and generally provided with this medicine, and can command it in all seasons and places: though it is inferior in strength, and slower in its effects, than strong caustic volatile alkali, yet experience has proved that it is sufficiently strong to effect a speedy and complete cure.

Oil should not be given before or during the exhibition of the hartshorn; for it would weaken its effects, or combine with it and make soap. That the volatile alkali, properly administered, will in a short time cure the bite of any snake,

snake, or the sting of a spider, or any other venomous insect, is a medical fact as well established as that the Peruvian bark will cure an intermittent fever. There are exceptions to all general rules, and probably more to the latter than to the former. With the exception of a few extreme cases in which the bite proves instantly mortal, either from the uncommon virulence of the poison, the peculiar nature of the part to which it is applied, or the operation of fear, the volatile alkali may be depended on to afford a certain and speedy cure. Of this we have authentic evidence in the books referred to above, which state cures performed in the East Indies by means thereof, even in cases where the poison had advanced so far that mechanical force was necessary to unlock the jaw before the medicine could be introduced.

Such persons as have no access to these authorities, or are slow to believe the records of distant events, are requested, for their further satisfaction, to inform themselves of the particulars of the cure before mentioned, as having taken place on Charleston Neck since the commencement of the present month. On inquiry, they will find that the most alarming symptoms were removed in a few hours by the unassisted operation of this single remedy.

That volatile alkali should always succeed is not to be expected; but in nine cases out of ten its failure, on a proper examination of every circumstance, would probably be found to arise from one or more of the following circumstances:—either the medicine given as volatile alkali was spurious, or inferior in its kind, or weakened by being frequently opened, or insecurely corked; or that it had been given in too small doses, or at too long intervals. Such persons as design to give it a trial are requested to be minutely attentive to each of these particulars.

As the hydrophobia following the bite of a mad dog has resisted all the remedies hitherto used for its cure, it is submitted to physicians whether, on principles of analogy, it would not be well to try the effects of volatile alkali, rather than resign a patient to his fate, or repeat the medicines which on frequent trials have always been found unavailing? A doubtful remedy is better than none. He who does not do all in his power to save a life, especially one committed to his care, is guilty of a species of murder.

I will be obliged by information of the result of any experiments that may be made in consequence of this communication. DAVID RAMSAY.

Charleston,
June 22, 1803.

XVII. *Letter*

XVII. *Letter to Dr.* Ramsay, *in consequence of his Observations on the Bite of a Snake cured by Volatile Alkali.* *By* Benjamin Barton, *M. D.**

DEAR SIR,

I have seen your Observations on "the Bite of a Snake cured by Volatile Alkali." I rejoice to find that you have undertaken the investigation of a subject so important as is the one on which you have favoured the public with the result of your experience. I hope you will pursue the inquiry, as I am well persuaded that we are in want of something much more efficacious as a cure of the evil effects induced by the venom of the rattlesnake, and other serpents, than any of the many vegetables which have been recommended to the public in such extravagant and unqualified terms.

Ever since the spring of 1801 I have paid a great deal of attention to the effects of the venom of the rattlesnake. I have had a number of these reptiles, both old and young, under my immediate care, and have caused them to bite many and various species of animals, with the view to collect materials for a history of the poison. My experiments have satisfied me, that the venom of the rattlesnake is one of the most deleterious substances with which we are acquainted. In many instances, the effects of the poison were observed *almost instantaneously*; and so rapid is the progress of effects, that several of the bitten animals, such as rabbits, dogs, &c., died in about thirty minutes. I may add, that a few weeks ago a man died in Jersey in twenty-seven minutes after he had been bitten by a rattlesnake.

The infirm state of my health, which compelled me to leave the city last summer, prevented me from pursuing my experiments as I had wished to have done; and the death of the only remaining two of my snakes, by the cold of the succeeding winter, has put it out of my power to do any thing on the subject this summer. But I shall not neglect to resume the inquiry next spring, as I have the promise of a number of living snakes; and I shall take great pleasure in making you early acquainted with the result of my experiments.

One of the objects of my inquiry is the discovery of the best means of preventing or of curing the disease occasioned by the bite of the rattlesnake, and others of our venomous

* Communicated by the Author.

serpents,

serpents, such as the copper-head, &c. I feel no disposition to exhaust any of my time in experimenting with all, or even a twentieth part, of the many vegetables which have been praised and employed for these purposes in different parts of the United States. Many of these are unquestionably inert, and I think I have elsewhere shown how they have acquired their reputation*: I am far from denying that some of the vegetables to which I allude are deserving of a *portion* of the praise which has been bestowed upon them. The seneca snake-root (*polygala senega* of Linnæus) is, without doubt, a plant of great powers; and may be worthy of our attention as a remedy against the bite of venomous serpents. You know that among the Indians this plant has sustained a high reputation in this respect. One of my correspondents (Mr. Samuel Preston, of this state,) has communicated to me a case which is worthy of being mentioned. In the year 1798, a man, whilst he was mowing, was bitten by a rattlesnake in the little toe of his foot. Almost instantly he was seized with a pain in his breast and eyes. The leg became greatly swollen, and violent symptoms of a genuine tetanus ensued. The seneca, which was at hand, was boiled in milk, and the patient drank large quantities of the decoction, at the same time that the root, in the shape of a poultice, was applied to the part immediately wounded. The medicine threw him into a profuse perspiration; in a short time all his spasms subsided, and at the end of two days he was able to return to his occupation of mowing again.

This case, to which I have alluded in my *Elements of Botany*, part iii. p. 105, is certainly an important one, as I think it plainly shows that the seneca is a medicine well adapted to *some* cases of the bite of a rattlesnake. I rather regret that, in the work just mentioned, I should have used the following words when speaking of the medicine:—"Its great virtues as a remedy for the bite of the rattlesnake may, I believe, be safely called in question." I am far, indeed, from supposing that it is an infallible medicine or specific: on the contrary, I have not a doubt that it would fail to effect a cure in many cases of the bites of venomous serpents. What relief could we expect from it, or indeed from any thing else, in cases (such as the one in Jersey) where death was induced in less than half an hour?

I shall not omit to try the effects of the volatile alkali. Hitherto I have not used it, because I had imagined that

* Transactions of the American Philosophical Society, vol. iii. no. 11.

correct experiments had nearly robbed it of all its former reputation. It appears from the abbé Fontana's highly interesting work on *poisons*, that this alkali, whether externally applied or internally exhibited, was of no use in diminishing the activity of the venom of the viper, which is so very similar to that of our rattlesnake. One quotation from the Italian philosopher's work I beg leave to lay before you: "I had (he says) several animals, such as hens, rabbits, guinea pigs, &c. bit in the leg, and some minutes after made deep and extensive incisions into the wounded parts. I washed these incisions with pure volatile alkali, and covered the legs with linen bandages. I got ready an equal number of animals of the same size, and of the same kinds, to serve as a comparison. These were likewise bit in the leg; but I neither made incisions, nor applied to them the volatile alkali. The result of twenty-four experiments was not favourable to this medicine applied to the incisions, and the violence of the disease was even more considerable in the former than in the latter*." Upon the whole, Fontana is of opinion that his experiments "not only demonstrate the absolute inutility of the volatile alkali against the bite of the viper, when applied externally; but," that "they at the same time prove still further that it cannot have a direct and specific operation when it is even taken internally."

I do not pretend, sir, to decide between your experience and the experiments of Fontana. I can, in great sincerity, assure you that I repose much confidence in your caution and accuracy in conducting medical inquiries, and in your candour in relating your observations. But do we not very often ascribe effects, both good and bad, to our remedies, which those remedies have not produced? Do not our patients sometimes recover from violent diseases without the aid of any medicines whatever? Does not nature (that is, the powers or tendencies of the constitution) very frequently cure a gonorrhœa? Nay, do we not find the same powers, in some instances, sufficient to cure the malignant disease of yellow fever?

The result of all my inquiries relative to the poison of serpents is very favourable to the opinion, that the instances of spontaneous recovery from the influence of these poisons are numerous. Without admitting this position as a fact, what satisfactory explanation can be offered of the many

* Treatise on the Venom of the Viper, &c. &c.—English translation, vol. ii. pages 5, 6.

recoveries

recoveries from the bite of the rattlesnake, when the vegetables that were applied externally, or exhibited internally, were, if not nearly inert (mere *nutrientia*), at least endued with the most opposite powers? Thus, the bulb of *hypoxis erecta* (which grows abundantly in Carolina and other parts of the United States) is by many persons deemed a sovereign remedy against the bite of the rattlesnake. But this bulb, which I have often eaten, is almost as mild and inert as boiled rice.

That an animal which has been bitten by a rattlesnake, whose poison has induced most violent symptoms, such as acute pain, fever, and even palsy of the extremities, shall completely recover from these symptoms without the aid of any medicine whatever, is a fact which is familiarly known to me from my own experiments.

Permit me to suggest to you the propriety of employing active emetics, so as to excite full vomiting, in some of the cases of the bites of serpents that may come under your care. The very striking analogy which subsists between the effects of the venom of the rattlesnake and those of the poison inducing malignant yellow fever, has led me to suspect that emetics might be useful in the former as well as in the latter of these cases. Fontana found the tartar emetic useful in cases of the bite of the viper; and D. Boys, an intelligent physician who is settled at Staunton in Virginia, informed me (in my visit to that place last summer) that he had found emetics so managed as to excite both puking and purging, *more useful* than any thing else in removing the symptoms originating from the bite of the copper-head snake, which is not less venomous than the rattlesnake.

Be assured of the high respect which I entertain for your talents and usefulness in life, and permit me to subscribe myself, dear sir,

Your very obedient and humble servant,
and affectionate friend,
BENJAMIN SMITH BARTON.

Philadelphia,
July 23d, 1803.

XVIII. *Analysis of Ambergris.* By BOUILLON-LAGRANGE.

[Concluded from p. 92.]

EXP. VI. Alkalies unite with ambergris, and form with it soluble soaps.

Thirty grains of ambergris with ten grains of pure potash

 were

were put into a platina crucible and exposed to a gentle heat: the mixture fused without manifesting the presence of ammonia: by cooling, a brownish homogeneous mass was obtained.

One ounce of distilled water being poured over it dissolved a part. This liquor was exceedingly alkaline.

The other portion not soluble remained under a soft tenacious form, which when warm adhered to the fingers.

A larger quantity of water being added, the whole was dissolved.

Caustic potash triturated some time in a mortar with ambergris does not facilitate its solution by water.

Ammonia cold has no action on it, but with the help of heat dissolves it. The mixture gradually becomes brown, and by evaporation gives a glutinous saponaceous matter, similar in every thing to that obtained by potash.

Exp. VII. Fixed oils, such as that of colsa, olives, &c. dissolve it with the help of heat in a very little time: the solution is yellow and transparent, and by evaporation becomes brown.

Exp. VIII. Volatile oils also dissolve ambergris. Those of turpentine, savin, and hyssop, do the same. With the help of heat the solution takes place speedily.

Evaporation gives a thick red magma which cannot be entirely dried, which burns on coals, emitting a thick smoke and an odour approaching that of ambergris. Alcohol dissolved this substance, and acquired a golden yellow colour: it was precipitated from it by the help of heat.

A complete solution cannot be obtained in volatile oils which are too old, even with the assistance of long continued heat.

Exp. IX. Solution by ether is very speedy even without heat.

Exp. X. The solution of ambergris by alcohol is that alone which can conduct to any certain results. The constituent parts may be separated in such a manner, that by uniting them a compound will be obtained the characters of which approach near to those of the compound.

One gros of ambergris being reduced to fine powder and put into a phial, two ounces of rectified alcohol were poured over it. Twenty-four hours' maceration were sufficient to give to the alcohol a dark yellow colour. When the liquor had been filtered a new quantity of alcohol was added to the undissolved part, and the solution was facilitated by elevating the temperature. When the whole was dissolved, except

except a small quantity of black matter, the liquor was filtered still warm. It passed through clear; but by cooling there was separated a light pale yellow substance, a part of which remained attached to the sides of the vessel.

The first alcoholic tincture made cold, and that arising from the matter precipitated, were mixed, and evaporated to the consistence of extract: it was of a reddish yellow colour, adhered to the fingers, had an agreeable odour and a sweet taste. The evaporation was continued to dryness: in this state the matter with a brilliant and transparent aspect became soft between the fingers, and burnt in the same manner as resins.

The experiment was repeated, to establish in a more positive manner the characters of these two substances.

For this purpose the ambergris was left, as before, to macerate in alcohol for twenty-four hours: it was then filtered, and a new quantity of alcohol was added to the residuum: the maceration was the same. This second liquor was less coloured than the former. A third dose of alcohol was poured over the undissolved part, but it was scarcely coloured. This little action of the alcohol on the residuum gave reason to believe that it was no longer soluble in that menstruum: but I soon was convinced of the contrary. I heated the mixture, and the whole matter was dissolved in a moment. Nothing remained but about four grains of a black powder, which was oxide of carbon. The liquor was filtered warm, and by cooling there was precipitated a whitish yellow glutinous matter, which was separated from the liquor.

This experiment proves the possibility of separating by the help of alcohol three very distinct products: the first soluble cold, the second soluble warm, and the third insoluble, which is separated in the form of dust.

To establish the characters of the two first substances, the alcoholic tincture made cold was evaporated to dryness. There remained in the capsule 22 grains of a brown dry matter, brilliant in the fracture, unalterable in the air, and which became soft in a gentle heat: fifteen degrees were sufficient to give it a tenacious and glutinous consistence: when placed on coals it was entirely volatilized. If this experiment be made in a silver spoon, the volatilization is effected with the same rapidity: it emits an aromatic odour, and leaves no carbonaceous residuum.

As I suspected that this substance might have some analogy with the resin extracted from the *propolis* by C. Vauquelin, I made some comparative experiments with it. The following are the points in which they differ:

1st, It fuses much more slowly.

2d, It emits a thick odorous smoke, which in smell approaches near to that of honey.

3d, It swells up, and leaves a very voluminous charcoal.

In the last place, this first substance extracted from ambergris, which may be considered as a real resin, is soluble in alcohol, and may be precipitated by water. This tincture reddens turnsole paper; which still proves that the alcohol dissolves at the same time the benzoic acid previously found, either by burning the amber under a bell, or in treating it with lime.

Nothing now remains but to examine the product obtained by alcohol warm, after the resin has been extracted by maceration.

I have already said that there is separated from the alcohol by cooling, a substance which deposits itself in part, and which adheres to the sides of the vessel.

When separated from the liquor and properly dried, it remains light and somewhat voluminous; it breaks and moulders under the pressure of the finger, but soon after it extends itself and becomes soft by the heat: it has a lamellated texture if left to cool slowly.

It retains between its moleculæ a little water and alcohol, which are separated by keeping this substance some time in a state of fusion. When re-fused it is much less white than before, and no longer possesses the granulated texture it exhibited. In a word, I have found in it all the properties of *adipo-cira*; a substance which C. Fourcroy found in the fat matter of dead bodies, and of which he described the characters in a memoir printed in the eighth volume of the *Annales de Chimie*.

Recapitulation.

It appears, then, that we may conclude from these experiments:

1st, That ambergris is a compound substance which burns and is entirely volatilized.

2d, That when distilled alone there is obtained from it a liquor slightly acid, and an oil partly soluble in alcohol and of an empyreumatic odour.

3d, That by sublimation, or the process of Scheele, benzoic acid is extracted from it.

4th, That water has no action on this substance.

5th, That

5th, That by help of the nitric acid a matter analogous to resins mixed with *adipo-cira* is separated from it.

6th, That concentrated sulphuric, muriatic, and oxygenated muriatic acid char it without dissolving it.

7th, That with alkalies it forms a saponaceous compound.

8th, That fixed and volatile oils, ether, and alcohol, are the true solvents of ambergris.

9th, That alcohol affords the means of separating its constituent parts in the following proportions:

	Grammes.
Adipo-cira - - - -	2·016
Resin - - -	1·167
Benzoic acid - -	0·425
Carbonaceous matter -	0·212
	3·820

XIX. *Observations on the Employment of Platina in Porcelain Painting. By Professor* Klaproth, *of Berlin**.

In the course of half a century since platina was introduced and known in Europe, the experiments made with it by various eminent chemists seem to have exhausted every thing that relates to the physical and chemical properties of this remarkable metal. The imperfect information, however, which relates to its mineralogical and natural history seems to require further investigation, though it must at the same time be acknowledged that our information in this respect appears to be worthy of confidence, as the Spanish government has entrusted the inspection and management of its mines in South America to men who to a knowledge of mineralogy and mining unite great zeal for the improvement of these sciences.

The real origin of platina is in all probability to be ascribed to revolutions which have taken place in the Cordilleras by volcanoes, earthquakes, and inundations; and it is not improbable that these mountains still contain in their interior parts entire veins of platina, the discovery of which is perhaps reserved for future times.

At present, Peru is the only known country where platina is found, and particularly the district of Choco, where it is collected in the valleys between the mountains and rivers along with the gold in small laminæ, or it is ob-

* From Scherer's *Allgemeines Journal der Chemie*, no. 52, 1802.

tained by washing the earth. When the largest grains of gold have been picked from the mixed mass of gold and platina, the remaining gold is extracted by amalgamation; by means of which operation the platina is left behind in the form of flat plates or scales.

The deceptions formerly practised by mixing gold with platina have induced the Spanish government to prevent the exportation of it, and to give orders to all their servants in that country to keep the platina by them, and to wash it in water from time to time. But as means have been found to detect easily and in a certain manner the adulteration of gold with platina, and also to employ it for valuable purposes, it is to be hoped that the Spanish government will not persist in causing a prohibition so injurious to the arts and to its own finances to be executed with the former severity.

My object at present is not to enlarge on the chemical and physical properties of platina, but only to offer a few observations on the uses in the arts to which it has hitherto been applied; and then to give an account of the result of an experiment which I made in regard to a new application of this metal to objects of manufacture.

The apparent infusibility of platina by itself, formerly considered as an insuperable obstacle, was sufficient to prevent the employment of it except in combination with other metals, as experience showed that it was capable of uniting with the greater part of them by fusion. Of such mixtures, that arising from a combination of brass and platina was found to be exceedingly proper for the specula of reflecting telescopes, as this alloy was susceptible of a beautiful polish, not subject to be injured by the prejudicial influence of the atmosphere and of moisture. At first, however, the employment of platina was not extended further until the experiments made known by Morveau, Sage, and other chemists, and afterwards prosecuted on a larger scale by count Von Sickingen, formed as it were an epoch in the history of this metal, and showed in what manner platina might be freed from its foreign particles, be welded, hammered, and drawn out into wire, so as to be applicable to a variety of purposes.

It was, however, not yet possible to employ it in cases which required an actual fusion for the purpose of casting it; because this metal, in its purified state, was always by itself infusible in a common furnace. It was therefore a discovery of great importance to find that platina may be rendered fusible by arsenic; and that when mixed with this

substance

substance it may be cast in moulds, while the volatile metal employed as a flux may be again driven off by heat, so that the cast platina may then be hammered like any other metal. By employing this method, first made known by my worthy colleague M. Achard, vessels and articles of various kinds are made of platina, and particularly at Paris.

Bergman, however, had shown that platina which could be reduced to a state of fusion only by employing a large burning mirror, might be fused also by means of oxygen gas. In this manner M. Pelletier, by means of phosphoric glass, made from bones, combined with charcoal powder, brought large masses of platina to a state of complete fusion.

How far platina might be employed in porcelain painting has never yet, as far as I know, been examined: I therefore thought it of considerable importance to make some experiments on this subject, which did not deceive my expectation; but, on the contrary, convinced me that this object, in the hands of an ingenious artist, may be brought to perfection.

Gold and silver have hitherto been the only metals susceptible of being employed in their metallic form in painting and ornamenting porcelain, glass, and enamel. Gold answers this purpose so completely, that nothing further can be wished for on this head; whereas silver does not answer so well. As it possesses less density and is more porous than gold, it does not cover the ground so completely when applied to porcelain in thin leaves. The second cause of the inferiority of silver when employed in painting on porcelain arises from its nature, in consequence of which, when exposed to sulphureous and other phlogistic vapours, it becomes tarnished, loses its metallic splendour, and at length grows black. This inconvenience renders silver unfit for being employed in fine porcelain painting, and confines the application of metallic substances in this manner to gold alone.

Platina, in this respect, may be classed next to gold; and by its white colour may supply the place of silver without possessing any of its faults. It is not only capable, on account of its density and weight, in which it exceeds gold, of covering the ground completely, without leaving any perceptible interstices, as silver does; but it withstands like gold all the variations of the atmosphere, as well as sulphureous and other vapours.

The process which I employ in the application of platina to painting on porcelain is simple and easy: it is as follows:

lows:—I dissolve crude platina in aqua regia, and precipitate it by a saturated solution of sal ammoniac in water. The red crystalline precipitate thence produced is dried, and being reduced to a very fine powder is slowly brought to a red heat in a glass retort. As the volatile neutral salt, combined with the platina in this precipitate, becomes sublimated, the metallic part remains behind in the form of a gray soft powder. This powder is then subjected to the same process as gold; that is to say, it is mixed with a small quantity of the same flux as that used for gold, and being ground with oil of spike is applied with a brush to the porcelain; after which it is burnt-in under the muffle of an enameller's furnace, and then polished with a burnishing tool.

The colour of platina burnt into porcelain in this manner is a silver white, inclining a little to a steel gray. If the platina be mixed in different proportions with gold, different shades of colour may be obtained; the gradations of which may be numbered from the white colour of unmixed platina to the yellow colour of gold. Platina is capable of receiving a considerable addition of gold before the transition from the white colour to yellow is perceptible. Thus, for example, in a mixture of four parts of gold and one of platina, no signs of the gold were to be observed, and the white colour could scarcely be distinguished from that of unmixed platina: it was only when eight parts of gold to one of platina were employed that the gold colour assumed the superiority.

I tried, in the like manner, different mixtures of platina and silver; but the colour produced was dull, and did not seem proper for painting on porcelain.

Besides this method of burning-in platina in substance on porcelain, it may be employed also in its dissolved state; in which case it gives a different result both in its colour and splendour. The solution of it in aqua regia is evaporated, and the thickened residuum is then applied several times in succession to the porcelain. The metallic matter thus penetrates into the substance of the porcelain itself, and forms a metallic mirror of the colour and splendour of polished steel *.

* At the time this paper was read in the Royal Academy of Sciences, the author exhibited several patterns of porcelain ornamented in this manner, which had been made in the royal observatory.

XX. *Ad-*

XX. *Advantageous Method of preparing Red Oxide of Quicksilver.* *By* J. W. C. Fischer *.

C. Mons has observed that, in the preparation of the red oxide of quicksilver from nitrate of mercury, the whole of the acid is far from being employed for the complete oxidation of the quicksilver, as during the heating of the nitrate of mercury a considerable quantity of the acid is again obtained. He therefore proposes the employment of a larger quantity of quicksilver than the quantity of nitrous acid destined for the solution is actually able to dissolve, as this excess of quicksilver must also be oxidated by the heating of the salt brought to a state of dryness by the escape of the acid. But as the nitrous acid of the shops does not always possess the same degree of concentration, I gave a recipe in another work † for finding the proper proportion of quicksilver, which is as follows: If the hot prepared dry nitrate of mercury be rubbed up with from one-third to one-half part of metallic quicksilver, and exposed in the usual manner to the fire, a proportion that may be employed under all circumstances will be obtained.

Mr. Schmidt, apothecary of Sonderburg, in consequence of the before-mentioned observation of C. Mons, made several experiments on this subject without the wished-for success, as he always obtained the excess of quicksilver in a metallic form. The results of my present experiments were quite different, and fully answered my expectation.

I dissolved in a common heat four hundred parts of metallic quicksilver in nitrous acid. To obtain a perfectly neutralized solution, the acid was added only in drops till all the quicksilver was dissolved. The solution was evaporated to dryness, in an evaporating dish, and the dry salt was rubbed up with 350 parts of metallic quicksilver. The powder assumed a dark gray colour: but when brought to the consistence of a thick paste by a little water, in order to complete the union of the metallic quicksilver, the colour became grayish white, and, in general, only five minutes were required to make the metallic quicksilver disappear entirely. The humid mass was moderately dried on a common stove, and being put into a retort was exposed to a sudden heat. In three minutes a disengagement of

* Scherer's *Allgemeines Journal der Chemie*, no. 43, 1802.

† *Handbuch der Pharmaceutischen Praxis, mit einer Vorrede von D. S. F. Hermbstadt.* 1801.

oxygen

oxygen gas was observed, and the whitish-gray colour of the whole mass was changed to a blackish red. The operation was then suspended; and, on cooling, the whole mass exhibited throughout that uniform red colour observed in red precipitate, when reduced to a state of the greatest fineness; and it was so much divided that it could be shaken from the retort without breaking it. No traces of metallic quicksilver remained, but a small quantity of acid fluid; which induced me to repeat the experiment with a larger quantity of mercury. I therefore took 400 parts of quicksilver, which were dissolved as before in nitric acid: when the solution was evaporated to dryness, it was mixed with 400 parts more of metallic quicksilver, and the mixture was treated as before. Except the difference in the weight, the results of this operation were not different from the preceding.

This method not only saves one half of the nitric acid, but the retort can be several times used for the same purpose. The tedious process of preparing precipitate is also avoided, as it is soon obtained in the form of a very fine powder. The loss of time and of fire is also much less, as several pounds of white mercurial paste can be converted into red oxide in less than thirty minutes. I subjected to experiment, however, only a few ounces, and the operation was always finished in from three to five minutes in a sudden heat. On this account the present method is highly worthy the attention of chemists and apothecaries.

XXI. *A Memoir concerning several indigenous Plants, which may serve as a Substitute for Oak Bark, and for certain foreign Articles in the Tanning of Leather*.*

The object of this memoir is to show how the destruction of trees, and particularly of oak-trees, which are so valuable, may in great part be prevented. A great consumption of them is caused by the tanneries. A discovery has been made last summer, which will contribute to the preservation of the trees, and to the continuation and even to the increase of the tanneries. Eight new sorts of leather have been prepared and tanned without any bark at all, and with materials of which we shall give a detailed account. By using these articles, there is a saving, not only of bark, but likewise of several foreign drugs, which are generally

* From the tenth volume of the *Transactions of the Royal Academy of Berlin.*

used

used in tanning. It is surprising that the experiments on which this discovery is founded have not been made sooner, as they are exceedingly easy, and the various methods practised by other nations, and even by the most savage ones, for making leather, pointed out the way to them. In fact, be it owing to the want of bark, or to old practice, it is usual in several countries to tan leather with leaves, roots, fruits, and juices. We shall not enter now into all the historical details of which the subject is susceptible; but it is proper, however, to give a sketch of them.

Some of the Calmuc Tartars, that rove about towards the great wall of China, tan the skins of their horses with sour mare's milk. In Persia, Egypt, and some countries bordering on Africa, goats' skins are tanned with the astringent and leguminous fruit of the true acacia, which is gathered before it is ripe. In several parts of the Turkish empire the same skins are made into Morocco leather by the means of galls. The green nuts of the turpentine tree, and, according to some, even the leaves, as likewise those of the lentisk tree, serve for the same purpose in many parts of the Levant. The *smak*, or bundles of the leaves and young branches of sumach, is very well known, and is used in all countries for the making of Cordovan leather. It is also well known that in several provinces of Italy, Spain, and France there are actually used several plants, which may be called *plantæ coriariæ*, such as the *arbutus*, the *celtis*, the *tamarisk*, the *rhamnus*, the *rhus myrtifolia*, &c. In Sweden they use the bark of one of the small species of mountain sallow, as also a wild plant known by the name of *uva ursi*. The Silesians use in tanning a sort of myrtle called *rausch*. But for tanning, nothing is used in Germany but the bark of oak and birch tree, with some acorn shells; and as to the making of Cordovan and Morocco leather, they use sumach and galls, as almost all other nations do.

When the eight new methods of preparing leather already alluded to shall be once introduced, all the other articles will be no longer necessary; and there will be found in his majesty's dominions the plants fit for tanning, among which are some that will serve also for dyeing skins. We have already about sixty species of such plants; and if, after having made an exact choice, there should remain but twenty of them, our object will be attained, both as to the preservation of wood, and the doing without foreign articles.

Skins differ from each other according to the species of animals, as likewise according to their age, food, and the climate

climate they belong to; whence it follows, that there must be various methods of tanning, all which can be reduced to the three methods called in Germany *weiss-gahr* (white preparation), *semisch-gar* (soft preparation), and *loh-gahre* (tanning). I omit parchment, shagreen, and what concerns skinneries.

The first preparation is the same in these three methods. When the skins are well cleansed, lime, or sand and salt are made use of to take off the hair, and then they are washed several times, &c.

But the following part of the process is not the same in these different methods. We shall omit at present the two first methods, which require several ingredients taken from the three kingdoms of nature, such as alum, common salt, raw tartar, bran, meal, and fish oil; but it is necessary to enter into some details with regard to the third, in which vegetables alone are used, that serve to make a sort of lye, by means of which the tanning is completed.

This third method can be subdivided again into four sorts, according to the four principal sorts of leather that are prepared with the help of different vegetables, viz. 1. Common leather; 2. Cow's leather; 3. Cordovan; 4. Morocco leather.

Every vegetable lye fit for making leather is either cold or hot.

The cold process is the simplest and easiest, but, at the same time, the slowest; it is used for the coarsest and heaviest sort of skins, which are put in holes, or in wooden vessels, with oak or birch bark.

The method of tanning with hot lyes is often very troublesome, but it is more expeditious than the former one. Some sorts of leather require three weeks; others eight, twelve, or fifteen days. From twenty-four to thirty-six hours are sufficient for Cordovan; Morocco leather takes seven or eight hours, and sometimes from sixteen to twenty. This method is as follows: The lye is poured into wooden vessels, together with hot water; the skins are put into it, and stirred often. After eight days time the water is thrown out, heated again, poured upon fresh lye, and the whole is poured upon the skins. This operation is continued and repeated until the vegetable parts have penetrated the substance of the skins so as to change them into leather; which is then dried, and given over to the curriers.

We may remark here, that cow leather cannot be made as cheap with us as in Russia; and that the scented sort called *cuir de Roussi* derives that property from two em-

 pyreumatic

pyreumatic oils, which it is rubbed with in the preparing of it.

As to Cordovan and Morocco leather, they are made of goats' skins, and prepared, the one with sumach, the other with galls.

We have said enough concerning the general principles of tanning, so as to throw a light upon what relates to the plants that can be made use of in it.

There is abundance of these plants in our country, and eight new methods of preparing leather with them have been discovered. They have been treated of in a memoir that was read before the academy on the 5th of last December. The author of this memoir, and the maker of these new sorts of leather, is M. Klein, a native of Nauen. He requested I should show him all the plants that I thought fit for tanning. I have mentioned the names of these plants to the academy, and specified their properties. They are all indigenous plants, very common and abundant, and which have been heretofore considered as noxious weeds, as the utility of them was not known; and accordingly, their being used in tanning will not be in the least hurtful to private œconomy. M. Klein has collected a considerable quantity of these species of plants; and among the eight sorts of leather that have been made with them there is very fine Cordovan prepared without sumach, and two sorts of calf-skin, tanned only with leaves of trees.

These coriaceous plants grow in almost all deep places and marshy grounds; there are some of them found also in sandy soil, on hills, and in woods. The hay which they yield is the coarsest of all, and in very small quantity; the cattle never touch it, except when they are starving with hunger. Such plants spoil good meadows. A great quantity of them is to be had, particularly near lakes and large ponds; and it is no exaggeration to say that there are sixty species of them.

It is very easy to discover the chemical principles in virtue of which these plants are fit for tanning, if one has a knowledge of those of sumach, galls, and different sorts of bark. With regard to this point, the plants may be divided into two principal classes. The principles that are chiefly to be considered are found generally in all of them; they are of a *fixed*, but still *active*, *terreo-gummy*, or *terreo-resinoso-gummy* nature. Besides these common principles, some other very active ones exist in some of these plants, in a greater or less quantity; and this is what constitutes the difference that we establish between the plants that can be used in tanning.

Those of the first sort have no smell, or at most a very weak one, but they have a very sharp and astringent taste. They contain only the active and fixed principles which we have mentioned, or at most an inconsiderable mixture of oleo-inflammable parts, which give a weak balsamic smell to the water distilled from them, without any sharp or styptic taste. The proportion of these parts varies in the terreo-resinoso-gummy substance; but that which commonly exists in the greatest part of the coriaceous plants is such, that, for instance, in a pound of them the terreous parts constitute one-third, or even one-half; and the gummy principle about one-fourth or one-third, and in some as much as one-half, while the proportion of rosin is the smallest of all, being only from twenty to fifty grains, or at most a drachm and about twenty grains.

In the second sort of these plants we find, indeed, the above-mentioned fixed active principles, but not in the same proportion, because they are mixed with other principles both volatile and fixed, so as to constitute the smaller part of the whole compound. Besides the fixed parts there exists in these substances an unctuous balsamic *oleoso-*, or *vaporoso-spirituoso-ethereous* principle. The volatile parts become soon disengaged from the rest, by the heat of the tanning lye, and evaporate, so that it is not at all times possible to discover any specific remains of them in the leather.

If we examine next what the fixed *terreo-gummy* or *terreo-resinoso-gummy* substance consists of, we shall obtain a very clear knowledge of it, either from considering the manner in which it is naturally produced, or by means of chemical experiments. This terreous matter is sometimes coarser, sometimes finer, sometimes in a greater and sometimes in a smaller quantity; and it contains an oily substance, or inflammable principle, attached to a light acid, of the nature of vegetable acid, but not caustic, like mineral acid. In analysing the fixed substance of coriaceous plants, we get by the alembic, out of a pound medical weight, nearly the following parts, in a proportion more or less different: 1. About an ounce and two drachms of a clear, empyreumatic, but not astringent phlegm; 2. About two ounces and five drachms of an acid yellowish liquor; 3. An ounce and somewhat more than six drachms of an empyreumatic oil. The *caput mortuum* often constitutes

stitutes one half, or even more, and sometimes contains a portion of fixed alkaline salt. In dry fruits, juices, and bulbous roots, this proportion suffers some exceptions. It is easy to conceive that the knowledge of these component parts, of their respective quantities, and of their properties, which are well known to chemists, may lead to that of their effects, and of the manner in which they produce them. We shall be able then to distinguish a false tanning plant from a real one, or to lay aside such as are too weak for that purpose. There are some, for example, that are much fitter for giving a fine dye to leather than for tanning it.

Nor is it difficult, after what we have said concerning the principles contained in the plants, to form an idea of their action upon skins, properly cleansed and macerated. The skins being left steeping in a decoction of these plants, or merely along with the coarse dust of them, undergo a change in the tissue of their parts, whereby they become leather. In this operation the soluble and active parts of the vegetables are separated from the coarse mass, with the help of air, evaporating moisture, water, work, and various degrees of heat. They remove imperceptibly from each other, and extend in every direction in a very gentle manner, which renders them fit for softly penetrating the substance of the skins, and producing gradually an alteration in them. It is easy to comprehend the effects which, in such a case, a gentle acid is capable of producing, when dissolved, mixed, and put in action with other particles highly volatile, oleoso-ethereous, and of great mobility. The skins are penetrated with these particles, and with those which we have called terreo-resino-gummy, as if with a sort of balsam, and are thereby condensed into leather. But as it is not our intention to enlarge upon the theory of tanning, we shall confine ourselves to our object, which is the indication of tanning plants, and shall mention another property of them, whereby they are plainly distinguishable from all others. This property occurs in their dust, or in a decoction of them, when mixed with copperas (vitriol de mars).

Take then these plants, and reduce them into dust, which you will throw into a solution of copperas; or put some copperas into an infusion or decoction of the plants which has been previously filtrated. The colour produced by this mixture is sometimes reddish or of a dark red, and sometimes blue or black. The cause of this phænomenon is known to chemists, who know also how to make these decoctions or infusions transparent, and to make the colours disappear, by pouring into them, drop by drop, a sufficient quantity of oil of vitriol.

The properties of these plants being thus sufficiently ascertained, and there being the greatest plenty of them in the country, it remains now for the connoisseurs to extend the use of them, and to apply them further to the advantage of our national manufactures.

A List of the Plants that have been used in the Experiments on Tanning.

The number of plants fit for tanning is much greater than that of those in the following list; and it has been observed that, if they be gathered at proper seasons, they can be used for the preparing of all sorts of skins, both coarse and fine. The best of them are such as have the greatest quantity of a coarse, astringent, and acid substance. They are also the fitter for penetrating the skins, in proportion as they contain a greater portion of aromatic and spirituous parts, and are possessed of an essential ethereous oil. On the contrary, the inferior species of them are those whose substance is principally composed of fat or mucilaginous parts, which do not make so strong an impression on the skins, and can scarce serve for tanning the most tender ones.

Salicaria *vulgaris purpurea, foliis oblongis.* Tourn. Instit. 253. Lysimachia spicata purpurea, fortè Plinio. C. B. pin. 246. Purple-flowered loosestrife.

Ulmaria; Clus. Hist. 198. I. B. III. 488. Regina prati. Dodon. Pempt. 57. Queen of the meadows.

Comarum; Linn. Gen. pl. ed. 5. 563. Quinquefolium *palustre rubrum.* C. B. pin. 326. Red marsh cinquefoil.

Filix *ramosa major, pinnulis obtusis, non dentatis.* C. B. pin. 357. Filix fœmina offic. et Dodon. Pempt. 462. Common brackens, or female fern.

Filix *non ramosa, dentata.* C. B. pin. 358. Filix mas offic. et Dodon. Pempt. 462. Common male fern.

Filix *palustris maxima.* C. B. Prodr. 150. Water-fern.

—— *mas aculeata, major et minor.* C. B. Prodr. 151.

Persicaria *salicis folio, potamogeton angustifolium dicta.* Raj. Hist. 184. Arsmart.

Persicaria *acida Jungermanni.* Water knot-grass.

Bistorta *major, radice minus vel magis intorta.* C. B. pin. 192. Snake-weed.

Tormentilla *sylvestris.* C. B. pin. 326. Wild tormentil.

Pimpinella *sanguisorba major.* C. B. pin. 160. Large wild pimpernel.

Caryophyllata

Caryophyllata *vulgaris*. C. B. pin. 321. Common avens, or herb bennet.

Caryophyllata *aquatica, nutante flore*. C. B. pin. 321. Water avens.

Anserina *offic. argentea*. Dod. Pempt. 600. et *Potentilla*. I. B. II. 398. Goose-grass.

Quinquefolium *majus repens*. C. B. pin. 325. Large cinquefoil.

Quinquefolium *minus repens luteum*. C. B. pin. 325. Spring cinquefoil.

Quinquefolium *folio argenteo*. C. B. pin. 325. Satin cinquefoil.

Horminum *pratense, foliis serratis*. C. B. pin. 238. Clary.

Agrimonia *offic*. Agrimony.

Equisetum *arvense, longioribus setis*. C. B. pin. 16. Horse-tail.

Equisetum *palustre, longioribus setis*. C. B. pin. 15. Marsh horse-tail.

Alchemilla *vulgaris*. C. B. pin. 319. Common lady's mantle.

Muscus *pulmonarius*, sive Pulmonaria offic. Lob. Ic. p. 248. Pulmonaria arborea, Muscus quernus. Oak moss.

Lysimachia *lutea major, quæ Dioscoridis*. C. B. pin. 245. Yellow wood-loosestrife.

Vaccinium; Rivini. *Vitis idæa, foliis oblongis crenatis, fructu nigricante*. C. B. pin. 470. Black-worts—in Irish *Fraochan*.

Vaccinium *foliis buxi, sempervirens, baccis rubris*. Rup. flor. Gen. p. 52. Red bilberry.

Rubus *vulgaris*, s. *fructu nigro*. C. B. pin. 479. Common bramble.

Rubus *repens, fructu cæsio*. C. B. pin. 479. Dewberry.

Fragaria *vulgaris*. C. B. pin. 326. Strawberry.

Filipendula; I. B. II. 189. Saxifraga *rubra off*. Red Saxifrage.

Pervinca; Tournefort. Vinca pervinca offic. Clematis daphnoides *major, flore cæruleo*. I. B. II. 132. Periwinckle.

Sparganium *ramosum et non ramosum*. C. B. pin. 115. Burn-reed.

Filago; seu *herba impia*. Dodon. Pempt. 66. Common cudweed.

Gnaphalium *montanum flore rotundiore et longiore*. Tourn. Inst. 453. Mountain cudweed.

Geranium *sanguineum maximo fiore.* C. B. pin. 319. Bloody crane's bill.

——— *batrachoides maximum, minus laciniatum, folio aconiti.* I. B. III. 477. Meadow crane's-bill.

Plantago *latifolia incana.* C. B. pin. 189. Broad-leaved plantain.

——— *angustifolia major et minor.* C. B. pin. 189. Narrow-leaved plantain, both great and small.

——— *latifolia sinuata.* C. B. pin. 189. All sorts of plantain.

Hypericum *offic. et Matthiol. vulgare.* C. B. pin. 279. Common St. John's wort.

It is proper to observe in this place, that only the herbs in flower, or even the flowers alone, of the preceding plants are to be used. Some of them are more weak than others, and accordingly must be used in a different way. But as to the following ones, their leaves and branches, as likewise the unripe fruits of them, the seeds, and even the roots of some of them, are all equally fit for tanning.

Frondes *vitis viniferæ.* The vine.

Prunus *sylvestris.* Wild plum-tree; its bark and unripe fruit.

Salix *vulgaris alba arborescens.* Common white willow; its leaves and twigs.

——— *caprea rotundifolia.* Common willow; its leaves, bark, twigs.

Rosa; sylvestris, variorum colorum. Wild rose-bush; its leaves.

Fagus. Beech. Bark and leaves.

Carpinus. Horse-beech. Bark and leaves.

Quercus. All sorts of oak. Leaves.

Betula. Birch-tree. Bark and leaves.

Alnus. Alder. Leaves.

Mespilus; *species sylvestris vulgaris.* Wild medlar. Leaves, twigs, unripe fruit.

Ledum *rosmarini folio.* Wild rosemary.

Cornus *sylvestris mas.* Wild cornel tree. Leaves, twigs, stones.

Acetosa *pratensis.* Sorrel. Root. Seed.

Lapathum *maximum aquaticum.* Large water-dock. Root, leaves, seed.

Lapathum *folio acuto plano.* C. B. pin. 115. Sharp-pointed dock. Root, leaves, seed.

Iris *palustris lutea.* Acorus adulterinus. C. B. pin. 34. Water-flag. Root.

Nymphæa

Nymphæa *lutea major.* C. B. pin. 193. Yellow water-lily. Root.

——— *alba major.* C. B. pin. 193. White ditto. Root.

XXII. *Process for Dyeing Nankeen Colour. By Mr.* RICHARD BREWER.*

MIX as much sheep's dung in clear water as will make it appear of the colour of grass, and dissolve in clear water one pound of best white soap for every ten pounds of cotton-yarn, or in that proportion for a greater or lesser quantity.

Observe:—The tubs, boards, and poles, that are used in the following operations must be made of deal; the boiling-pan of either iron or copper.

First Operation.

Pour the soap liquor prepared as above into the boiling-pan; strain the dung liquor through a sieve; add as much thereof to the soap liquor in the pan as will be sufficient to boil the yarn, intended to be dyed, for five hours. When the liquors are well mixed in the pan, enter the yarn, light the fire under the pan, and bring the liquor to boil in about two hours, observing to increase the heat regularly during that period. Continue it boiling for three hours, then take the yarn out of the pan, wash it, wring it, and hang it in a shed on poles to dry. When dry, take it into a stove or other room where there is a fire; let it hang there until it be thoroughly dry.

N. B. The cotton yarn, when in the shed, should not be exposed either to the rain or sun: if it is, it will be unequally coloured when dyed.

Second Operation.

In this operation use only one half of the soap that was used in the last, and as much dung liquor (strained as before directed) as will be sufficient to cover the cotton yarn, when in the pan, about two inches. When these liquors are well mixed in the pan, enter the yarn, light the fire, and bring the liquor to boil in about one hour; then take the yarn out, wring it without washing, and hang it to dry as in the former operation.

* From the *Transactions of the Dublin Society,* vol. i. part 1.

Third Operation.

This operation the same as the second in every respect.

Fourth Operation.

For every ten pounds of yarn make a clear lye from half a pound of pot or pearl ashes. Pour the lye into the boiling-pan, and add as much clear water as will be sufficient to boil the yarn for two hours; then enter the yarn, light the fire, and bring it to boil in about an hour. Continue it boiling about an hour, then take the yarn out, wash it very well in clear water, wring it, and hang it to dry as in former operations.

N. B. This operation is to cleanse the yarn from any oleaginous matter that may remain in it after boiling in the soap and dung liquors.

Fifth Operation.

To every gallon of iron liquor* add half a pound of ruddle or red chalk (the last the best) well pulverized.

Mix them well together, and let the liquor stand four hours, in order that the heavy particles may subside; then pour the clear liquor into the boiling-pan, and bring it to such a degree of heat as a person can well bear his hand in it; divide the yarn into small parcels, about five hanks in each; soak each parcel or handful very well in the above liquor, wring it, and lay it down on a clean deal board. When all the yarn is handed through the liquor, the last handful must be taken up and soaked in the liquor a second time, and every other handful in succession till the whole is gone through; then lay the yarn down in a tub, wherein there must be put a sufficient quantity of lye made from pot or pearl ashes, as will cover it about six inches. Let it lie in this state about two hours, then hand it over in the lye, wring it, and lay it down on a clear board. If it does not appear sufficiently deep in colour, this operation must be repeated till it has acquired a sufficient degree of darkness of colour: this done, it must be hung to dry as in former operations.

N. B. Any degree of red or yellow hue may be given to the yarn by increasing or diminishing the quantity of ruddle or red chalk.

Sixth Operation.

For every ten pounds of yarn make a lye from half a

* Iron liquor is what the linen printers use.

pound

pound of pot or pearl ashes; pour the clear lye into the boiling-pan; add a sufficient quantity of water thereto that will cover the yarn about four inches; light the fire, and enter the yarn, when the liquor is a little warm; observe to keep it constantly under the liquor for two hours; increase the heat regularly till it come to a scald; then take the yarn out, wash it, and hang it to dry as in former operations.

Seventh Operation.

Make a sour liquor of oil of vitriol and water; the degree of acidity may be a little less than the juice of lemons; lay the yarn in it for about an hour, then take it out, wash it very well and wring it; give it a second washing and wringing, and lay it on a board.

N. B. This operation is to dissolve the metallic particles, and remove the ferruginous matter that remains on the surface of the thread after the fifth opertion.

Eighth Operation.

For every ten pounds of yarn dissolve one pound of best white soap in clear water, and add as much water to this liquor in your boiling-pan as will be sufficient to boil the yarn for two hours. When these liquors are well mixed light the fire, enter the yarn, and bring the liquor to boil in about an hour. Continue it boiling slowly an hour; take it out, wash it in clear water very well, and hang it to dry as in former operations: when dry it is ready for the weaver.

N. B. It appears to me, from experiments that I have made, that less than four operations in the preparation of the yarn will not be sufficient to cleanse the pores of the fibres of the cotton, and render the colour permanent.

XXIII. *On the Benzoic Acid in the Urine of Horses.* By *M.* Ferdinand Giese, *of Berlin**.

According to the researches of Fourcroy and Vauquelin on the urine of different graminivorous animals, the benzoic acid at all times forms a component part of it. Partly with a view to place this beyond a doubt, and partly that I might accurately determine the proportion which this substance bears to the other component parts, I made the following

* From Scherer's *Allgemeines Journal der Chemie*, no. 41.

 experi-

experiments; but these conducted me to phænomena which induced me to proceed further than I had at first purposed.

Experiment I.

To two pounds of fresh horse's urine I added muriatic acid the specific gravity of which was as 115 to 100. A weak effervescence took place, and there were formed thick white vapours, which soon fell to the bottom like flakes. I now continued to add muriatic acid till nothing more was separated, and till there remained a small excess, three ounces of acid having been employed. The whole was then placed on a filter; and the precipitate, being washed with pure water to free it from the urine still adhering to it, was then dried. It amounted in weight to two drams and forty-eight grains. On being subjected to a proper test, it evidently exhibited all the properties by which the benzoic acid is characterized; namely, a scarcely sourish taste, crystallization, complete volatility, the disengagement of an acrid vapour, which occasioned pain in the breast, and ready solution in spirit of wine.

Having fully convinced myself by this experiment of the abundant existence of benzoic acid in urine, I continued my researches on the urine of more horses, partly with a view of observing the difference of the proportions in it, and partly to ascertain whether something determinate might not be established on this subject.

Experiment II.

Four pounds of urine were subjected to the same treatment as before. The phænomena were here different from those of the first experiment; for, on adding muriatic acid, no precipitate was produced. When the fluid was evaporated to a fourth, and after the fluid had stood at rest for some time, I observed a small and resin-like precipitate, which, after being treated with spirit of wine, gave benzoic acid, but in so small a quantity that it bore no proportion to that of the first experiment, for it amounted only to five grains.

Experiment III.

Eight pounds of horse's urine being evaporated to the consistence of syrup, muriatic acid was then added; but no precipitation ensued. The fluid was then brought to complete dryness; and spirit of wine being poured over it, when it had stood some time the undissolved residuum was separated by the filter, and the liquor evaporated. I obtained a very small quantity of crystallized benzoic acid, which, as none appeared by pouring muriatic acid into the urine evaporated to the consistence of syrup, must have existed in the urine in a free state. The weight of it amounted to fifteen grains.

Experiment IV.

Five pounds of urine were evaporated to dryness, and a fourth part of alcohol being added, the whole was exposed to heat. The alcohol, which after some time had acquired a dark colour, was again filtered and evaporated. No traces of benzoic acid, however, were perceptible.

Experiment V.

Of four pounds of urine a small part was subjected to previous proof by muriatic acid: a nebulous precipitate immediately took place, but on the addition of more muriatic acid it again disappeared. The remaining urine not decomposed with muriatic acid I evaporated to the consistence of syrup, by which means a great quantity of pure calcareous earth was separated; to the discovery of which I was conducted by dissolving the residuum in muriatic acid, which was very easily done, and without effervescence. Having dropped sulphuric acid into this solution, sulphate of lime was immediately formed. The urine separated from the calcareous earth was decomposed by sulphuric acid: there was formed a perceptible precipitate, which being digested with alcohol had lost none of its weight, and which was merely sulphate of lime. The precipitate then, first produced in the unevaporated urine by muriatic acid, did not by any means arise from benzoic acid.

It appears from these experiments, that in consequence of the great difference observed in them it is not possible to determine the proportions of the component parts of the urine.

In the many experiments which I made with the urine of different horses, I always found deviations in those which contanied benzoic acid. In general, I found none of this acid; in some cases, but very seldom, I found a considerable quantity of it; calcareous earth I found only once.

Whence then arises this great difference? The answer to this question will, perhaps, make us better acquainted with the cause of these differences. To accomplish this end, it was, in the first place, necessary to examine into the origin of this acid, whether it was formed from the vegetables on which the horses fed, and conveyed into the urine, or whether it was created in the animal body by the mutual

action

action of its original elements. I therefore first undertook to examine the usual food of these animals, hay and oats. Hay contains a large quantity of a grass with a very agreeable smell, the *anthoxanthum odoratum* Linn. Fourcroy and Vauquelin had already suspected that this plant contained benzoic acid: this and other considerations confirmed me in the same opinion, and gave me reason to hope that I should find in it the source of the benzoic acid.

Experiment I.

A quantity of this grass was put into a very dry retort connected with a balneum mariæ, and, being placed in a sand-bath, was exposed to such a degree of heat that the benzoic acid contained in it could be sublimated; but after the fire had been maintained a considerable time, no traces of it were observed.

Experiment II.

One part of this grass was boiled with twelve parts of lime water. The decoction had a very agreeable smell: it was then brought to the consistence of syrup; and muriatic acid being added, a precipitate was produced, which however on being tried exhibited none of the properties of benzoic acid.

Experiment III.

An extract prepared from a quantity of this grass had a very strong smell, very much like that of the *trifolium melilotum*. This extract, being digested some time in spirit of wine, had a very agreeable smell. It was then exposed to a slow evaporation, after which it exhibited no perceptible traces of benzoic acid.

It results from these experiments, made in different ways, that the benzoic acid does not originate from the hay.

It now remained for me to examine oats: I therefore subjected it to the same process, but could discover no signs of benzoic acid.

Being confident that I had pursued the right method in these experiments, I thought myself authorized to conclude with certainty that I must look for the origin of the benzoic acid in the animal body itself. The following experiments will serve as a confirmation of this idea:

I examined the urine of a horse which had been fed on the same food as that given to those the urine of which produced a large quantity of benzoic acid. This urine, however, produced very little. Had the benzoic acid been indebted for its origin to the food, the urine of horses fed

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on the same fodder must have produced a like quantity of benzoic acid; which, after repeated experiments, was not found to be the case. A question now arises, In what state of the animal is this acid formed in the body? in the sound or diseased state? I flatter myself that I am able to answer this question, as I had an opportunity of ascertaining, with great correctness, the state of the horses the urine of which I examined. The result was, that a horse whose urine gave a great deal of benzoic acid had been long diseased, and that the horse whose urine gave very little or no benzoic acid was perfectly sound. But what is the disease during which benzoic acid is produced? This question is the most important and most difficult. The determination of it is of great importance to the physiologist, as it calls his attention towards the cause of the formation of this acid; and is worthy the notice of the chemist also, as it holds forth an inducement for him to examine under what circumstances he can derive utility from this product.

For this purpose a long series of experiments would be necessary; but these experiments can be made only by those who have the care of diseased horses, that is to say, in a veterinary college. Hitherto I have had no opportunity of undertaking this labour; I shall therefore content myself with collecting into one point of view the facts which seem to result from these experiments.

I. The urine of horses is so very different, that nothing certain can be determined in regard to the quantity of benzoic acid which it contains.

II. The following five cases, however, occur in this respect in the preceding experiments:—1st, There are some kinds of urine in which at first a large quantity of benzoic acid is found neutralized with soda: 2d, In which a very small quantity of benzoate of soda exists: 3d, In which the same quantity is found in the free state: 4th, In which none is to be found: and, 5th, In which only a large quantity of pure calcareous earth is observed.

III. The difference of urine in regard to the benzoic acid it contains, does not arise from the food of the horses, but from the various states in which these animals may be by derangements in their functions.

IV. The state of the animal in which a quantity of benzoic acid is produced, is worthy of further examination.

Remark by M. Scherer.

It is always very difficult in researches of this kind to obtain certain results. I think there is great reason to be-

lieve

lieve that benzoic acid is to be found in the urine of every sound horse; but the principal point is the time when it is voided. It is well known that in the *urina cruda* of man very little uré is found; nay, it often seems to be entirely wanting. On the other hand, it is always found in the *urina cocta* of persons who are in a sound condition. May not the case be the same with animals? Is it not therefore more than probable that the concocted urine of sound horses always contains benzoic acid, when no trace of it is to be found in the crude urine of the same animals? This difference is of so much importance that it ought not to be entirely overlooked.

XXIV. *On some Properties of the Phosphoric Acid not yet sufficiently known. By* M. J. F. Guersen, *Apothecary of Kiel**.

I. *Susceptibility of crystallization.*

The property which the phosphoric acid possesses of being transformed into a vitreous mass by exposure to heat, was one of its characteristic signs first known: this was not the case, however, with its susceptibility of crystallization. It is not improbable that the method long employed of obtaining it from urine and bones, and the continued fusion of it to free it from the sulphurous acid, may have prevented chemists from knowing it in that state of concentration in which it shoots into crystals.

De Lassonne and Cornette †, however, speak of a phosphoric acid which was in the ratio of 19·8 to water, and which being mixed in the proportion of two parts to one part of water, formed after cooling a gelatinous kind of mass. This phænomenon, however, while the phosphoric acid was so much diluted, seems to have arisen rather from a mixture of earthy matter than from the property of the acid to crystallize.

Göttling ‡ is undoubtedly the first chemist who observed this property of the phosphoric acid, which he did accidentally, on having suffered phosphorus to stand for three months in a cellar in a glass filled with carbonic acid: at the end of this period he found the sides of the glass covered

* From Scherer's *Allgemeines Journal der Chemie*, no. 44.

† Mem. de l'Acad. de Paris, 1780; and Crell's Chem. Annals, 1786, vol. ii.

‡ Göttling's Taschenbuch fur das jahr, 1797.

vered with sharp-pointed crystals, which on closer examination were found to consist of pure phosphoric acid.

No further observations, however, as far as I know, were made on this property of the phosphoric acid; nor was the crystallization of it in larger quantities ever remarked.

Having been frequently employed in preparing phosphoric acid from phosphorus, I had an opportunity to observe that it possessed the following properties:

1st. Four ounces of phosphoric acid, perfectly free from nitric, muriatic, and sulphuric acid, as appeared on trying it with a solution of silver, caustic lime, and a solution of barytes, and the specific gravity of which, at the temperature of 12° Reaumur, was to that of distilled water as 2·1, shot up, by rest, into feather-like crystals in the course of a few weeks, during which time the temperature of the atmosphere varied between + 2° and − 1°.

This acid, having remained several days in a temperature which varied from − 2° to − 8°, it curdled into an opake, thick, tallow-like mass, in which no regular crystallization was any more observed.

To convince myself of the absence of siliceous earth, which might have been taken up by the acid in consequence of its continual contact with the glass, and which might have produced this curdling, I took some of the curdled acid, by means of a glass rod, from the glass in which it was contained, and placed it on my hand, where by the heat it was immediately transformed into a fluid perfectly transparent.

On diluting it with two parts of distilled water, and saturating it with carbonate of potash and of soda, no earthy precipitate was formed: I observed also, that the glass in which the acid had been kept showed no signs of having been in the least attacked. These were sufficient proofs that the acid was not rendered impure by siliceous earth.

2d. An ounce of crystallized acid, which by heat had been brought again to a fluid state, was exposed in a small glass tube to the temperature of − 36° Reaumur, produced by a mixture of equal parts of snow and muriate of lime. At the end of 15 minutes the mixture was taken from this exposure to cold, as fluid as it was before the experiment: the same acid in the course of some days, in the temperature of − 2°, returned to the same tallow-like consistence.

It appeared to me to result from this experiment, that the crystallization of the phosphoric acid is not produced by a low temperature alone, but chiefly by rest.

This conjecture I found fully confirmed by several other quantities

quantities of phosphoric acid of from 8 to 12 ounces, which I was obliged to prepare during the course of the last summer, and which crystallized, though more slowly than in winter, in a temperature of from 10° to 16° of Reaumur.

The whole mass of acid generally curdles into tallow-like lumps, which exhibit signs of crystallization only at the surface. I have, however, been able several times to obtain the quantity of six ounces in needle-like crystals, which resembled the acid of sugar, and which remained unaltered during the hottest days of summer.

3d. Acid of a less specific gravity I was not able to make crystallize; but by the addition of more water it curdled in the course of some time into a thick irregular mass.

It thence appears, that to make phosphoric acid crystallize, it requires besides rest a degree of concentration, which, according to its specific gravity, must be as 2 to 1 of distilled water.

II. *It does not appear to have been yet proved, whether phosphoric acid produces or not a precipitate in a solution of nitrate of silver.*

It is asserted in some Elements of Chemistry* that nitrate of silver is decomposed, and suffers the phosphate of silver produced to be separated from it as a white precipitate.

Others † refer to the experiments of Margraff ‡, who, by means of an acid prepared from salt of urine, precipitated silver dissolved in nitrous acid in the form of white soft lumps. Morveau § asserts also, that silver is precipitated from its solution in nitrous acid by phosphoric acid.

Lavoisier ||, as far as I know, is the only person who has denied this precipitation; and Morveau wonders how Lavoisier could assert that no precipitate is formed. The opinion of so celebrated an observer, however, was of so much weight, that I was unwilling to entertain any doubt on this subject without further proof.

I therefore dissolved four gros of the crystals of nitrate of silver in a sufficient quantity of distilled water, and two gros of concentrated phosphoric acid prepared by nitric acid and phosphorus were added.

At first, a quantity of small crystals which had a perfect

* Hermstadt's Experimental Chemie, part iii. p. 115.

† Gren's Handbuch der Chemie, second edit. part ii. p. 168.

‡ Margraff's Chemical Works, part i. p. 107.

§ On the Acid Salts decomposed by Bourguet, vol. ii. p. 281.

|| Lavoisier's Chemical Works, translated into German by Weigel, vol. ii. p. 418.

resemblance

resemblance to nitrate of silver fell to the bottom, and which, by a proper mixture of concentrated acid, and the addition of a little water, was again dissolved.

This precipitation of crystals before the phosphoric acid was diluted may be easily explained by this circumstance, that the concentrated acid, which had the appearance of thick syrup, greedily attracted some of the solvent from the nitrate of silver, by which means a part of the nitrate of silver was necessarily obliged to crystallize; as is the case in all saline solutions when deprived of their aqueous principles by the addition of other bodies.

As no precipitate was produced by a proper mixture of phosphoric acid with a solution of nitrate of silver, I am of opinion that the assertion of Lavoisier may be confirmed; namely, that nothing was separated from a mixture of phosphoric acid and nitrate of silver.

To obtain more certainty on this subject, I prepared a small quantity of phosphate of silver by precipitating a solution of silver with phosphate of soda, one part of which I mixed with nitric acid, and the other with diluted phosphoric acid. In both cases the phosphate of silver was completely dissolved.

If a decomposition therefore should take place in a mixture of phosphoric acid with a solution of nitrate of silver, enough of free acid will still remain to prevent the precipitation of the phosphate of silver.

It however appears from the following experiments that such a decomposition is not probable.

Two gros of nitrate of silver dissolved in a sufficient quantity of distilled water, were mixed with one gros of concentrated phosphoric acid, and the clear solution was subjected to slow distillation over a lamp.

The matter which passed over had not the least taste of acid, even when the degree of the heat was increased by enlarging the flame of the lamp. As soon as the formation of small crystals was observed in the retort, I interrupted the distillation, and left the mixture at rest to cool.

At the end of several hours a great many crystals of nitrate of silver had shot up, which when dried gave nearly the same weight again. After repeated solution and slow crystallization, all the properties of nitrate of silver were observed.

The fluid which remained over the crystals in the retort had an exceedingly sour taste, which was perceptibly that of the phosphoric acid: it left on the tongue, however, a metallic

metallic savour, and tinged the skin black; but the latter property does not belong to phosphate of silver.

By rest a considerable quantity of nitrate of silver still crystallized, but the metallic savour was not yet entirely lost.

More crystals continued to appear by spontaneous evaporation, in consequence of which the metallic savour became still less perceptible: but as the crystals possessed all the properties of nitrate of silver, I considered all further examination of the supernatant acid as superfluous, as it could be nothing else than phosphoric acid.

III. *A doubt similar to that in regard to the question, Whether solution of silver is decomposed? arises in regard to that, Whether a solution of muriate of barytes gives a precipitate by mixture with phosphoric acid?*

Morveau poured phosphoric acid into a solution of muriate of barytes, and obtained a precipitate of phosphate of barytes *.

Gren † found it confirmed, by his own experiments, that the phosphoric acid decomposes muriate of barytes by simple affinity.

As phosphate of barytes is so easily dissolved by free acid, I was of opinion that this assertion of that chemist, however respectable, was not to be admitted without further examination.

To ascertain the truth of my conjectures, I dissolved in distilled water two gros of perfectly pure muriate of barytes; and having mixed it with one gros of concentrated phosphoric acid which had been before somewhat diluted in distilled water, no trace of precipitate appeared.

A repetition of this experiment several times with the same and larger quantities of these substances, confirmed the observation, that no precipitate is formed by a mixture of pure phosphoric acid with a solution of pure muriate of barytes.

As in every case when a very small quantity of phosphoric acid was dropped, a very perceptible taste of this acid was observed, this phænomenon seemed to show that no decomposition of the muriate of barytes had taken place.

To ascertain this, however, beyond a doubt, I mixed the solution of two gros of muriate of barytes with one gros of

* Morveau ut supra; and Macquer's Chem. Dict. part iv.

† Handbuch der Chemie, vol. ii. p. 300.

phosphoric

phosphoric acid, diluted the mixture with distilled water, and exposed it to distillation over a lamp.

The fluid which passed over had not the smallest taste of acid, and produced no action on lacmus paper. As soon as crystals began to be formed, the distillation was ended. There were separated 45 grains of a salt which possessed all the properties of muriate of barytes.

By repeated distillation of the remaining acid fluid, which had a very perceptible taste of phosphoric acid, I again obtained by degrees the two gros of muriate of barytes, and as little altered as the phosphoric acid which I had employed for this experiment.

My conjecture was still further confirmed by the following experiments:

1st. The solution of an ounce of muriate of barytes was mixed with half an ounce of concentrated phosphoric acid, by sufficiently diluting it with distilled water.

2d. I evaporated the mixture in a glass capsule till it appeared dry on cooling. At the end of the operation a great quantity of pungent muriatic vapours were disengaged.

3d. The saline mass, which had a very acid taste, was washed with alcohol till the fluid no longer turned lacmus paper red, and until the salt was entirely freed from the adhering acid.

4th. The washed salt, when dissolved in distilled water, gave a precipitate, which when washed and dried weighed 20 grains.

5th. To ascertain the nature of this precipitate, which had no saline taste, and which made a noise under the teeth like an earth, I boiled it with 30 grains of the carbonate of soda, and then edulcorated the liquor.

6th. It dissolved completely in muriatic acid with very little effervescence, and when mixed with sulphuric acid gave an abundant precipitate.

7th. The spirit of wine (3) which had taken up the salt adhering to the acid was distilled in a retort till the residuum had acquired the consistence of a syrup.

8th. The result of the distillation, when a solution of silver was dropped into it, showed traces of a little free acid.

9th. The acid in the retort, which had a very perceptible taste of phosphoric acid, was no longer impure by muriatic acid. It rendered lime water exceedingly turbid, and in weight amounted to three gros and thirty grains.

10th. The saline solution (4) gave, after crystallization, seven gros and three grains of salt, which exhibited the same phænomena as muriate of barytes.

It appears to result from these experiments, that in evaporating a mixture of a solution of muriate of barytes and phosphoric acid, towards the end of the process, when the saline mass already formed is capable of bearing a greater degree of heat than that of boiling water, some muriate of barytes is decomposed, which can combine with a part of the free phosphoric acid.

But that no proper decomposition of the muriate of barytes takes place by the action of the phosphoric acid, seems to be proved by the large quantity of undecomposed salt and pure phosphoric acid which was again obtained.

I shall abstain from any further inquiry why Morveau and Gren obtained a precipitate by combining this salt with phosphoric acid: but I think I can on good grounds conclude, that neither of these chemists made their experiments with pure phosphoric acid.

XXV. *Description of a New Safety-Piston for Papin's Digester, with the Application of it to the Boilers of Steam-Engines, and also of an Apparatus for regulating the Heat of Furnaces. By* A. N. Edelcrantz, *Knight of the Swedish Order of the Polar Star, and Member of several Academies and Learned Societies.*

To Mr. Tilloch.

SIR,

Agreeably to your desire, I have sent you the description of a safety-piston which I have employed in Papin's digesters; the use of which I have endeavoured to render more exact, safer, and more convenient *. This small apparatus, attached to the cover of the digester, consists of a brass cylinder *a b*, fig. 2. (Plate III.) in which a piston of the same metal, *c d*, moves with very little friction, in order that it may descend by its own weight after it has been raised up, without however permitting the vapour to pass between it and the cylinder. The lower part of the cylinder communicates with the digester, and is covered by a small sphere, *s, s*, perforated with holes, to prevent the matters in a state of ebullition from entering the in-

* The description of my piston may be seen in the *Journal de Physique*, vol. lvi. p. 147 But since that time I have made some change in its construction.

side

side of it, but allowing the vapour to pass. The upper part (*a*) is closed by a small cover screwed on to it, and perforated with a hole through which the piston-rod passes easily. This cover serves the double purpose of guiding the rod, and preventing it from being blown out. The piston-rod is furnished with a shoulder, *g*, *g*, which serves to support different weights, *v v v*, which can be changed at pleasure. In the side of the cylinder there are holes, *e*, *e*, as small as possible, placed above each other at the distance of about a line; but this distance, as well as the number of them, is a matter of indifference.

To give an idea of the effect of this small apparatus, let us suppose the piston lowered, and loaded with any weight, and that a fire is kindled under the boiler. When the vapour has acquired sufficient elasticity to raise the weights, the piston will ascend, and, having passed the first hole, some vapour will escape. If this aperture be of sufficient size for the passage of the quantity of vapour continually produced, the piston will remain there stationary, and in a state of oscillation; if not, it will ascend above the second, third, &c. hole, and, if the intensity of the fire is sufficiently strong, above the last, which must be made larger, that, by giving the proper means of escape to the vapour, all accidents may be prevented. It is here evident, that though the greater or less elevation of the piston, as well as the number of the holes open, depends on the variations and different intensities of the fire; these variations, however, have no influence on the interior heat, and the elasticity of the vapour contained in the digester, since their force is always proportioned to the weight with which the piston is loaded, and which is constant. This safety-piston seems likely to afford, for delicate experiments, greater exactness than the usual safety-valves, with or without levers charged with weights, hitherto employed. For, in the whole course of the space which the cylindric piston passes over in ascending, the state of the elasticity of the vapour is the same; whereas, when the conical valve in common use is once raised up, nothing indicates whether, or how much, the present state of the vapour surpasses the first effort it made to open a passage. Besides, the diameter of the piston being once known, the force of the vapour requisite for each experiment can be easily regulated and determined. If we suppose, for example, that the lower surface of the piston is $\frac{1}{16}$th of a square inch, each ounce of weight on the shoulder, *g*, will be equivalent to the pressure of a pound on each square inch of surface, and so on in proportion.

As this pressure then remains constant, the experiment will be more determinate, and consequently more comparative.

The application of this piston to the boilers of steam engines needs no further explanation, except that, in this case, the diameter of the piston must be considerably increased. It seems here to offer the same advantage of greater uniformity in the force of the steam, especially if the motion of the piston be employed to regulate the fire of the furnace, and to prevent the useless dispersion of the vapour, by preventing an excess of intensity in the fire. For this purpose, the following apparatus may be used. Let *m*, *n*, fig. 3. be the aperture of the conduit for the current of air which maintains the combustion of the fuel, and *o*, *p*, *a* register; which, by rising or falling, opens or shuts that conduit. If the motion of the safety piston be combined by any means with the register, in such a manner that, when the former ascends, the latter descends, so that when the piston is at its greatest elevation the register shall be entirely shut; it is evident, that, since the heat produced depends on the access of the air, the elasticity of the vapour being determined by the weight of the piston, will not only remain within the bounds prescribed for it, but will regulate itself, by preventing more air from entering into the furnace than is necessary to maintain its force.

I do not know what obstacles may occur in the application of this apparatus on a large scale; but it seems to promise a greater saving of fuel, since, instead of throwing out to no purpose a superabundant quantity of vapour, it will prevent its production, without expending any considerable part of the force of the machine for that purpose.

XXVI. *Description of Mr.* Arthur Woolf's *Steam-Valve.*

In our last we laid before our readers an account of Mr. Woolf's newly invented boiler, in which we mentioned that, besides employing safety-valves, he had introduced a valve of a new construction to regulate the quantity and power of the steam passing from the boiler. We shall now lay before them a description of this ingenious contrivance.

A (Plate IV.) is a part of the main cylinder of one of Mr. Woolf's boilers; B B the neck or outlet for the steam, surmounted by the steam-box C, which is joined to the neck

B B by

BB by the flanges *a a*. The top or cover of the steam-box C, marked with the letter D, which is well secured in its place, has a hole through it for the rod of the valve, so contrived as to answer the purpose of a stuffing-box to make the rod work up and down steam-tight, the stuffing being kept in its place by the usual means, as shown in the section. By means of a pin or nail, *b*, and the two vertical pieces *ee*, the piston rod is made fast to *m*, which is a cover of and joined to the hollow cylinder *n*, *n*. The cover *m* fits steam-tight into the collar *o*, *o*, which is made fast on the flange *a a*. The cylinder *n n* is open at the bottom, having a free communication with the main cylinder A, and has three vertical slits, one of which, S, is shown in the plate*. The sum of the surface of all these slits or openings is equal to the area of the opening of the collar *o*, *o*, in which the cylinder *n*, *n* works. When the steam acquires a sufficient degree of elastic force to raise the valve (that is, the cylinder *n n* with its cover *m*, and the rod R) and whatever weight it may be loaded with, then the openings S, getting above the steam-tight collar *o*, *o*, allows the steam to pass into the steam-box C. The quantity of steam that passes is proportioned to the elastic force it has acquired, and the weight with which the valve is loaded; and the rise of the openings S above the collar *o*, *o* will be in the same proportion. This valve may be loaded in any of the usual methods; but Mr. Woolf prefers the one shown in the drawing, in which the upper part of the rod R is joined by means of a chain to a quadrant of a circle Q with an arm projecting from it, as represented in the plate, and which carries a weight, Z, that may be moved near to or further from the centre of the quadrant, according as the pressure of the valve is wished to be increased or diminished. As the valve rises, the weight moves upwards in the arch *n n*, giving an increased resistance to the further rising of the valve, proportioned to the greater horizontal distance from the centre of Q, which the weight attains by its rise in the said arch, the said distance being measured in the line Q *p* by a perpendicular from the said line Q *p* passing through the centre of the weight. Thus, if the weight Z press with a force equal to twenty pounds on the square inch of the aperture in *o*, *o* in its present position, it will, when it rises to the position at *i*, press with a force equal to thirty pounds, and at *p* with a force equal to forty pounds, on the square inch; so that the rod Q Z may be made to serve at the same time as an in-

* These openings may be covered with a grating.

 dex

dex to the person who attends the fire, nothing more being necessary for this purpose than to graduate the arch described by the end of the rod Q Z. In the side of the steam-box C there is an opening N to allow the steam to pass from it by a pipe or tube to the steam-engine, or to any secondary boiler, or for the purpose of conveying and applying it to any other vessel or use to which steam is applicable.

Before dismissing this article, we must beg our readers to correct an error in printing the description of the boiler in our last number, page 41. The second line from the bottom should read "not joined to any of them, excepting the middle one, at the points," &c.

XXVII. *Description of a Portable Chamber Blast Furnace. By* C. R. Aikin, *Esq.*

To Mr. Tilloch.

DEAR SIR,

Some of my chemical friends having expressed their approbation of a small portable blast-furnace which my brother and myself have been in the habit of using for a variety of experiments on a small scale; I am induced to send you a description of it, in hopes that it may prove as serviceable to others as it has been to us. It is particularly adapted to those who, like myself, can only devote a small room and a moderate share of time to these pursuits.

Dr. Lewis in his *Commerce of the Arts* (page 27) describes a very powerful blast-furnace formed out of a black-lead pot, which "has a number of holes bored at small distances in spiral lines all over it, from the bottom up to such a height as the fuel is designed to reach to." This is let half way into another pot, which last receives the nozzle of the bellows, so that all the air sent in is distributed through the spiral holes of the upper pot, and concentrates the heat of the fuel upon the crucible, which is placed in the midst.

The furnace which I am going to describe resembles very closely this of Dr. Lewis; with this difference, however, that the air-holes are only bored through the bottom of the pot, and this merely stands upon another piece, instead of being let into it. It is on this account somewhat more commodious, and I imagine not less powerful.

Fig. 1. (Plate V.) is a view, and fig. 2. a section of the furnace.

furnace. It is composed of three parts, all made out of the common thin black-lead melting-pots sold in London for the use of the goldsmiths. The lower piece, A, is the bottom of one of these pots cut off so low as only to leave a cavity of about one inch, and ground smooth, above and below. The outside diameter over the top is $5\frac{1}{2}$ inches. The middle piece or fireplace, B, is a larger portion of a similar pot with a cavity about six inches deep, and measuring $7\frac{1}{2}$ inches over the top, outside diameter, and perforated with six blast-holes at the bottom. These two pots are all that are essentially necessary to the furnace for most operations: but when it is wished to heap up fuel over the top of a crucible contained within, and especially to protect the eyes from the intolerable dazzle of the fire when in full heat, an upper pot, C, is added, of the same dimensions as the middle one, and with a large side opening cut out to allow an exit to the smoke and flame. It has also an iron stem with a wooden handle (an old chisel will do very well), to lift it off and on.

The bellows (which are double) are firmly fixed, by a little contrivance which will take off and on, to a heavy stool, as is represented in the plate; and their handle should be lengthened, to make them work easier to the hand. To increase their force on particular occasions, a plate of lead may be tied on the wood of the upper flap. The nozzle is received into a hole in the pot A, which conducts the blast into its cavity. From hence the air passes into the fireplace, B, through six holes, of the size of a large gimlet, drilled at equal distances through the bottom of the pot, and all converging in an inward direction, so that, if prolonged, they would meet about the centre of the upper part of the fire. The larger hole through the middle of the bottom of the same pot is for another purpose. Fig. 3. is a plan of the same, showing the distribution of these holes.

As a stand or support for the crucible, I have found no method so good as to fit an earthen stopper into the bottom of the pot B, through the large centre hole which is made for this purpose. This keeps the crucible in its proper place, in stirring down the coals and managing the fuel. These stoppers are made with great ease and expedition out of the soft red fire-brick sold in London. A piece of this brick, made to revolve a few times within a portion of iron or earthenware tube, presently takes the form of its cavity, and comes out a very neat portion of cylinder or cone, according to the shape of the tube, from which the stoppers may readily be fashioned. Fig. 4. represents one of these stoppers,

which

which is also seen in its proper place in fig. 2. supporting a crucible.

As the construction of this furnace (exclusive of the bellows and its stool) is easy to any one at all used to these little manual operations, I trust that the *working* chemist will allow me to add a few words on the method which I have found the most convenient and œconomical. Almost any broken pot of the proper width will furnish the lower piece A; and often the middle and upper pieces may be contrived out of the same refuse matter. Dr. Lewis advises a saw to cut these pots: but most saws are too thick; and when a little used, the teeth get rounded off, which makes them work intolerably slow. I have found by far the best tool to be an old table knife (or rather two of them) worn thin by use, and hacked and jagged as deeply as possible by striking the edges strongly against each other. These work well and expeditiously, and when they become dull are again roughened by the same simple means. The holes may be drilled with a common gimlet of the largest size, and a little steadiness of hand will easily enable the operator to give them the oblique direction with sufficient accuracy; for much is not required. To make a smooth surface to the parts intended to adapt to each other, first wear them down a little with the soft fire-brick, and then grind them with water on a flat free-stone (a sink-stone for example), and lastly make them entirely fit by rubbing one surface on the other.

No luting of any kind is ever required; so that the whole may be set up and taken down immediately. Nor is it necessary to bind the pots with metal hoops; for they are thick enough to endure considerable blows without breaking; and yet they will bear, without cracking, to be heated as suddenly and intensely as possible. In short, the black-lead crucible seems to be the best material that could possibly be devised for these purposes.

The heat which this little furnace will afford is so intense, and so much more than would at first sight be expected from so trifling an apparatus, that it was only the accidental fusion of a thick piece of cast iron in it that led us to suspect its power. The utmost heat which we have procured in this furnace has been one hundred and sixty-seven degrees of a Wedgwood pyrometer piece, which was withdrawn from a very small Hessian crucible when actually sinking down in a state of porcellanous fusion. A steady heat of 150° to 155° may be usually depended on, if the fire be properly managed and the bellows worked with vigour. This is suf-

 ficient

ficient for most operations in chemistry; and the œconomy in time and fuel is extreme, since a furnace of the given dimensions will very well raise to the above point of heat in from five to ten minutes a Hessian crucible of such a diameter, that the average thickness of burning fuel around its bottom is not more than one inch and a half. A smaller crucible will take a higher heat, but at the risk of its softening and falling in by the weight of the incumbent fuel.

Coak, or common cinders taken from the fire just when the coal ceases to blaze, and broken into very small pieces, with the dust sifted away, form the best fuel for the highest heat. A light spongy kind of coak, formed of a mixture of coal and charcoal, called *Davey's patent coal*, also answers extremely well. Charcoal alone has not weight enough, when broken so small as it must be to lie close in this little fire-place, to withstand the force of the blast when very violent. A bit of lighted paper, a handful of the very small charcoal called in London *small coal*, and ten or a dozen strokes of the bellows, will kindle the fire in almost as many seconds.

Various little alterations and arrangements, which will readily occur to the practical chemist, will fit this little apparatus for distillation with an earthen retort, heating a gun-barrel passed through the fire, bending glass tubes, &c.

I shall only add, that the dimensions of this furnace were determined merely by the circumstance of having at hand pieces of black-lead pots of this size, so that doubtless they may be varied without any diminution, and probably with some increase of the effect. The same may be said of the number of holes; for in another instance four appeared to answer as well as six,—with this difference, however, that, by long working, the melted slag of the coak will now and then partially block up one or two of the holes; on which account perhaps the greater number is preferable.

I remain sincerely yours,

C. R. Aikin.

Broad-street Buildings,
Nov. 20, 1803.

XXVIII. *On the Preparation of the Fulminating Mercury of Mr.* Howard, *by Mr.* A. S. Burkitt.

To Mr. Tilloch.

DEAR SIR,

Having at various times prepared the fulminating mercury of Mr. Howard, I was desirous to collect the gas which

which escapes during the process, which I have done frequently; but the last time I had occasion to repeat it with more exactness than before. Should you think the result worthy a place in your very valuable and interesting Journal, it is at your service.

Fleet-street, Nov. 16, 1803.

I am, dear sir, &c.
A. S. BURKITT.

I took three ounces of mercury, which I dissolved in $1\frac{1}{4}$ pound of nitrous acid. When the solution was complete, I poured it into a six-gallon retort, in which I had previously put $1\frac{3}{4}$ pound of rectified spirits of wine heated to about 80 degrees. I then introduced the neck of the retort into a ten-gallon carboy which had by accident a hole broken in its side*: the mouth of the latter was inverted in an earthen vessel containing four pints of water (see fig. 4. Plate III.). In the space of three minutes the usual effervescence took place; when a considerable quantity of gas was disengaged, and condensed in the carboy. In about twenty minutes the process was complete, and the precipitate formed. I moved the apparatus, and poured the liquor from the precipitate in the retort, washed it well, and dried it upon filtering paper. The produce was three ounces and one dram of the fulminating mercury.

I then moved the carboy, and obtained upon the surface of the water, in the earthen vessel, four ounces of nitric ether.

Not being in the habit of throwing any thing away until I am satisfied it cannot be turned to account, I added one pound of spirit of wine to the water that had washed the ether, and, by distillation in a common sand-bath, obtained from it one pint of sweet spirit of nitre.

The preparation of the fulminating mercury is generally conceived to be a dangerous process, but is not at all so in my opinion, as the precipitate will not fulminate until it has been well washed. I have prepared it very often: once I made nine ounces at one operation; but I never employ heat, as I add the mercury in the acid as soon as the solution is complete, which is sufficiently heated by the action of the acid upon the mercury, to the spirits previously warmed to about eighty degrees.

* The fitting was completed by applying a wet rag round the neck of the retort.

XXIX. *Tenth*

XXIX. *Tenth Communication from Dr.* Thornton.

To Mr. Tilloch.

SIR, No. 1, Hinde-street, Manchester-square, Nov. 20, 1803.

From the inclosed case you will find that the cause of Pneumatic medicine is not abandoned by me, as has been circulated; nor are its virtues less effectual now, than when I first commenced its application in the year 1792. The inclosed case I have no doubt you will think with me is a very striking instance of the superior efficacy of vital air in removing a load of disease supposed incurable, such as seldom falls to the lot of humanity. It is published, like the many others I have before given to the world, at the express desire of the patient, in order to extend, as far as our weak but anxious endeavours can avail, the blessings of this inestimable and truly philosophic remedy; and is brought forward, I solemnly assure you, by me, not for any individual advantage, but to rouse my medical brethren to make trial of similar means in cases that appear to be adapted to its application, and which might otherwise remain incurable.

Case of Miss Margaret Gorst.

This amiable young lady, daughter of the Rev. Mr. Gorst, rector of Marton and Kirbythore, near Appleby, in the North of England, had naturally a most excellent state of health. Her eldest sister taking cold fell into a decline; and constantly attending upon her, and sleeping along with her, previous to her death, gave the first shock to her constitution. Going after this upon a very hot summer's day into some lead mines possessed by her father at Dufton Fell, she was struck with the damps; and at the early age of seventeen commenced her martyrdom to disease. Her appetite forsook her, she had constant pain on the left side, felt a continual lassitude, palpitation of the heart, and the feet towards evening would frequently swell. The dyspepsia increased to that degree that all animal food was loathed, and when taken rejected; and, in consequence, her support was obliged to consist wholly of vegetable food. Her limbs were cold to the touch, and appeared blue even in the midst of summer. Her nerves were in that depressed state, that the smell of a candle badly snuffed, or a nosegay introduced into the room, or even melted sealing-wax, would instantly take away her voice, so that no one could hear her. If a door was suddenly opened, or from any unexpected noise, she

she would tremble, and fall into a flood of tears. Her eyes became sunk and inanimate. Her colour, before extremely blooming, forsook her cheeks, and her whole complexion appeared of a mahogany colour. Her bones were nearly through her skin from emaciation, and she was obliged to be carried in the arms of the servant from one room to another, having entirely lost all power over her limbs. She was reduced to that state of lowness, that for days together she would scarce notice any person, or even speak. The daily inquiries that were made at the house, were not whether this young lady was better, but whether she was still alive: and as tonic and stimulant remedies of every kind had been ineffectually employed by the most skilful practitioners of the country, all of whom had pronounced to the family her recovery as a thing not to be looked for, she was universally lamented, as a person labouring under a disorder that could not be removed. This melancholy state had existed now more than thirteen years, when her brother*, who favoured me with the particulars of this melancholy case, from perusing the cures performed by vital and other airs, recorded at length in vol. i. of my Philosophy of Medicine, as a dernier ressort applied to me for my advice; when I recommended the inhalation of the vital air. It was begun September 14, 1802. From the journal drawn up by the lady, I shall beg leave to make a few extracts. I had ordered two quarts of vital air mixed with fourteen or fifteen of atmospheric to be inhaled daily, at two different intervals.

Observations.

"Feel faint and languid after each time of inhaling; but this sensation soon goes off, and then I feel refreshed. I experience a glow, and seem as if I was lighter.

"So pleased was I at feeling myself enlivened by this quantity of vital air, that, contrary to the direction given, I doubled the dose; and after the inhalation in the evening I was seized with the most dreadful convulsive fit, which lasted six hours, and I was in consequence confined to my bed. So convinced was I, however, that this fit, a thing I had never experienced in my life before, arose from an overdose of the vital air, that I requested to have the pneumatic apparatus brought to my bedside, and with difficulty could persuade my frightened relations to let me try the medicated air again in a more cautious manner.

"The amendment was by its continuance in this way so great

* Mr. William Gorst, wine-merchant, No. 14, Little Tower-street.

great, that it was visible to every one who noticed the alteration in my looks, and my increase of strength. So far from requiring assistance, I was enabled to walk out above a mile. Instead of living upon vegetable I could take animal food, which my stomach did not reject. Smells had no longer any effect on my voice; so that after nine months, continuing the use of the vital air, I went to Hartlepool. The sea air continued on the benefit; but after six weeks absence, thinking I could do without the vital air, upon my return home I omitted taking the air, and was relapsing into my former weak state: but all the bad symptoms went off upon my resuming again the vital air, which has now been continued with the same advantage above a twelvemonth."

Observations on this Case, by Dr. THORNTON.

This *almost* miraculous* effect from vital air furnishes many curious reflections.

1. The *disoxygenation*, or want of *vital air* in the blood, was shown by the *sallowness* of the complexion, and *blueness* of the extremities; their *coldness*; the *torpor* of the bowels; want of *energy* in the nerves of the stomach, and total *loss* of muscular powers, without paralysis.

2. The disappearance gradually of all these symptoms, which had existed upwards of *thirteen* years, from the inhalation of a *superoxygenated air*, proves, or seems to prove, in the strongest manner the powerful influence of vital air on the animal œconomy. The *complexion* became clear; the *cheek* acquired its vermilion; the *fingers* no longer appeared blue; a general *warmth* was diffused; the *stomach* digested animal food; the *bowels* performed their daily office without the aid of medicine (before, they used to be suffered to go unrelieved eight or ten days, as the mildest purgatives produced always dreadful swoonings); the *muscles* acquired their energy, and the *nerves* their influence. No other medicine was employed here but tincture of colombo, which had before been long uselessly exhibited.

* Old Dr. George Fordyce used to say, speaking of the *factitious airs*, "As to *us*, *we* don't perform *miracles*." I might have said, Nor do the *pneumatic physicians*: they record upon the accredited testimony of others the effects said to be felt, and by multiplying similar evidences they are in hopes *finally* of settling *legitimate conclusions*. They esteem it as the fairest plan to record what they are told, and leave to others to disprove or approve, by making themselves trials under somewhat similar circumstances. They reckon this science still as in its infancy, and would wish to see it advance by the combined efforts of many practitioners, friends to science and mankind.

3. That

3. That the superoxygenated air is not an *inert power*, is shown by its producing in an overdose, in a weak habit, a dreadful convulsive fit; which was not the case when employed afterwards in a less proportion. I have before recorded the case of a lady subject to epileptic fits, which had ceased six months, and which recurred immediately upon the inhalation of the superoxygenated air (vide my Philosophy of Medicine, case xi. page 475); also a very wonderful case as recorded by the ingenious and indefatigable Dr. Beddoes, (vide Philosophy of Medicine, case x. p. 474.*)

4. The proportion being diminished, the same good arose as before; which shows that this remedy requires *some judgment* in its exhibition.

5. That the air absorbed by the blood in the lungs influences *appetite* and *digestion*, is known by such who expose themselves to the sea air, the air of mountains, or even the air of a field; which usually creates an appetite.

6. That *such*, but in a *superior degree*, is the effect of a superoxygenated air, is a general remark. Mrs. Lowry, wife to a well-known eminent engraver employed in your magazine, a lady endowed with a most excellent understanding, recollects what others have told her; and from her journal I can collect, that upon inhaling the superoxygenated

* Mr. Davy, lecturer on chemistry at the Royal Institution, certainly one of the most enlightened philosophers of Europe, found, after breathing the pure oxygen or vital air, that his respiration became *laborious*, and his pulse *harder*,—"effects as though a less quantity of oxygen was absorbed by the blood" (see Researches Chemical and Philosophical, chiefly concerning Nitrous Oxide, p. 473): but this could not be the fact, for the following reasons: In given proportions of common and vital air, an animal will live four times longer in the latter than in the former; and so increased are the actions of life, that in animals made to breathe the pure vital air, the liver after death will be found so far oxygenated as to lose its liver-colour, and appear florid; marks of inflammation will every where be discoverable, and the death produced on the animal will arise from an excess of life. That the absorption of oxygen is greater than when breathing common atmospheric air, is shown from the following accurate experiments by my late ingenious friend Dr. Ingenhousz:

Thirty cubic inches of vital air was put into a dry bladder, and all drawn into the lungs, and ejected, and so employed for several times. The result was,

The proof of vital air was 0·78, 0·48, 0·21, 1·18 - - - - -	The degree of goodness of the air before it was inspired, and after each inspiration, is indicated by the numbers. The proof was by the employment of nitrous air.	382
After the first inhalation, 0·80, 0·60, 1·60		240
After being breathed a second time, 0·75, 1 16, 2·15 - - - -		185
After the third time, 0·86, 1·86 -		114
After the fourth time, 1·21 - -		79

The

nated air, it created so strong a sense of hunger, that, as she was returning home, she could not refrain from going into a baker's shop, buying, and eating up directly, two penny rolls. Afterwards she came with a supply of biscuits; which plan was followed at the same time by some other patients*.

7. *The sea air at Hartlepool kept up the advantages of an artificial inhalation of a superoxygenated air.* That there is more vital air in sea-air than in-land, has been proved by a very ingenious paper by Dr. Ingenhousz, presented before the Royal Society†. Most of the advantages of going to the sea side arise from this cause‡, instead of bathing. How much more easy the expense of artificial inhalation of a superoxygenated air, if the advantages are the same, than distant journeys to those remote from the coast for the recovery of health! This idea is worthy of some consideration.

The examination of common air was as follows:

	The degree of goodness, and its decrease, will be found as follows:
The common air by proof was 1·06 - - -	94
After one inspiration, 1·25	75
After the second, 1·37 -	63
After the third, 1·47 -	53
After the fourth, 1·48 -	52

The *hardness* of the pulse and the *difficulty of breathing* in Mr. Davy, after inhaling the pure vital air, seem then to have arisen from a degree of *inflammatory* fever having been induced; or by taking backwards and forwards the same air too often. To a philosophic mind this is no objection; or that animals are destroyed by pure vital air, dying from an excess of excitement; for the most potent poisons are the best remedies, when judiciously employed.

* This effect might be contradicted by future experience on a small scale, especially upon healthy individuals. Let the reader, therefore, be acquainted, that Mrs. Lowry at first came to me in a coach, and could not support herself upright. She had been given up by the most able practitioners. As strength returned, appetite increased: and this is ever as the wants of the system: after a recovery from a fever every one must have experienced the cravings of nature, and her state was soon that of convalescency. So predisposed, it is not to be wondered at if the oxygen produced a circumstance at which some may smile; and I have added this note, fearful of a contrary account being hastily published by an experiment made upon persons in the vigour of life.

† This ingenious memoir on the degree of goodness in the air (that is, the proportion of vital air to azote,) as found on the open sea, on the sea side, and at a distance from the sea, was read April 24, 1780; and is published in vol. lxx. of the Philosophical Transactions.

‡ The surprising cures recorded by Dr. Gilchrist, and others, from long sea voyages, must have partly proceeded from this circumstance. The increase of appetite in short sea voyages has been noticed by me more than once, and by others.

8. *That muscular power was restored.* Mrs. Lowry carefully noted, at my desire, the number of steps she took in coming to my house, and upon returning after the inhalation of a superoxygenated air; and she found that the number required upon return was reduced nearly one-third. If you notice the pavior :—before he strikes in the stone he forcibly drives out the air in his lungs, takes in a full inspiration, and then uses his powerful exertion. The panting for breath shows the use of this principle in the blood for exercise.

9. *The whole frame had a deadly cold, and the fingers looked blue.* The Promethean fire inspired into the man of clay, to those fond of interpreting of antient hieroglyphics, I would say was no other than vital air, which contains, and imparts to the body, the animal heat. "And he breathed into him the breath of life." MOSES. "In the blood is the life;" (*the breath of life, the vital air*;) therefore (*in reverence to this principle*) "Thou shalt not eat the blood." MOSES.

10. *That the voice was no longer taken away by smells.* This is a curious fact, and shows the influence of the vital air in giving energy to the muscles of the larynx. I could mention, that a certain great actress upon inhaling the vital air found the power of her voice perceptibly increased; all her lower tones were in every part of the house distinctly heard, and a person was appointed by her purposely to ascertain this fact. The voice is always found stronger by the sea side.

11. When the blind boy recovered to sight was asked by the Jews about it, his answer was, "I know *before* I was blind, *now* I see." So of those who have been recovered by the VITAL AIR, *before* they were thought incurable, *now* they are cured. These attribute the *effect* to the *cause*: why should medical gentlemen then hesitate making an experience for themselves? There is no concealment of names, or of the remedies at the same time employed, or any thing above plain reasoning. Mr. Watt of Birmingham has kindly contrived a simple apparatus for making the vital and other airs*; the process is easy†. A pneumatic apparatus for breathing the airs is cheap‡. Artificial air may be conveyed to any part of the world in

* This costs, to fabricate the airs, three pounds.

† This is described by me, with a figure of the apparatus by Mr. Lowry, vol. i. page 347, of my Philosophy of Medicine. A pound of manganese will yield 20 quarts of vital air, and a hundred weight of manganese is sold in London for 18 shillings.

‡ A tin apparatus costs about thirty shillings.

barrels,

barrels, and bottled off as wanted, like wine; the shrine of Diana is not in danger, as other remedies may and should be exhibited at the same time: it does not interfere with them; but, on the contrary, gives them power, whereas without it they have no basis to act on*: in the exhibition of the pneumatic remedy there is neither danger if used with precaution, nor disgrace in trial; the harvest of discovery is wide, the only want is harvest-men.

I shall conclude with the following energetic appeal by Dr. Fourcroy † to the faculty at Paris on this subject:

"It cannot any longer," says that eminent chemist and philosopher, "be permitted to the physician to remain an inactive spectator of the power of gaseous bodies on the animal œconomy. No professional man, if he is at all interested in the advancement of his studies, if he is at all animated with a proper zeal for the progress of medicine, can any longer neglect to instruct himself in the conclusions of modern discoveries ‡. The cold statue-like insensibility of some, the affected indifference of others, the sneer uttered by this man, the irritated self-love of the other, the attachment of mankind for the doctrines of their fathers, the hatred of novelty, prejudices of every kind, all the mean passions which glide into society, playing their part on the theatre of civilized life, are to be found also in the career of science: the excesses which these have produced; the pleasantries which they give rise to; the sarcasms, or epigrams, with which they arm discourse; the ridicule which some have endeavoured to throw on the inventors; the epithet of innovators, of which they are prodigal; all this may

* The philosophy of the *balance* of *principles* (HYDROGEN and OXYGEN) in the body is a wonderful consideration for the contemplation of the man of science and the physician. As fire burns not so much from the fuel poured on, as from the air without, so has this external principle a greater effect on us than most people are aware of. The oxygen air, or vital air, acts as a bellows to the frame. The fire, which was once bad, being kindled up by the bellows, maintains afterwards its own blaze; so the *vis vitæ*, energy of life, being roused by the inhalation of *vital air*, afterwards keeps up its own natural inherent vigour. This comparison is made for such who will not receive facts as they are recorded, and will allow no virtue in *vital air*, as not being inhaled all day long. What would we say of the practitioner who was ordering bark every five minutes, or wine?

† This fine appeal is at the commencement of an essay which this distinguished chemist and physician read in the School of Medicine at Paris, on the medical virtues of oxygen; and the whole essay is given in the 28th volume of the Annals of Chemistry.

‡ A physician of considerable practice and estimation was lately consulted about the oxygen air; when he assured the patient that it did not at all apply to his case, as he was *already* too much filled with air (*flatulent*)!!

retard for some *few years* the progress of new ideas: but *truth* will overcome every obstacle; she cannot be frightened either by the clamours of envy, or the resistance of prejudice, or by the opposition of ignorance. She is the rock against which the impotent billows of human passions are broken. The cry yet vibrating in our ears against the circulation of the blood, the use of antimony, and the inoculation of the small-pox, could not hinder these discoveries from being finally established. It will turn out exactly the same with the new chemical discoveries, when applied to illustrate the functions of the animal œconomy."

"Its career so gloriously begun will never stop. I do not in the least hesitate to pronounce," he continues, "that *modern chemistry* has done more in a few years for *medicine*, than all the united labours of physicians in all the preceding ages. Only contemplate before this period what has been written on the motion of the blood, the blood itself, the nature of respiration, on animal heat, perspiration, digestion, and irritability; examine the subtle and ingenious hypotheses on these subjects, which appear at this time so degrading to the human reason; let even the immortal Haller be tried by this test, whose facts are so valuable, but whose hypotheses are altogether a mere mass of dark and futile reasonings; and we shall perceive how much we are indebted for the new lights thrown in by *chemistry*, and how much we have *yet to expect*." I remain, sir,

Your obedient humble servant,

ROBERT JOHN THORNTON.

P. S. If any medical gentleman would favour Dr. Thornton with the result of any trials with the factitious airs, they will be communicated to the Editor, for the philosophic world.

[*These Communications are intended to be continued.*]

XXX. *Mr.* CLOSE'S *Communication to the Board of Agriculture.*

[Concluded from our last volume, p. 60.]

An Account of the Instruments alluded to in this Essay.

THE instruments alluded to in this essay are, the common Suffolk plough without any wheel, worked by two horses and one man: this implement is too well known to require a description. Mr. Cooke's drill is an instrument which will deposit any quantity of seed per acre, at any given depth, with intervals of nine, eleven, or eighteen inches, two,

 three,

three, or four feet, with mathematical exactness; so that, wherever it should fail of success, the failure must not be attributed to a defect in the machine, but to the ignorance, or more frequently the obstinacy, of the person who works it. I have tried it with success in all soils: the utility was most apparent, I should without hesitation say, in strong clays and clayey loams. To obtain a fine tilth on the surface of the soil, in the spring of the year, when the plants are growing, is indispensably necessary. This, should an incrustation be formed by heavy rains and sudden droughts, may at all times be secured by the use of the fixed harrow, scarifiers, and hoes. The cultivator is another instrument for which the agricultural part of the nation is indebted to the ingenious and very superior mechanical knowledge of the same gentleman. It consists of a diagonal beam with seven narrow shares, and when used with these it is called a tillage scarifier: there are also five broad triangular shares, which may be fixed in the same beam, and with these it is termed a scuffler: the whole complete forms the cultivator. The scarifier may be used with three, four, or seven tines or teeth, according to the cleanness or foulness, the looseness or tenacity of the soil. It is calculated to pulverize the soil, and to cleanse it from quitch grass. In short, it in a great measure supersedes the necessity of the plough. In tilling land, the objects are to pulverize, to expose, to cleanse from weeds, and to ridge up for keeping the land dry and healthy, and for sowing. These are the desiderata, and all of these, except the last, may be most completely attained, at half the usual expense, by the use of the tillage scarifier. To secure a garden tilth on the fallows without much expense, scarify the stubbles twice, deep and well, soon after harvest; with half a ploughing lay the land on to three-feet ridges before Christmas; reverse them in February, and after barley-sowing sled or harrow down the tops; roll and scarify alternately until you have a very highly pulverized soil seven inches deep. Form your three-feet ridges, and drill your turnips. The scufflers, or broad shares, are to skim the land and destroy the surface weeds. The fixed harrow is also a most excellent instrument, and, without the use of any other implement, will prepare land that was ridged up before Christmas for any spring-corn crop. It pulverizes the surface which has been exposed to the frost four or five inches deep, without turning up the cold sterile land below that depth*.

* The scarifying harrow is admirably calculated to pulverize crops in an early stage of their growth, as it will pass in the nine- or eleven-inch intervals without injuring the plants.

All these instruments may be considered as appendages to the drill, all may be applied to the same axis and wheels; and as all of them are worked and directed by handles, by more or less pressure the depth may be regulated at pleasure. As I have been applied to by many gentlemen from various parts of the kingdom for information as to the number of these instruments, and horses requisite to cultivate any given quantity of land, I shall take this method of stating to the Board my ideas on this subject. For keeping one hundred acres of arable land in high tilth and regularly cropped, five horses would be necessary, two Suffolk ploughs, one cultivator complete, one beam and handles, with only the tillage scarifiers, one fixed harrow, and one drill with corn scarifiers, and a set of flat hoes. I should also recommend two pair of wheels with axis, independent of the drill wheels, which I could never use but for the purpose of drilling, except on very particular occasions. It is unnecessary to say, that one strong waggon and one light harvest ditto, with three dung carts, would be necessary; one common pair of harrows, and two rollers, (one very heavy, and only five feet long, to follow the scarifiers,) and one common roller for passing over the corn in the spring of the year. Though an instrument not alluded to in this essay, I should strongly recommend Mr. Cooke's chaff-cutter, with which I cut almost all the straw raised upon my farm, which is applied to the purposes of animal food, and by passing through the stomachs of the beasts is converted into strong manure; one load worth three such as is usually made in yards, which is little better than wet straw. I derive great advantage also from a boiler invented by Mr. Cooke, which saves two-thirds of the fuel. By a tub over this boiler I steam seven four-bushel bags of potatoes or turnips with three pecks of coals. A thrashing machine, capable of being removed easily from one barn to another, appears to me a desideratum. The quantity of corn which might be saved by a complete machine of this sort would be of real national importance. Though the cultivator and fixed harrow may be considered as appendages to the drill, yet they are applicable to the broad-cast husbandry, and would save, if generally used, more than half the common expense for tillage.

Upon Drilling and Horse-hoeing.

Drilling is an operation which requires but very little attention. On this subject I shall only state the depth at which the seed should be deposited, the quantity per acre, and the width of the intervals, which appears to me, after fourteen or fifteen years practice, to be the most eligible. Many

Many crops of wheat have been greatly injured by depositing the seed too deep, especially in wet soils: a little attention to the principles of vegetation will demonstrate this. Nature is uniform in her operations; and whether the seed be put into the earth at four, three, two, or one inch below the surface, the roots, which are to carry the corn to perfection, will be formed at one precise depth and very near the surface. Wheat has two sets of roots, which may be termed the *seminal* and *coronal:* the first come from the grain, and the others are formed in the spring from the crown of the plant; they are united by a tube of communication, by which the plant is supported until the coronal roots are formed. By depositing the seed too deep, it frequently perishes by a superabundance of moisture; and certainly from its increased length this little thread-like tube is more liable to be cut asunder by the red or wire-worm. This theory is confirmed by practical observation; for in the spring of the year I have frequently taken up plants of broad-cast wheat, and always found that those which appeared most luxuriant had been covered by not more than an inch of mould, and those which had fallen into the furrows, and were three or four inches below the surface, had a very sickly appearance, with a small blade of a bad colour, and making no efforts for tillering. From this theory, strengthened and confirmed by observation, I conclude that an inch is the best depth for depositing the seed of wheat. The same observations will apply to oats, barley, and rye, all plants which form their coronal roots near the surface. I should recommend wheat, barley, oats, vetches, and rye, on soils not very wet, to be drilled on five- or ten-feet ridges, in equidistant rows of one foot. Beans, pease, and turnips, on three-feet ridges, two rows on a ridge, nine inches from row to row, with intervals of twenty-seven inches. Lands in high tilth, and on five-feet ridges, will require only three pecks of seed wheat or rye; five pecks of oats, barley or vetches, and one bushel of beans or pease, per acre, and half a pound of turnip-seed on the three-feet ridges, varying a peck an acre, according to the goodness of the seed and the richness of the soil. For scarifying, and horse-hoeing, some attention and judgment will be requisite. No corn should be scarified until the spring of the year. Pulverize the surface by passing the fixed harrow across the wheat previous to scarifying, to break the incrustation on the surface, lest the scarifiers should throw large flakes of earth over the rows of corn. After this operation, pass the scarifiers through, about an inch below the surface, returning in the same track, as deep as the land was ploughed; then roll with a heavy roller, which will give the whole land a concussion, and pulverize it six inches below the surface, allowing the tender roots room to expand in a fine bed of vegetable food. In short, care must be taken not to throw any earth up to the plants in this early stage; for, as nature always forms the coronal roots at the most advantageous depth below the surface of the soil, by throwing earth to the plants you impede her operations, and she will, by a sort of vegetable instinct, be obliged to form fresh coronal roots. I have known the progress of vegetation much retarded for want of this precaution; and nature has laboured so steadily to rectify the errors of man, that sometimes three sets of coronal roots have been formed, those beneath dying as the joint at the proper distance below the surface sends out new ones. When these operations are performed with judgment, the advantages are beyond calculation. The scarifiers and roller moving all the soil, without earthing up, give the roots room to expand, and assist the operations of nature: the tillering will be greatly increased *, and all the offsets ripen at the same time; and by earthing up the plants when the ears are risen six or seven inches above the surface, a plump and fine sample will be secured, and no more offsets can be formed. Rolling will be injurious when the ears are risen above the surface. These precautions are only necessary with wheat, and the white corn crops with coronal roots: with pease, beans, vetches, and all tap-rooted plants, no injury can be sustained for want of such attention. Never attempt to perform any of these operations until the land be dry; and be sure to keep a fine tilth on the surface of your lands four or five inches deep in the spring, whilst the plants are in a young and growing state. Were this new system universally adopted, the saving in seed corn would be of the utmost national consequence; certainly not less than eight million bushels of rye, three million bushels of barley, four million of oats, and one million of pease and beans. This statement does not amount to the full quantity which might be saved. This last autumn more than a sixth part of the scanty crop of wheat was thrown into the ground for seed. Such are the times, that the noblemen and gentlemen of landed property must considerably increase their rents, or they cannot hold their situations in the scale of society. To answer this de-

* I have counted one hundred and one stems of barley, all likely to arrive at perfection, from one seed.

mand,

mand, and the additional expenses upon every agricultural instrument, the rise of poor rates and the high price of labour, the farmer must receive at least one-third more from the produce of his farm. Should this be effected by such an additional price on the articles of necessary consumption, the wages of our manufacturers must be such as to oblige us to give up all competition in foreign markets, and our trade will decline. But I am thoroughly convinced that the landlord may enjoy his increased rent, and the farmer not only eat the fruits of his own labours, but acquire a competency for his family, by an improved method of husbandry, without any increase on the average price of the necessaries of life, taken for ten years previous to these seasons of dearth. These, my lord, you and the Board will feel to be subjects of the utmost national importance. In a letter to the Bath society I affirmed that the saving of seed corn by the general use of drilling would amount to five million pounds sterling annually; and that, by the increase of crop, and a judicious application of that crop, particularly of the straw, which when good is preferable to bad or indifferent hay, an addition to the produce of the lands now in cultivation might be made to amount, with the seed corn saved, to fifteen million pounds sterling: and so careful was I not to exceed the bounds of truth, that I am fully persuaded my calculation is below what might be effected, by one-half. May the laudable exertions of such patriotic noblemen as yourself, and your intelligent predecessor lord Somerville, be crowned with success! and may our agricultural improvements and internal resources keep pace with the increasing demands which the necessities of the times must occasion!

A comparative Estimate between Grass and Arable Lands.

Though I have demonstrated, by actual and extensive experiments, the advantages resulting from a judicious mode of converting lands exhausted by tillage into meadow and pasture, yet I do not allow that lands under tillage for any number of years must necessarily be in such an exhausted state as to make this plan requisite: on the contrary, I am fully persuaded that all lands capable of cultivation will, if well tilled, fairly cropped and dressed, be in a progressive state of improvement, and not only produce a better rent to the landlord, and pay twenty times as much to the productive labourers, but also yield a much greater profit to the occupier than the same number of acres in grass. Fine rich

 meadows

meadows on the banks of rivers liable to be flooded, and such as can be irrigated, no one would think of converting into tillage; but all grass lands from ten to thirty shillings per acre rent, I should wish to see tilled by judicious agriculturists. It is not necessary to give validity to my opinion by an exact detail of the produce of grass lands and arable lands of the value to which I have confined my assertion. If grass lands let for ten shillings per acre yield the gross sum, on an average of years, of seventeen shillings, there is so very little expense upon them the tenant could not complain. If let for twenty shillings, thirty shillings may be the gross produce: if for thirty shillings, let forty-five shillings be the average. As rates and taxes advance with the rents, probably this may be a fair estimate. In a national point of view, how can these sums be equivalent to those which must be produced from arable land, when every agriculturist is convinced that the expense of labour only on every acre of land well cultivated will amount to more than three pounds by the time its produce is carted to market? Whilst therefore these lands continue to pay the farmer for his additional trouble, skill, and capital, it is evident the national produce must be increased. But some gentlemen apprehend such a preference to the plough would increase the price of butchers meat to an alarming height. To this Mr. Adam Smith would answer, that wheat will ultimately regulate the price of all the necessaries of life. I have full faith in the conclusion drawn by this able writer; but, as a farmer, I can obviate this objection without resorting to his authority. Take this course of husbandry on lands worth thirty shillings per acre, turnips, or cabbages, oats, clover, and wheat. The eighth part of an acre of good turnips steamed, and with the liquor mixed with oat straw cut, will keep a full grown beast in good order six months. An acre of turnips, with the first crop of clover hay, will fatten two bullocks in the same time. The wheat straw, with the addition of one-eighth of an acre of turnips, will winter another beast; and the second cut of clover another. Thus the produce of straw, turnips, and clover, from the four acres, with the addition of one-fourth of an acre of turnips, will keep three beasts six months, and in the same time will fatten two bullocks of fifty score each. The produce of four acres of grass land let at thirty shillings per acre, would not send two fat bullocks to the market, and summer two. If I be correct in my statement, which I trust I am, the advantage in favour of the arable lands is more than the whole of the crops of

wheat

wheat and oats. Gentlemen and farmers who have not tried the effect of steaming the potatoe and turnip crops, and stalling all their cattle, may suppose my calculations erroneous; but my own practice confirms the theory. The quantity of rich manure raised will pay the additional labour. I am aware that the estimate of productive labour should not be restricted to the farm, and that the cattle or the sheep, after they are disposed of by the grazier, find employment for our manufacturers. But the advantages derived from this do not more than counterbalance the sums expended in manufacturing the produce of the arable lands after it is carted to market by the grower. The wheat is turned into various sorts of flour, starch, and hair powder; the barley into malt, beer, and spirits. I have therefore omitted the expense and profit on the produce both of grass and arable lands after it is disposed of by the farmer. My statements, from actual experiments, which constitute probably the most material part of this essay, your lordship and the Board may depend upon as correct. Should my theory on other subjects, of the utmost national importance, appear erroneous, it will be disregarded; but, I trust, with this indulgent conclusion, that the author's wishes to be of service to his country far outstrip his abilities; and that, however light and superficial his arguments, when weighed by the scale of superior knowledge and more extensive information, may appear, no one will doubt the purity of his intentions. I have the honour to be, &c.

THE AUTHOR.

To the Right Hon. Lord Carrington.

A Table showing at one View a Course of Crops, adapted to various Soils, for any Number of Years.

Clay	Turnips or Cabbages	Oats	Beans and Clover	Wheat	Turnips or Cabbages
Clayey Loams	Turnips or Cabbages	Oats	Clover	Wheat	Turnips or Cabbages
Rich Loams or Sandy Loams	Turnips and Potatoes	Barley	Clover	Wheat	Beans
	Beans	Barley	Pease	Wheat	Ad infinitum
	Turnips	Barley	Clover	Wheat	Potatoes
Peat Earth	Turnips	Barley	Clover	Wheat	Potatoes
Chalky substratum	Turnips	Barley	Clover	Wheat	Potatoes
Gravels	Turnips	Barley			
Light Lands	Turnips	Barley	Clover and Rye Grass	Clover and Rye Grass	

Days.

Days.	Occurrences.	Men.	Women.	Boys.	Horses.	How employed.
April 28, Monday	Delivered 18 bushels of oats out of the granary	12	9	6	10	Two men and four horses ploughing the first field in —— lane; 3 men and 6 horses scarifying and harrowing the further field; 2 men turning up dung at Hill Barn yard, at ——; 2 men cutting hay and straw, looking after oxen and cows at ditto; two men and 1 boy ditto at ——; 9 women cutting potatoes at ——; 2 boys keeping birds; 2 keeping cows; 1 boy pulling turnips; 1 man cutting coppice.
Tuesday						
Wednesday						
Thursday						
Friday						
Saturday						
Sunday						

XXXI. *Proceedings of Learned Societies.*

SOCIETY OF ARTS AND SCIENCES AT UTRECHT.

This society, in its sitting of June the 15th, proposed the following new prize question, to be answered before the 1st of October 1805:

As the last observations and experiments on electricity, the electric

electric eel and other fish of the like kind, as well as on the Galvanic power, seem to indicate a great similarity and coincidence in their nature, and at the same time a perceptible difference in their effects, the society requires a comparative view of these powers and effects, clearly explained and founded on experiments.

The prize question proposed in the year 1800, in regard to prevailing diseases, to which no answer has been given, is again proposed to be answered before the 1st of October 1805, with the usual prize:

"What are the reasons that the diseases which prevail at present among the inhabitants of Holland, at the different seasons of the year, are not so simple as in former times? that is, do they arise from sources of an infectious, bilious, or slimy kind, or from several other causes combined? and what is the best method of distinguishing with certainty, at the commencement of these diseases, which of the above causes has the ascendency? and what is the best method of cure?"

The following question was proposed in the year 1802, to be answered before the 1st of October 1804:

"What are the causes that Holland, about the beginning of the seventeenth century, was so much distinguished over other countries by the great number of its writers, original poets, and men of real learning; and at the same time produced in the course of that century so many celebrated painters, though the number of these has been gradually decreasing ever since? and what means of reviving the arts and sciences may be discovered by researches respecting these causes?"

Another question proposed in the year 1799 was repeated in 1802, with a double prize, to be answered before the 1st of October 1804:

"As the difference of opinions which prevail among physicians respecting the so called *pathologia humoralis*, has an influence not only on physiological researches, but on the state of the medical science, the society requires that the following points may be determined by more accurate examination;

"1st, What peculiar diseases and faults in the juices, represented by Gaubius as *vitia humorum absoluta* *, actually take place in the human body, and what are merely supposed?

"2d, Whether and how far such diseases arise from a

* Instit. Path. Med. § 268 to § 382.

peculiar

peculiar and original degeneration in the juices? and whether these diseases of the juices arise wholly from a change in the vital functions of the vessels and solids, or depend chiefly on them? In case this question be answered in the affirmative, Is the change of the juices which appears after the use of medicines, to be deduced chiefly from the action of these medicines on the juices and solids?"

The answers to these questions must be written in a strange hand, and furnished with a motto. The name must be written by the author himself in a sealed note. The papers may be written in Dutch, German, but not in German characters, English, French, or Latin, and must be transmitted, post paid, to the first secretary, professor Rossyn, or to the assistant secretary, Dr. Van Toulon, at Utrecht. They must remain the property of the society, and can be printed only by them.

XXXII. *Intelligence and Miscellaneous Articles.*

SCHERER'S JOURNAL.

PROFESSOR SCHERER of Berlin has been appointed professor at Dorpat, to which he has removed. His *Allgemeines Journal der Chemie* has therefore been closed with the sixtieth number. It is to be succeeded, however, by the following work, *Allgemeines Journal der Chemie*, edited by Hermbstadt, Klaproth, Richter, A.N. Scherer, and Gehlen. The first number has been already published, and contains Essays on the analysis and origin of meteoric stones and metallic masses, by Klaproth, Vauquelin, and Wrede: Essays on the prussic acid in vegetable substances, by Vauquelin and Bucholz; chemical apparatus; correspondence; intelligence. M. Gehlen has undertaken to be principal editor.

AEROSTATION.

Bologna, October 8th.

Yesterday the long announced aërial excursion of Count Zambeccari took place, and in a manner entirely new. The balloon, which was furnished with a lantern, and which the count imagined he should be able to direct by means of two wings applied to it, ascended in the night-time. Dr. Grassetti and M. Andreoli accompanied the aëronaut in the car. About one o'clock in the morning the balloon was seen at Castel-Franco, about twelve Italian miles from Bologna.

logna. Its further fate is not yet known. Count Zambeccari's intention was to make an aërial excursion from Bologna to Milan.

Venice, October 14.

I write this to communicate to you the particulars of a very singular and remarkable aërial voyage. Count Zambeccari of Bologna, Dr. Grassetti of Rome, and M. Pascal Andreoli of Ancona, had some months ago prepared a large and strong air balloon, which they filled in that city on Friday the 7th. The filling, however, went on very slowly, and was not completed till midnight. Count Zambeccari and his companions were therefore desirous to put off their ascent till the next day: but the impatience and clamour of the populace obliged them to step into the car and suffer the balloon to ascend about three quarters of an hour after twelve, though with a resolution of descending as soon as they possibly could. The balloon rose with the utmost rapidity, and soon reached such a height, that Count Zambeccari and Dr. Grassetti, benumbed with cold and seized with a nausea, fell into a state of insensibility and deep sleep.

M. Andreoli, who alone retained the use of his senses, was not able to determine the height by his barometer, as the candle which he had in a lantern had gone out. About half an hour after two in the morning the balloon began to descend, and M. Andreoli soon observed distinctly the waves of the Adriatic sea dashing against the coast of Romagna. He therefore waked his companions, and endeavoured to kindle the light by a phosphoric match, but without success. At length, however, he obtained a light by a piece of flint and steel, and immediately after the balloon fell into the Adriatic, and with such violence that the water was dashed up to the height of several feet above them. The aërial travellers, drenched with sea water and benumbed with cold, threw out in great consternation a bag of sand, their instruments, and every thing they had with them in the car. By these means the balloon rose again rapidly: they then passed through three strata of clouds lying over each other; in consequence of which their clothes were covered with a thick rime; and on account of the rarity of the air in which they now were when raised above the clouds, they could scarcely hear each other speak. The moon illuminated the atmosphere under them, and had a blood-red colour. About three o'clock in the morning the balloon again descended, but slowly, and a violent gust of wind at south-west drove it across the Adriatic towards the

 coast

coast of Istria. The car several times touched the waves; and the travellers were carried in this manner over the surface of the sea for five hours, every moment in expectation of being swallowed up by it. At eight o'clock on Saturday morning they were about twenty Italian miles from the harbour of Veruda in Istria, when they were fortunately picked up and saved from destruction by Anthony Bazol, master of a large bark, who accidentally discovered them. The balloon was abandoned to the wind, which drove it towards the mountain of Opero, and in all probability it has been conveyed to Dalmatia. The aërial travellers, having their feet and hands quite benumbed, arrived in the above bark in the harbour of Pola, where they remained four days to recover from their fatigue. This morning, at eight o'clock, they arrived here, and gave the above account of their expedition. Their journey from the coast of Romagna to Istria was about twenty German miles. Had they not fallen in with the before-mentioned master of a bark, they no doubt must have been buried in the waves. The aërial travellers were received here with great hospitality; but they seem to have no desire of undertaking another aërial excursion at midnight.

Genoa, October 24.

According to further accounts from Venice, one of the aëronauts, whose misfortune we already have announced, count Zambeccari, has altogether lost the use of his hands. It appears that these philosophers ascended to a greater height than any person ever did. Before Bazol observed them and saved their lives, they were seen by a boatman of Lorrono in Istria; but as he thought he saw the devil in the air surrounded by a globe of fire, he rowed from them as fast as possible, and left them exposed to their fate.

Bologna, October 27.

Private letters from Venice represent the present state of the unfortunate aëronaut, count Zambeccari, as very melancholy. It has already been found necessary to amputate his frozen fingers. His two companions, Dr. Grassetti and M. Andreoli, have come off better: the former has arrived at this place. The other two are at Venice. The journey they performed amounts to 30 German miles. When they arrived at Pola, they were immediately blooded by a surgeon, and their hands and feet were so much swelled that it was found necessary to make incisions in the skin.

Extract

Extract of a Letter from M. Garnerin.

Moscow, October 5.

My thirty-fifth ascent took place the day before yesterday during calm weather, the wind being at north-west. I ascended at five o'clock with my countryman, M. Aubert, who suffered considerably in his ears by the rarefaction of the air. I saw for the first time an image of my balloon formed in the clouds in very bright prismatic colours. We descended at six o'clock at the country seat of prince Viasemsky. Next morning I made another ascent at eight o'clock. I passed through different regions of the air, and rose to the height of more than 4000 toises, without experiencing any other inconvenience than a cold of 4° Reaumur (41° Fahr.). I galvanised myself, and observed flashes of light. I discharged a musket twice: the report appeared to be fainter than at the earth. I should have continued my voyage and observations, had it not been for the folly of a hunter, who fired his piece loaded with shot at my balloon at the moment when I was hovering over a wood. I was therefore obliged to descend, and at the same time to be on my guard against the peasants, who, seeing me descend from the clouds, frequently crossed themselves with profound inclinations, and approached me and my balloon slowly. A note written in the Russian language, which I threw down, enabled them to form some idea of the prodigy. Count Solticoff advised me to this measure; which succeeded.

METEOROLOGY.

An uncommonly luminous meteor was seen on Sunday, the 13th of November, about forty minutes past eight o'clock at night. To some it appeared of an oval form, and as followed by sparks which gave it somewhat the appearance of having a tail. To others it seemed a wavy line of light, which burst and divided itself into several small balls of fire before it disappeared. It emitted a very vivid light, by which the most minute objects could be distinguished, and moved with great velocity in a north-westerly direction. It was seen not only all round the metropolis, but, by the accounts that have reached us, over the greater part of England, and nearly at the same instant of time; which proves that its height was considerable. It was succeeded, after an interval of a few seconds, by a peal of distant thunder.

GEOGRAPHY.

A letter from Madrid, dated October 10, states, that orders have been issued from the secretary of state's office in regard to a general map of Spain, the plan of which was formed some time ago, and actually begun, but interrupted several times in consequence of various unforeseen circumstances. This plan, however, is now about to be carried into execution, having been intrusted to the society of geographers established some years ago under the ministry of the Prince of Peace, and placed under the inspection of don Salvador de Ximenes, director of the observatory of Madrid, to whom the society is particularly indebted for its organization and progress. Two of its members, captains Ybarra and Sarasa, have already received their instructions; one to superintend the geometrical and the other the astronomical operations, by which the position of each place will be accurately laid down. A certain number of pupils distributed in different provinces, and always stationed in such a manner as to be under the inspection of the chiefs, will assist them in their labour; and eminent mineralogists and botanists have been appointed to collect information in regard to the productions of the different provinces, their population, the nature of the soil, &c. By these means the Spanish government will obtain a complete statistical account of its wide dominions, and be better enabled to introduce such improvements as the present state of the country may require.

LONGEVITY.

The following extraordinary instance of longevity is given in a late German journal:—" There is now living near Polosk, on the frontiers of Livonia, a Russian who served under Gustavus Adolphus, king of Sweden. He was present at the battle of Pultawa in 1709, at which time he was eighty-six years of age. At the age of ninety-three he entered into the married state, and had children. The family of this patriarch consists of 186 individuals, who reside together in a village which comprehends ten houses. The oldest of his grandchildren is 102; the age of the next is not less than a century. This old man still enjoys a perfect state of health, though now 180."

ERRATUM.—In our last Number, page 95, last line of Note, for *either* read *ether*.

XXXIII. *On Gems. By* W. H. Pepys *jun. Esq. P. R. I. Member of the Askesian Society. Read in the Session* 1802-3 *.

This class of bodies has engaged the attention of all ranks of society from the earliest ages: their beauty, and property of decomposing light, producing the variegated colours of the prism and the rainbow, will always procure them a place in the most splendid and sumptuous displays of human magnificence.

To the philosopher they open a wide and extended field in his inquiries into the secret works of nature; and the cabinet of the mineralogist becomes more interesting and enlivened by their presence.

We find the greater part of them were used in the costume of the priests of the temple:—"And they set in it (the breast-plate of the priest) four rows of stones: the first was a sardius, a topaz, and a carbuncle,—this was the first row; and the second row an emerald, a sapphire, and a diamond; and the third row a ligure, an agate, and an amethyst; and the fourth row a beryl, an onyx, and a jasper; and they were inclosed in ouches (or foils) of gold in their inclosings."

Those which are most esteemed, and reckoned the most valuable, with the moderns, are:

1. The diamond.	6. The hyacinth.
2. The ruby.	7. The beryl.
3. The sapphire.	8. The amethyst.
4. The emerald.	9. The garnet.
5. The topaz.	10. The chrysolite.

1. The diamond, formerly classed with the siliceous genus, is now acknowledged to belong to the inflammable or carbonaceous: it has the greatest degree of transparency, and is the most beautiful and most brilliant of all the precious stones. It produces only single refraction, but its refractive powers are stronger than that of any other body; it separates the colours better; and this is the cause why it sparkles with so much lustre, especially in the light of the sun. An artificial gem of glass does not reflect the light from its hinder surface until that surface is inclined in an angle of 41 degrees, while the property of the diamond is such as to occasion all the light to be reflected, which falls on

* Copied, by permission, from the Records of the Society.

on any of its interior surfaces at a greater angle of incidence than 24¼ degrees. The diamond, therefore, will not only throw back all the light which an artificial gem would reflect, but likewise one-half as much more, which, falling between the angles of 41 degrees and 24¼, would have been suffered to pass through by the false gem.

There are two kinds of the diamond, the Oriental and the Brasilian, which differ only in the form of their crystallization.

The Oriental diamond crystallizes in octaëdra, composed of two pyramids having four equilateral triangular faces, a little convex, united by their bases. This form is sometimes modified into a figure of twenty-four faces, and sometimes even of forty-eight, all triangular and somewhat convex. The specific gravity of the Oriental diamond is 3·5212.

The Brasilian diamond crystallizes in dodecaëdra, the twelve faces of which are rhombs a little convex. The specific gravity of this stone is 3·4444.

The Oriental diamonds are found in the kingdoms of Golconda, Visapour, Bengal, and the island of Borneo. There are four mines, or rather two mines and two rivers, whence diamonds are drawn. The mines are: 1st, That of Raolconda, in the province of Carnatica, five leagues from Golconda and eight or nine from Visapour: it has been discovered about 300 years. 2d, That of Gani or Colour, lying eastward of Golconda: it was discovered about 200 years ago by a peasant, who digging in the ground found a natural fragment weighing 25 carats. 3d, That of Somelpour, or rather of Gaoul, that being the name of the river in the sand of which these stones are found: this is the most antient of them all. Lastly, The fourth mine, or rather the second river, is that of Succudan, in the island of Borneo.

The diamonds from Raolconda are found in a rocky soil, through which run several small veins of half an inch, or sometimes an inch, broad, out of which the miners, with a hooked instrument, draw the sand in which the diamonds are. When a sufficient quantity of the earth is obtained, they wash it several times to separate the stones therefrom. These men work quite naked, except a cloth drawn round the middle; and besides this precaution, they have likewise inspectors to prevent their concealing of stones, which they frequently do by swallowing them.

In the mine of Gani, or Colour, was found the famous diamond of Aureng Zeb, the great mogul, which, before it was cut, weighed 793 carats. The miners dig 12 or 14 feet deep, and till such time as they find water, which serves them to wash the earth obtained: when well washed and dried, they sift it in a kind of open sieve, and search it well for the diamonds it may contain. These people work also naked, with inspectors over them.

The diamonds from the river Gaoul and Succudan are obtained by damming or stopping a part of the rivers, which they empty of their water; then taking up the sand, they sift it and search it for the diamonds.

The province of Brasil, which produces diamonds, is situated inland between $22\frac{1}{2}$ and 16 degrees of south latitude: its circumference is near 670 leagues. This province is divided into four districts. The diamonds are found chiefly in the last, called Sero Dosrio, or Cold Mountain. The whole of this province is rich in the ores of iron, antimony, zinc, tin, silver, and gold.

The mountains are the true matrix of the diamond; but as the work in the beds of rivers and on their banks is less tedious, can be conducted on a larger scale, and affords larger diamonds, they abandoned the mountain, and formed great establishments in the river of Toucanbirnen, which flows through the valley, and is near ninety leagues in length. It was found, on examination and digging, that the whole surface of the ground immediately beneath the vegetable stratum contained more or less of diamonds disseminated and attached to a matrix, ferruginous and compact in various degrees, but never in veins.

These works are not carried on by the Portuguese government, but are farmed to certain individuals, who are bound by contract not to employ above a stipulated number of slaves upon these districts, as before this condition the quantity of diamonds brought into the market considerably lowered their value.

In the choice of rough diamonds great care should be taken in regard to their colour, their being free from extraneous matter, and their shape.

The most perfect are crystalline, and resembling a drop of clear spring water, in the middle of which you will perceive a strong light playing with a great deal of spirit. If the coat be smooth and bright, with a little tincture of green in it, it is not the worse, and seldom proves bad: but if there be a mixture of yellow with green, then beware of it; it is a soft greasy stone, and will prove bad.

If a stone has a rough coat that you can hardly see through it, and the coat be white, and look as if it was rough by art, and clear of flaws or veins, and no blemish

N 2 cast

cast in the body of the stone, which may be discovered by holding it against the light, the stone will prove good.

It often happens that a stone shall appear of a reddish hue on the outward coat, not unlike the colour of rusty iron, yet by looking through it against the light you may observe the heart of the stone to be white; and if there be any black spots, or flaws, or veins in it, which by a true eye may be discovered, although the coat of the stone be opake, such stones are generally good.

If a diamond appear of a greenish bright coat resembling a piece of green glass inclining to black, it generally proves hard, and seldom bad: such stones have been known to be of the first water: but if any tincture of yellow seems to run with it, you may depend upon its being a bad stone.

All stones of a milky coat, whether the coat be bright or dull, if ever so little inclining to the bluish cast, are naturally soft, and in danger of being flawed in the cutting; and though they should have the good fortune to escape, yet they will prove dead and milky.

All diamonds of a cinnamon-coloured coat are very dubious; but if of a bright, mixt with a little green, then they are certainly bad, and are accounted amongst the worst of colours.

The greatest care must be taken to avoid beamy stones; and this requires greater skill and practice than many jewellers are equal to. By beamy stones are meant such as look fair to the eye, and yet are so full of veins to the centre that no art or labour can polish them; they run through several parts of the stone, and sometimes through all: when they appear on the outside they show themselves like protuberant excrescences, from whence run innumerable small veins obliquely crossing each other and shooting into the body of the stone: the stone itself will appear a very bright coat, and shining, and the veins looking like a very small polished steel needle; sometimes the knot of the veins will be in the centre, and fibres shoot outward, and the small ends terminate in the coat of the diamond: stones having these properties are difficultly cut, and will never take a good polish.

There are diamonds of almost all colours: some incline to rose colour, others to green, blue, brown, and black. Mr. Dutens saw a black diamond at Vienna in the collection of the prince of Lichtenstein.

The diamond becomes phosphoric by exposure to the solar rays, or by heating it red hot in a crucible on the fire. It

is

is electric when rubbed, and affects the electrometer *with the negative power.*

It was always supposed to be the most refractory and indestructible in the fire, till the experiments of d'Arcet and Macquer proved the contrary: but they supposed it to be volatilized; they had no idea of its combustion. D'Arcet and Macquer's experiments were made in consequence of an observation of Boyle's, that the diamond, when exposed to the action of a violent fire, emitted acrid vapours.

The emperor Francis the First caused diamonds and rubies to be exposed in crucibles to a reverberatory fire for 24 hours: the diamonds disappeared, but the rubies remained unaltered. These experiments he had again repeated at an expense of six thousand florins.

The grand duke of Tuscany had a series of experiments made with a large mirror and the concentrated rays from the sun upon the diamond, in which it was destroyed. It required a short period for its being completely volatilized, as it was then called.

Macquer seems latterly to have had another opinion, when he says, he observed the diamond dilated and swelled up, and that a blue flame was observable on its surface.

Lavoisier and Cadet proved the combustion of the diamond, and that it ceased as soon as the oxygen was destroyed; and that the stone only burnt in proportion to the oxygen present, like all other combustible substances. Lavoisier also observed that the gas produced during the combustion precipitated lime water, which effervesced upon the addition of an acid.

Sir Isaac Newton, from its great power of refracting the light, conjectured it was a combustible body: his words are, "it is probably an unctuous body coagulated."

Tennant exposed two grains and a half of small diamonds and a quarter of an ounce of nitre (nitrate of potash) in a gold tube, connected with a pneumatic apparatus, in a red heat for an hour and a half: the gas that was given out was from the decomposition of the nitre, with scarcely a trace of carbonic acid; but the residuum, upon careful examination, had been partly converted into carbonate of potash; the diamonds had completely disappeared. Upon analysing the residuum, as much carbonic acid gas was obtained as would occupy the space of 10·1 ounces of water. Upon repeating this experiment with another weight of diamonds, he found the proportions as 10·3 of carbonic acid to two grains and a half of diamond: two grains and a half of charcoal would have given ten of carbonic acid.

 That

That oxygen gas assists materially in the combustion of the diamond, has been proved by some experiments made by the London Philosophical Society *. These experiments were suggested by Mr. Francillon, who supplied the stones for that purpose from his cabinet.

A diamond weighing $\frac{15}{64}$ths of a carat was exposed to the action of a stream of oxygen gas upon ignited charcoal: in one minute and fifty seconds it was found to have lost $\frac{11}{15}$ths of its original weight; it had also lost its figure, transparency, and polish. The unconsumed portion was cut after the experiment, and exhibited exactly the same lustre as before.

Several others were tried, with the same results: one, which was accidentally thrown from the charcoal, was seen distinctly burning during its passage through the air; the flame was of a blueish pearl colour, and nearly 3-4ths of an inch in length.

Guyton has proved, by a series of experiments on the diamond in oxygen gas, exposed to the action of the concentrated rays from the sun, that this substance is one of the purest forms of carbon; and that the other known classes of carbonaceous bodies are in intermediate states of oxygenation, which to a certain degree increases their combustibility, and power of decomposing the air.

The difference between the degrees of temperature necessary for the combustion of the diamond and charcoal are as 188 to 2765 of a Wedgwood's scale.

Charcoal set on fire in oxygen gas does itself maintain the temperature necessary for its combustion; but the combustion of the diamond ceases as soon as it is no longer maintained by the heat of the furnace, or the concentration of the solar rays.

The diamond requires for its complete combustion a much greater quantity of oxygen than charcoal does, and likewise produces more carbonic acid; for one part of charcoal absorbs 2·527 of oxygen, and produces 3·575 of carbonic acid. But one part of the diamond absorbs somewhat more than four of oxygen, and really produces five of carbonic acid.

The diamond is the pure state of carbon. Plumbago is its first state of oxidation; charcoal its second; gaseous oxide of carbon its third; and carbonic acid its completion.

Guyton, to prove the carbonaceous property of the diamond, converted soft iron into steel by cementation with

* See Philosophical Magazine, vol. viii.

it,

it. Mushet converted the iron into the same state without the diamond being present. Mackenzie supports Guyton, and denies that this could have been done without the presence of some carbonaceous matter in the crucibles. Mushet says that carbon penetrates the crucibles at these elevated temperatures: and thus the experiment rests.

The substance of diamonds is lamellated, consisting of very thin plates like those of talc, but extremely hard and intimately united, whose direction lapidaries must find out, not only to cleave the ill-shaped stones, but to cut and shape them properly. This last operation is performed by rubbing one diamond with another till it has acquired the shape; it is afterwards polished on a horizontal wheel of steel, employing the same powder that falls from their rubbings with common olive oil.

Jeffries calculates the mean value of diamonds by multiplying the square of their weight in carats by two pounds sterling, when the diamond is rough or uncut; but if it is already cut, the simple square of their weight must be multiplied by eight pounds sterling: this great difference in price proceeds from the great loss which a diamond suffers in being cut.

The two first of the following diamonds are uncut, the other six are cut diamonds:

1st. The greatest diamond that ever was known in the world is one belonging to the king of Portugal, which was found in Brasil; it is still uncut: it was of a larger size, but a piece was cleaved or broken off by the ignorant countryman who chanced to find this great gem, and tried its hardness by the stroke of a large hammer on an anvil.

This prodigious diamond weighs 1680 carats: if we employ to value it the general rule above mentioned, this great gem must be worth at least 5,644,800 pounds sterling, which are the product of 1680^2 by two pounds.

2d. The diamond which adorns the imperial sceptre of Russia, under the eagle at the top of it, weighs 779 carats, and is worth at least 4,854,728 pounds sterling, although it hardly cost 135,417 guineas. This diamond was one of the eyes of a Malabarian idol, named Scheringham. A French grenadier, who had deserted from the Indian service, contrived so well as to become one of the priests of that idol, from which he had the opportunity to steal its eye: he ran away to the English at Tricinapalli, and thence to Madras. A ship captain bought it of him for 20,000 rupees; afterward a Jew gave 18,000 pounds sterling for it: at last a Greek merchant, named Gregory Suf-

 fras,

fras, offered it to sale at Amsterdam, and the late prince Orloff bought it of him for the empress of Russia.

3d. The diamond of the great mogul is cut in rose, weighs $279\frac{9}{16}$ carats, and is worth 380,000 guineas.

4th. Another of the king of Portugal, which is cut, weighs 215 carats, is extremely fine, and worth at least 369,800 guineas.

5th. The diamond of the grand duke of Tuscany, now of the emperor of Germany, weighs $139\frac{1}{2}$ carats, and is valued at 109,520 guineas.

6th. The diamond of the late king of France, called the Pitt or Regent, weighs $136\frac{3}{4}$ carats: this gem is worth 208,333 guineas. It was sold by governor Pitt to the duke of Orleans for 135,000 pounds.

7th. The other diamond of the same monarch called the Grand Sancis, weighs 55 carats *, and cost 25,000 guineas.

8th. The diamond called the Pigot weighs $47\frac{5}{8}$ carats, valued at 20,000 guineas: parted with by the Pigot family by lottery in 1800.

The Ruby.

The ruby is a precious stone of a fine full red colour, electrical by friction, giving fire with steel; the most ponderous and the hardest of the precious stones after the diamond: it crystallizes in long hexaëdral pyramids applied base to base without an intermediate prism.

Its specific gravity is from 3·18 to 4·283. It is not vitrified in the fire without addition, and even resists the action of the burning mirror. Flame urged by oxygen gas easily fuses it. It does not lose its colour at the degree of heat which is sufficient to melt iron. The borate of soda and microcosmic salt fuse it, and give a transparent glass of a pale green colour: with the mineral or vegetable alkali the glass is opake, and of various colours.

A perfect ruby above $3\frac{1}{2}$ carats weight is more valuable than a diamond equally heavy. If it weighs one carat, it is worth 10 guineas; two carats, 40 guineas; three carats, 150 guineas; if six carats, above 1000 guineas.

There are 108 rubies in the throne of the great mogul, which from their weight are called carbuncles; they are from 100 to 200 carats each.

The varieties of the ruby are called the oriental ruby, the spinelle ruby, the balass ruby, and the rubicelle. The first is of a deep red colour; the second of a bright corn poppy-

* Chaptal says 106 carats.

flower

flower colour; the third a pale red inclining to violet; and the fourth of a reddish yellow colour.

Vauquelin's analysis of the oriental ruby gives

Alumine - - -	86·00
Magnesia - - -	8·50
Chromic acid - -	5·25
	99·75

The Sapphire.

The sapphire is a precious stone of a transparent blue colour, and is the hardest next the ruby: the oriental sapphire and that of Puy have the form of two very long hexaëdral pyramids, joined, and opposed base to base without the interposition of a prism. Sapphires have been found of a rhomboidal form.

The specific gravity of the sapphire of Puy is in proportion to water as 40·769 to 10·000; that of the white sapphire is as 39·911; and the Brasilian as 31·307.

The sapphires from d'Expaily have a green tinge, and change in the fire in the same manner as those of the Brasils; whereas the oriental sapphire is not altered in our furnaces. The action of oxygen gas upon this stone gives a perfect white opake globule.

A good sapphire of ten carats is valued at 50 guineas; if it weigh twenty carats, its value is 200 guineas; but under ten carats it may be valued by multiplying the carat at ten shillings and sixpence into the square of its weight.

They are found, as well as rubies, in the East Indies, Brasil, Hungary, Silesia, Bohemia, and also in Siberia.

The analysis by Bergman and by Klaproth:

Bergman.		Klaproth.	
Silex - -	35	Alumine - -	98·50
Alumine -	58	Oxide of iron -	1·00
Lime -	5	Lime - - -	50
Iron - -	2		100
	100		

The Emerald.

The emerald is a gem of a fine, full, transparent green colour, electrical by friction. It is next in hardness after the topaz. The Peruvian emerald crystallizes in hexaëdral prisms truncated, flat at each extremity. Crystals of emerald

rald are frequently found inserted in the gangues of quartz, and even of fluor.

Its specific gravity compared with that of water is as 27·755 to 10·000.

The emeralds which come from America are called occidental: Peru and the Brasils afford the most beautiful.

The emerald melted in the furnace of Pott: it was speedily fused by the mirror: oxygen gas fuses it in a white milky bubble tinged with green.

The emerald analysed by Vauquelin afforded

Silex - - -	64·60
Alumine - -	14·00
Glucine - -	13·00
Chrome - -	3·50
Lime - - -	2·56
	94·66

The Topaz.

The topaz is a precious stone of a fine golden yellow colour. The oriental topaz takes the octaëdral form: the Brasilian crystallizes in rhomboidal tetraëdral prisms, grooved longitudinally: they are terminated by two tetraëdral pyramids with smooth triangular faces. The Saxon topaz exhibits long suboctaëdral prisms, terminated by hexaëdral pyramids more or less terminated at their base.

The specific gravity of the oriental is as 40·106 to 10·000; that of the Brasilian 35·365 to 10·000.

The topaz is not fused in the porcelain furnace; but both the Oriental and the Brasilian are fused, and lose their colour for a white opake mass, by oxgen gas.

The topaz analysed by Vauquelin gave

Silex - - -	68
Alumine - -	31
	99

The Hyacinth.

The hyacinth is a stone of a fine reddish yellow colour; it is usually crystallized in the form of a rectangular tetraëdral prism, terminated by two quadrangular pyramids with rhombic faces.

Its specific gravity compared with water is as 36·873 to 10·000.

It

It loses its colour in the fire: with oxygen gas it is fused into a globule resembling bottle glass.

Hyacinths are found in Poland, in Bohemia, in Saxony, Velay, &c.

Modern analysis has classed the jargon of Ceylon with this stone, the analysis of which is given by Klaproth and Vauquelin:

Hyacinth.		Jargon of Ceylon.	
Zirconia - -	68·0	Zirconia -	70·0
Silex - - -	31·5	Silex - -	25·0
Nickel and iron	0·5	Oxide of iron	0·5
	100·0		95·5

The Beryl, or Aqua Marina,

Is a precious stone of a blueish green colour: the Saxon as well as the Siberian crystallize in hexaëdral, striated, truncated prisms of a lamellated texture. This stone is also found at Baltimore, in America.

Its specific gravity is 35·489 for the oriental, 27·227 for the occidental.

It yielded, upon analysis by Vauquelin,

Silex - - -	69
Alumine - -	13
Glucine - - -	16
Oxide of iron - -	1·5
	99·5

The violet-coloured amethyst, the crimson garnet, the pale blue water sapphire, the girasol, the jacinth, and the chrysolite, do not offer us any thing new, considered in a chemical point of view: they are also stones of an inferior value to those we have spoken of, which by their lustre and superior hardness have obtained the first place in the cabinet of the virtuoso.

XXXIV. *Of*

XXXIV. *Of the general Relation between the Specific Gravities and the Strengths and Values of Spirituous Liquors, and the Circumstances by which the former are influenced.*

[Continued from vol. xvi. p. 312.]

Of Mr. Gilpin's Tables.

§ 28. It appears that the importance of the subject of the present essay has long since been universally acknowledged, and that it has accordingly at various periods attracted the attention of the legislature. Shortly after the passing the act 27 Geo. III. c. 31, already mentioned in § 18, an application was made by government to sir Joseph Banks, bart., president of the Royal Society, to put the matter in such a train of investigation as might lead to the ascertaining of the actual relative values of spirituous liquors, and the consequent just appreciation of the duties to be paid in respect of them. Sir Charles Blagden, who was at that time the secretary of that learned body, was accordingly requested to assist in this business, and draw up a report of the results of such experiments as should have been made with regard to the subject, and which Dr. Dollfuss, a Swiss gentleman, at that time in London, was engaged to perform. He accordingly tried a vast number of experiments for ascertaining the effects of combination and temperature under all possible circumstances on the specific gravities of spirituous liquors. The general course of experiments was made with malt spirit; but he tried also several comparative ones with such as had been rectified from rum and brandy, and found no other difference than such as might be fairly ascribed to unavoidable errors.

Upon examining the whole series of Dr. Dolfuss's results, it was afterwards perceived, however, that though the numbers as tabulated agreed tolerably well upon the whole, yet there was in some places found a sufficient degree of irregularity in the progression of the first differences to render it adviseable to repeat several of the experiments; and Dr. Dollfuss leaving England about that time, the business of this repetition was entrusted to Mr. Gilpin, clerk of the Royal Society. This gentleman had already participated in the work, by assisting Dr. Dollfuss in the former experiments, particularly in the very nice operation of weighing the mixtures; his skill, accuracy, and patience, being well known to the society in general. Mr. Gilpin became interested in the business; one experiment led on to another, and

and he was at length induced to go through the whole series anew. Of the results of these experiments sir Charles Blagden laid a report before the society, which was read the 22d of April 1790; and afterwards a supplementary report, which was read the 28th of June 1792. To state every thing of importance which they contain, they must be copied verbatim: we shall however endeavour, with as much perspicuity as we can, to trace the outlines of their contents.

The spirit at first employed by Mr. Gilpin was furnished him by Dr. Dollfuss, under whose inspection it had been rectified from rum supplied by government: its specific gravity at 60° was 825·14. That which he afterwards used was distilled for the purpose by Mr. Schmeisser, who brought some of it to the specific gravity of 817; and its agreement with the former with respect to its specific gravity, when diluted and subjected to change of temperature, was tried before it was employed in the experiments. The spirit, however, which they thought proper to assume as what appeared to them a convenient standard of value, was that which has the specific gravity of 825 at 60°; and the stronger alcohol which they used was therefore previously diluted with distilled water to that degree of strength.

The mixtures were made by weight, as the only accurate method of fixing the proportions. It was conceived that, in fluids of such very unequal expansions by heat as water and alcohol, if measures had been employed, it would not only have been necessary to make a different mixture for every different degree of heat, but the proportions of the masses would have been sensibly irregular; and the object in view was to determine the real quantity of spirit in any given mixture, abstracting the consideration of its temperature. Another principal consideration was, that with a very nice balance, such as was employed on this occasion, quantities would be determined to much greater exactness by weight than by any practicable way of measurement: the proportions were therefore always taken by weight. A phial being provided of such a size as that it should be nearly filled with the mixture, was made perfectly clean and dry; and, being counterpoised, as much of the pure spirit or of distilled water as appeared necessary was poured into it. The weight of this spirit or water was then ascertained, and the water or spirit required to make a mixture of the intended proportions was calculated. This quantity of fluid was then added with all the necessary care, the last portions being

4 put

put in by means of a well known instrument, which is composed of a small dish terminating in a tube drawn to a fine point: the top of the dish being covered with the thumb, the liquor in it is prevented from running out through the tube by the pressure of the atmosphere, but instantly begins to issue by drops, or in a very small stream, upon raising the thumb. The liquor lastly added being thus introduced into the phial till it exactly counterpoised the weight, which, having been previously computed, was put into the opposite scale, the phial was shaken, and then well stopped with its glass stopple, over which leather was tied very tight to prevent evaporation.

In this manner 100 parts by weight of spirit of the last-mentioned specific gravity of 825 at 60° being first put into the bottle, five parts by weight of distilled water were added, so as to form a compound in these proportions. In the next experiment 10 parts of water were added to 100 by weight of the spirit; in the next, 15; in the next, 20; and so on, increasing the weight of water by five parts in each, until 100 parts, or an equal weight of water, were added to the spirit. One hundred parts of water by weight were then taken as the invariable quantity, and 5, 10, 15, 20, &c., parts of the same spirit successively added, so as to produce 20 more weaker compounds; the last, or 100 to 100, being equal in strength to the last of the former series. No mixture was used till it had remained in the phial at least a month, for the full penetration to have taken place; and it was always well shaken before it was poured out to have its specific gravity tried.

The mode of performing this operation which these gentlemen preferred on this occasion, was that of actually weighing the liquor in a vessel which was capable of being at all times equally filled to a great degree of exactness, having first ascertained its weight when so filled with distilled water. It was a hollow glass ball, terminating in a neck, which was formed of a portion of barometer tube 1-4th of an inch in diameter, and 1½ inch long. That used by Dr. Dollfuss contained, when filled to a mark cut round the neck with a diamond for that purpose, 5300 grains of distilled water; but the one afterwards preferred by Mr. Gilpin was smaller, and contained when so filled only 2965 grains of the same fluid at 60°. The bottle itself weighed 916 grains, and with its silver cap 936. Its bulb was about 2·8 inches in diameter; and Mr. Gilpin found, that on filling it several times successively to the same mark at equal temperatures,

temperatures, and with every possible precaution, the quantities of fluid by weight did not appear to differ more than about $\frac{1}{15000}$th of the whole.

The bottle being filled nearly to the mark, the liquor was then brought to the required temperature, as ascertained by a thermometer made for the purpose by the late Mr. Ramsden, and graduated to fifths of a degree of Fahrenheit's scale, which was introduced through the neck into the liquor, its bulb being only ·22 of an inch in diameter. The neck was then filled quite up to the mark with more of the same liquor at the same degree of heat, and the whole weighed in that state. This was performed at every five degrees of temperature. The first temperature at which the liquor was weighed was 60°; it was then gradually cooled down to 55°, 50, 45, &c., and, lastly, to 30°; after which its temperature was in like manner raised to 100°, it being again weighed at every five degrees; and, lastly, it was again cooled down to 60°, at which temperature it was weighed a third time, and the process terminated with respect to that compound.

The balance was that of the society, made by the late Mr. Ramsden, and of which some account may be found in the 33d volume of the *Journal de Physique*. It was so exceedingly sensible, that the fiftieth part of a grain considerably deranged the position of the beam when loaded with the scales and their contents in these operations.

From this course of experiments Mr. Gilpin afterwards computed a voluminous set of tables, which are published in the Philosophical Transactions for the year 1794. They occupy 100 quarto pages closely printed; each page being divided in the middle, so as to be virtually extended to twice its length.

They are calculated for every degree of temperature, from 30° to 80° of Fahrenheit's thermometer, the results at each of which occupy two of these pages, the degree of heat standing at the head of each.

The left hand page contains those belonging to all compounds of 100 parts by weight of alcohol of the specific gravity of 825 at 60°, with every integral proportion of water also by weight from 0 to 100; and the right hand page those belonging to all compounds of 100 parts by weight of water, with every proportion of such alcohol also by weight from 0 to 100. These mixtures by weight constitute Column I in each table, which is entitled accordingly, on the left hand page, "Spirit and Water by Weight," and on the right hand page, "Water and Spirit by Weight."

Column

Column II, of all the tables, gives the specific gravities of the corresponding mixtures of spirit and water in Column I, compared with that of distilled water at 60°.

In Column III, 100 parts by measure of pure spirit, at the temperature marked on the top of every separate table, is assumed as the constant standard number to which the respective quantities of water by measure at the same temperature are to be proportioned in the next column. It is entitled "Spirit by Measure."

Column IV therefore, which is entitled "Water by Measure," contains the proportion of water to 100 measures of spirit, answering to the proportions by weight in the same horizontal line in Column I.

Column V shows the number of parts which the quantities of spirit and water contained in the third and fourth columns would measure when the mixture has been completed; that is, the bulk of the whole compound after the concentration or mutual penetration has fully taken place. It is entitled "Bulk of Mixture."

Column VI gives the effect of that concentration, or how much smaller the volume of the whole mixture is than it would be if there was no such principle as the mutual penetration. It is entitled "Diminution of Bulk."

Column VII shows the quantity of pure spirit by measure, at the temperature in the table, contained in 100 measures of the mixture laid down in the fifth column; and is entitled "Quantity of Spirit per Cent."

And, lastly, Column VIII, entitled "Decimal Multipliers," gives the proportion by measure of the beforementioned spirit, when reduced to 60° of heat, which is contained in any measure of each compound, if measured at the temperature expressed at the head of the table, pursuant to the idea suggested in sir Charles Blagden's report, that "the simplest and most equitable method of levying the duty on spirituous liquors would be to consider rectified spirit as the true and only exciseable matter."

The whole of these tables, therefore, contain, as appears by the foregoing account of them, no less than 80,000 deductions from experiment or calculation. It is difficult to speak with sufficient praise of this work: those only who have been in the habit of conducting similar operations are at all capable of appreciating labours like these.

§ 20. There seems to be no doubt of the authenticity of the experiments on which these tables are founded. They were repeated again and again with extreme care, with the most exquisite instruments, and with great knowledge of the

the subject; and, if it be not presumptuous in us to make the assertion, they stand strongly confirmed by our own experiments with respect to these matters.

It appears, therefore, at first sight, rather extraordinary that a work which does so much honour to the country should not be more generally known and understood than this is; and is, perhaps, only to be attributed to two causes.

Firstly, The arrangement of the tables is confessedly inconvenient: the entering them with the quantities of spirit and water by weight, (a proportion which is in no case the primary result of an experiment for the examination of a spirituous compound, and can only be deduced from calculation founded on its specific gravity and temperature), renders them ill adapted to general purposes.

Secondly, They are calculated on the supposition that the recommendation of sir Charles Blagden, to consider alcohol of the specific gravity of 825 at 60° as the true and only exciseable matter, would be adopted by the government; and though they therefore give the equivalent quantities of spirit of this kind to the respective quantities of the several compounds which are there mentioned, yet they do not give the equivalent quantities of the present proof.

Though it is with diffidence that the authors of this tract venture to differ from those gentlemen who have already displayed in the above work so intimate an acquaintance with the subject, yet they cannot help saying, that, from the opportunities which they have had of observing the practical course of this business, they have always rather been of opinion that it would be more convenient to fix on some strength which most frequently occurs in commerce as the standard for that of spirituous liquors in general, than one which considerably differs from that of those usually found in the market. It is a new race of men who can alone derive advantage from improvements founded on any considerable innovation in habits or modes of thinking; and they are therefore always accompanied with practical inconveniences and errors, which their authors did not consider them as likely to be productive of. The thing in itself is arbitrary: but so are our weights and measures, and monies of account; and yet what confusion should we create amongst busy, bustling, ignorant men, if we were to abolish our present system, and introduce new ones! It appears, therefore, to the writers of this essay, that the most convenient degree of strength which can be assumed as a standard of comparison will be one which does not differ exceedingly from that of which we have hitherto had some indefinite idea.

§ 30. It must be recollected, however, that this circumstance, though it may render these tables less convenient for practical use, by no means lessens their value, considered as a register of experimental results. It is true, they will not give an answer with respect to equivalent quantities of liquors of all strengths by mere inspection; but we can deduce from them, by calculation, any information respecting this subject which we may be desirous of obtaining.

The modes of doing this will, of course, easily occur to the mathematical reader: we shall, however, make no apology for presenting the public with rules and examples for finding from these tables a solution of almost every question which can occur in the course of practice, on the supposition that proof spirit is of the specific gravity of 920 at 60°, and that the mode of comparison employed is that recommended in § 26; and which, *mutatis mutandis*, will also be applicable to any other standard which may be adopted. They have been of some advantage to the authors in the course of their trade, and they will probably not be useless to society.

[To be continued.]

XXXV. *On the Preparation of Indian Ink; presenting an easy and expeditious Method of providing a Substitute possessing all its valuable Properties. By* THOMAS GILL, *Esq.*

To Mr. Tilloch.

SIR, London, Nov. 15, 1803.

IN a former communication * I mentioned that the Chinese mixed their water colours up with parchment size: I am now able to furnish you with a confirmation of that fact, in a discovery I made a few days since, of a composition possessing all the valuable properties of Indian ink, which is as follows:

Boil parchment slips, or cuttings of glove leather, in water until it forms a size, which on being suffered to

* See our last volume, p. 272.

cool becomes of the consistence of jelly *: then, having blackened an earthen plate or dish by holding it over the flame of a candle, mix up, with a camel hair pencil, the fine lamp-black thus obtained, with some of the above size, while the plate is still warm. This black requires no grinding, and produces an ink of the very same colour, which works as freely with the pencil, and is as perfectly transparent, as the best Indian ink: it possesses the advantage of furnishing artists, &c. with a substitute for that article, which may be prepared in situations where it might be difficult to obtain the ink itself.

If a larger quantity is required, lamp-black obtained from the smoke of oil, tallow, &c. (that sold in the shops being too coarse for the purpose,) may be formed into a mass with the size; to which a little spirituous extract of musk may be added, to give it the smell of Indian Ink. When it has obtained a proper consistence it may be pressed into moulds to form it into sticks, which, when dry, will be found to agree with the real Indian ink in its property of rubbing smoothly on the finger nail when wetted, and leaving the surface polished on becoming dry; and, in short, differing from it in one trifling circumstance only, namely, that the genuine Indian ink has a yellowish metallic lustre when dry, which may probably be owing to the mixture of some oily or saponaceous substance, possibly ox gall: this, however, is entirely needless.

I trust that we shall now be no more misled by the strange accounts most writers have given of the fabrication of Indian ink from the ink of the cuttle fish, burnt fish bones, burnt peach stones, extract of liquorice, &c. &c.; when it appears that the above two simple substances are fully sufficient to produce an ink possessing every good property that can be desired. I am, Sir,

Your most obedient servant,

THOMAS GILL.

* If it is thought too much trouble to prepare the parchment size, a solution of good common carpenter's glue, of the consistence described, may be employed in its stead.

XXXVI. *An*

XXXVI. *An Account of some Experiments and Observations on the constituent Parts of certain astringent Vegetables; and on their Operation in Tanning.* By HUMPHRY DAVY, *Esq. Professor of Chemistry in the Royal Institution.*

[Continued from p. 76.]

III. *Experiments and Observations on Catechu or Terra Japonica.*

THE extract called catechu is said to be obtained from the wood of a species of the *mimosa* *, which is found abundantly in India, by decoction and subsequent evaporation.

There are two kinds of this extract; one is sent from Bombay, the other from Bengal; and they differ from each other more in their external appearance than in their chemical composition. The extract from Bombay is of an uniform texture, and of a red brown tint, its specific gravity being generally about 1·39. The extract from Bengal is more friable, and less consistent; its colour is like that of chocolate externally, but, when broken, its fracture presents streaks of chocolate and of red brown. Its specific gravity is about 1·28. Their tastes are precisely similar, being astringent, but leaving in the mouth a sensation of sweetness. They do not deliquesce, or apparently change, by exposure to the air.

The discovery of the tanning powers of catechu is owing to the president of the Royal Society, who, concluding from its sensible properties that it contained tannin, furnished me, in December 1801, with a quantity for chemical examination.

In my first experiments, I found that the solutions of catechu copiously precipitated gelatine, and speedily tanned skin; and, in consequence, I began a particular investigation of their properties.

The strongest infusions and decoctions of the two different kinds of catechu do not sensibly differ in their nature, or in their composition. Their colour is deep red brown, and they communicate this tinge to paper; they slightly redden litmus paper; their taste is highly astringent, and they have no perceptible smell.

The strongest infusions that I could obtain from the two kinds of catechu, at 48° Fahrenheit, were of the same specific gravity, 1·057: but, by long decoction, I procured solutions

* See Kerr. Medical Observations, vol. v. p. 155.

lutions of 1·102, which gave, by evaporation, more than 1-6th of their weight of solid matter.

Five hundred grains of the strongest infusion of catechu from Bombay, furnished only 41 grains of solid matter: which, from analysis, appeared to consist of 34 grains of tannin, or matter precipitable by gelatine, and 7 grains that were chiefly a peculiar extractive matter, the properties of which will be hereafter described. The quantity of solid matter given by the strongest infusion of the Bengal catechu was the same, and there was no sensible difference in its composition. Portions of these solid matters, when incinerated, left a residuum which seemed to be calcareous; but it was too small in quantity to be accurately examined, and it could not have amounted to more than $\frac{1}{200}$th of their original weights.

The strongest infusions of catechu acted upon the acids and pure alkalis in a manner analogous to the infusion of galls. With the concentrated sulphuric and muriatic acids, they gave dense light fawn-coloured precipitates. With strong nitrous acid they effervesced; and lost their power of precipitating the solutions of isinglass, and the salts of iron. The pure alkalis entered into union with their tannin, so as to prevent it from being acted upon by gelatine.

When the solutions of lime, of strontia, or of barytes, were poured into the infusions, copious precipitates, of a shade of light brown, were formed; and the residual fluid assumed a paler tint of red, and was found to have lost its power of precipitating gelatine.

After lime had been boiled for some time with a portion of the infusion, it assumed a dull red colour. The liquor that passed from it through the filter had only a faint tint of red, did not act upon gelatine, and seemed to contain only a very small portion of vegetable matter. Pure magnesia, when heated with the infusion, acted upon it in an analogous manner; the magnesia became light red, and the residual fluid had only a very slight tinge of that colour. With carbonate of magnesia, the infusion became deeper in colour, and lost its power of precipitating gelatine; though it still gave, with oxygenated sulphate of iron, a light olive precipitate.

The carbonates of potash, of soda, and of ammonia, in their concentrated solutions, produced only a slight degree of turbidness in the infusion of catechu: they communicated to them a darker colour, and deprived them of the power of acting upon gelatine; though this power was restored by the addition of an acid.

 After

After the mixture of the solution of carbonate of potash, and the infusions had been exposed to the atmosphere for some hours, a brown crust was found to have formed upon its surface, and a slight precipitation had taken place.

The salts of alumine precipitated the infusions, but less copiously than they precipitate the infusion of galls. A similar effect was produced by nitrate of potash, sulphate of magnesia, prussiate of potash, and many other neutral salts.

The nitrate, or acetite, of lead, in concentrated solution, when poured into the infusion produced in it a dense light brown precipitate, which gave to the fluid a gelatinous appearance. After this effect, there was no free acid found in it; and both the tannin and the extractive matter seemed to have been carried down in union with a portion of the metallic salt.

The solution of muriate of tin acted upon the infusion of catechu in a manner similar to that in which it acts upon the infusion of galls.

The least oxygenated sulphate of iron produced no change in the infusion. With the most oxygenated sulphate it gave a dense black precipitate, which, when diffused upon paper, appeared rather more inclined to olive than the precipitate from galls.

The infusions were precipitated by the solution of albumen.

The precipitates by gelatine had all a pale tint of red brown, which became deeper when they were exposed to the air. The compound of gelatine and the tannin of the strongest infusions of catechu appeared, by estimation of the quantity of isinglass in the solutions used for their precipitation, to consist of about 41 parts of tannin and 59 of gelatine.

Of two pieces of calf-skin which weighed, when dry, 132 grains each, and which had been prepared for tanning, one was immersed in a large quantity of the infusion of catechu from Bengal, and the other in an equal portion of the infusion of that from Bombay. In less than a month they were found converted into leather. When freed from moisture, by long exposure in the sunshine, they were weighed. The first piece had gained about 34 grains, and the second piece $35\frac{1}{2}$ grains. The leather was of a much deeper colour than that tanned with galls, and on the upper surface was red brown. It was not acted on by hot or cold water; and its apparent strength was the same as that of similar leather tanned in the usual manner.

In

In examining the remainder of the infusions of catechu, in which skin had been converted into leather, I found in them much less extractive matter than I had reason to expect, from the comparative analysis of equal portions of the unaltered infusions made by solutions of gelatine. At first, I was inclined to suppose that the deficiency arose from the action of the atmosphere upon the extractive matter, by which a part of it was rendered insoluble. But, on considering that there had been very little precipitation in the process, I was led to adopt the supposition, that it had entered into union with the skin at the same time with the tannin; and this supposition was confirmed by new experiments.

Both kinds of catechu are almost wholly soluble in large quantities of water; and, to form a complete solution, about 18 ounces of water, at 52°, are required to 100 grains of extract. The residuum seldom amounts to $\frac{1}{14}$th of the original weight of the catechu: and, in most cases, it is found to consist chiefly of calcareous and aluminous earths, and of fine sand, which, by accident or design, had probably been mixed with the primitive infusion at the time of its evaporation.

A considerable portion of both kinds of catechu is soluble in alcohol; but, after the action of alcohol upon it, a substance remains of a gelatinous appearance and a light brown colour, which is soluble in water, and is analogous in its properties to gum or mucilage.

The peculiar extractive matter in the catechu is much less soluble in water than the tanning principle; and, when a small quantity of water is used to a large quantity of catechu, the quantity of tannin taken up, as appears from the nature of the strongest infusion, is very much greater than that of the extractive matter.

The extractive matter is much more soluble in warm water than in cold water; and, when saturated solutions of catechu are made in boiling water, a considerable quantity of extractive matter, in its pure state, falls down as the liquor becomes cool.

The peculiar extractive matter of the catechu may be likewise obtained by repeatedly lixiviating the catechu, when in fine powder, till the fluids obtained cease to precipitate gelatine; the residual solid will then be found to be the substance in question.

The pure extractive matter, whether procured from the Bombay or Bengal catechu, is pale, with a faint tinge of red brown. It has no perceptible smell; its taste is slightly

 astringent;

astringent; but it leaves in the mouth, for some time, a sensation of sweetness stronger than that given by the catechu itself.

Its solution in water is at first yellow brown; but it gains a tint of red by exposure to the air. Its solution in alcohol does not materially change colour in the atmosphere; and it is of an uniform dull brown.

The extractive matter, whether solid or in solution, was not found to produce any change of colour upon vegetable blues.

It became of a brighter colour by the action of the alkalis; but it was not precipitated from its solution in water by these bodies, nor by the alkaline earths.

The aqueous solution of it, when mixed with solutions of nitrate of alumine and of muriate of tin, became slightly turbid.

To nitrate of lead it gave a dense light brown precipitation.

Is was not perceptibly acted upon by solution of gelatine; but, when solution of sulphate of alumine was added to the mixture of the two fluids, a considerable quantity of solid matter, of a light brown colour, was immediately deposited.

To the solution of oxygenated sulphate of iron it communicated a fine grass green tint; and a green precipitate was deposited, which became black by exposure to the air.

It was not precipitated by the mineral acids.

Linen, by being boiled in the strongest solution of the extractive matter, acquired a light red brown tint. The liquor became almost colourless; and, after this, produced very little change in the solution of oxygenated sulphate of iron.

Raw skin, prepared for tanning by being immersed in the strong solution, soon acquired the same kind of tint as the linen. It united itself to a part of the extractive matter; but it was not rendered by it insoluble in boiling water.

The solid extractive matter, when exposed to heat, softened, and became darker in its colour, but did not enter into fusion. At a temperature below that of ignition, it was decompounded. The volatile products of its decomposition were, carbonic acid, hydrocarbonate, and water holding in solution acetous acid and a little unaltered extractive matter. There remained a light and very porous charcoal.

In considering the manner in which the catechu is prepared, it would be reasonable to conclude that different specimens

cimens of that substance must differ in some measure in their composition, even in their pure states; and, for the purposes of commerçe, they are often adulterated to a considerable extent with sand and earthy matter*.

In attempting to estimate the composition of the purest catechu, I selected pieces from different specimens, with which I was supplied by the president, and reduced them together into powder; mixing, however, only those pieces which were from catechu of the same kind.

Two hundred grains of the powder, procured in this way from the catechu of Bombay, afforded by analysis

Tannin - - - - -	109 grs.
Peculiar extractive matter - -	68
Mucilage - - - -	13
Residual matter, chiefly sand and calcareous earth - - - -	10

The powder of the Bengal catechu gave, by similar methods of analysis, in 200 grains,

Tannin - - - - -	97 grs.
Peculiar extractive matter - -	73
Mucilage - - - - -	16
Residual matter; sand, with a small quantity of calcareous and aluminous earths,	14

In examining those parts of the catechu from Bengal which were differently coloured, I found the largest proportion of tannin in the darkest part of the substance; and most extractive matter in the lightest part. It is probable that the inequality of composition in this catechu is owing to its being evaporated and formed without much agitation; in consequence of which the constituent parts of it that are least soluble, being first precipitated, appear in some measure distinct from the more soluble parts, which assume the solid form at a later period of the process.

From the observations of Mr. Kerr † it would appear that the pale catechu is that most sought after in India; and it is evidently that which contains most extractive matter. The extractive matter seems to be the substance that gives to the catechu the peculiar sweetness of taste which follows the impression of astringency; and it is probably this sweetness of taste which renders it so agreeable to the Hindoos, for the purpose of chewing with the betle-nut.

[To be continued.]

* One specimen that I examined of the terra japonica of commerce, furnished, by incineration, one-fifth of sand and earthy matter; and another specimen nearly one-sixth.

† Medical Observations, vol. v. p. 155.

XXXVII. Of

XXXVII. *Of the Herring Fishery. Translated from the French of M.* DUHAMEL *and others**.

Of the Spawning Seasons.

It is well known that herrings do not all spawn at the same time, and it is generally observed that in the years that the air is mild they spawn sooner than when the season has been very cold. Sometimes, for instance, a great quantity of shotten herrings is caught in the beginning of December, whereas in other years great numbers of full ones are found in January. This is a general observation; and if we inquire more particularly into the business, we shall find that some herrings spawn much sooner than others; so that in October, when almost all the herrings that come into the Channel are full, there are some shotten ones found among them.

Some fishermen think that in the English sea the spawning season is in October: this may be the case as to some herrings, but not as to the greatest number. However, towards the middle of November they take shotten herrings at Yarmouth, though not in as great quantities as in the Channel, where shotten herrings are sometimes found in the middle of October. The common opinion is, that herrings spawn but once a year, and that they come into our seas for that purpose. It is certain that they spawn near our coasts; and the condition of the eggs of the herrings that are taken at Shetland compared with that of the eggs of those that are taken at Yarmouth and in the Channel, actually seems to prove that they come into our seas on purpose to spawn. Nevertheless, if we consider the immense quantities of them that come from the north, we shall be inclined to think that some of them spawn there. They are, perhaps, like the bees, that multiply in their hives, and send out swarms when they become too numerous.

Shotten herrings do not constitute a distinct species from the others. They are those which have discharged their eggs or milt, and are therefore generally worse than the full ones, on account of the sickness that they are subject to at the time of spawning, and because the most of them are caught before they are recovered, whereas the greatest part of the herrings quit the coasts a short time after they have spawned.

* From *Transactions of the Dublin Society*, vol. i, part 2.

Of

Of the Seasons in which Herrings are found in different Places, and of the Variations that occur in the Courses they take.

In the beginning of spring the inhabitants of the North take a great quantity of herrings in their own seas. In June and July the fishery is carried on near the Shetland islands. In September and October the fishermen take up their quarters at the entrance of the German sea, and near the coasts of the north of England: this is called the Yarmouth fishery. When it is over, they follow the herrings into the Channel in October, November, and December. It appears, therefore, that the herrings come from the North by the Orkney islands, and that, after having touched upon the coast of Norway, they cross the North sea to come to the north of Scotland and England, whence they proceed through the Streights of Dover into the Channel, where the greatest part of them spawn; after which they disappear, and several are of opinion that they return to the North along the coasts of Ireland.

It having been observed that the herrings leave the North towards April or May, the Dutch used formerly to go in quest of them near the Island of Helygeland and the coast of Norway. But as that fishery often proved but middling, they do not set out now until June, at which time they go to meet them between Shetland and Newcastle.

OF THE HERRING FISHERY IN THE CHANNEL.

Of the Orders issued by the French Government not to continue the Herring Fishery in the Channel after the Month of December.

There are two things that contribute to the prosperity of a branch of commerce. The one consists in meriting the confidence of the purchasers, by taking particular care to have the article well conditioned, and, above all, in observing great fidelity in the expediting of it; the other consists in obtaining a preference by keeping the article at a moderate price. It was with a view to these objects that the Dutch, having perceived that the herrings caught between the rocks of Ireland, Shetland, and Norway, were not of a good quality, have prohibited fishing in those places. They have also made regulations concerning their salt works, so as to have salt of a good quality; and for the purpose of keeping it at a low price, they have not only no salt tax, but they even give encouragement to those who carry on salt works,

works. And in France, the merchants that cure salt fish get salt at a moderate price, that they may be enabled to sell their fish at nearly the same price that the Dutch do. For similar reasons regulations have been made concerning the time that the herring fishery should cease.

The herrings come from the north of England into the Channel; they are certainly poorer there than they were in the North, or even on what is called the Yarmouth coast. However, they are still very good, either fresh or salted; and, as we have said elsewhere, the fattest herrings are not the best for salting. The fishing for herrings has therefore been always allowed, from the time that they come into the Channel until the latter end of December; but from that time it has been prohibited by several orders of government. We shall now mention the reasons of this prohibition.

It is certain that a great quantity of herrings spawn in the Channel, and especially towards the mouth of the Seine, in the end of the season, whereby they lose much of their good quality, particularly for salting. About that period there are some shotten ones taken that are very good fresh; but when they have not had time to recover from the spawning sickness, they dry up in the salt, and become what they call horny; whereas in October and November numbers of them are full and very good, either fresh or salted. This, however, must be understood of what usually happens; for there are some late seasons in which the abundance of shotten herrings does not come on until January, or even February. As salt shotten herrings were known to be inferior to the full ones, it was prohibited, by a decree of March 24, 1687, to continue this fishery after the month of December, or to purchase herrings from foreign vessels after that time; and in confirmation of this prohibition another decree was issued in 1759, wherein is added an order not to bring any such herrings to market; which has been since confirmed by several regulations.

The motives of these prohibitions were, that the herrings salted in that season were bad, and that thereby all those of the Channel were brought into disrepute; that they were unwholesome and caused diseases; and that the fishing for herrings in that season was destructive of the species.

There were some representations made against these decrees, and the fishermen of several ports alleged that herrings do not spawn on the coast of Normandy. But this plea could not stand, as it was manifestly false.

They added, that the Irish do not prohibit this fishery on on their coasts, where there are great quantities of shotten herrings. But should the Irish be wrong in allowing it, it does not follow that the French should imitate them.

On the other side, the herring merchants, who applied for these prohibitions, had probably their own advantage in view, viz. the selling their fish dear, rather than that of commerce. They alleged that shotten herrings were unwholesome, and caused diseases. But there is no foundation for this assertion, although we shall readily grant that they are not as pleasing food as full herrings.

And as to the third plea, viz. that the fishing for herrings after December was destructive of the species, it was a very nugatory one, not only because the quantity of herrings that the fishermen can take is a mere trifle compared with the immense quantities of them that are destroyed by multitudes of fish that feed upon them, but also because, were the multiplication of the species to be considered, it would be much more proper to prohibit the fishing for full herrings.

The only plausible reason for making the above-mentioned regulations was, that, as shotten herrings are not as good as full ones when salted, it was to be apprehended, that if the taking and salting them were allowed it would bring all the salted herrings of the Channel into disrepute; which would be very hurtful to trade. But still it is hard that the poor should be deprived of an article of food which could be procured very cheap.

The fishermen of Dieppe, having represented that herrings were absolutely necessary for baiting their hooks, have obtained leave to fish for them with a few small boats, under condition of cutting off the heads and tails of such as they should take. This favour has been granted also to some other ports. Now, if a regulation of this kind were generally adopted, it would be of great service to the fishermen and to the poor, without injuring the herring trade. For, by taking care that the heads of such herrings as are caught after December should be cut off, it will be easy to distinguish the good ones from those of an inferior kind, and the purchasers of salt herrings will be sure not to be imposed upon.

Of the Circumstances thought to be favourable to the Herring Fishery.

The fishery is expected to be good, when after a troubled sea there comes on a calm, accompanied with a mist or thick fog; when the wind blows from the north or north-

west,

west, or rather from that part of the horizon whence the herrings usually come: for in these cases they come sooner and in greater numbers to our coasts. Those winds generally blow from a northern direction, and are the same that bring woodcocks to our coasts; and therefore it is supposed that the herring season will be good, when there is plenty of woodcocks.

When a great number of sea birds assemble in any particular place, it is an almost certain sign that there is abundance of herrings there. It is also a good sign to catch sea dogs, as they follow the herrings to feed upon them. Another good sign is, when the water is agitated to a certain depth; likewise when there are fat or greasy spots floating like oil upon the sea, when not much troubled.

Lights kept in the fishing boats are rather serviceable than hurtful to the fishery, but great lights coming from land drive the fish away. It is also to be observed that the ebbing or flowing of the tide is immaterial, but that the greatest quantity of fish is usually caught when the water is smooth.

Of the Pec Herrings, or those taken most early in the Northern Seas by the Dutch.

These herrings are very fat and large; they are delicate and pleasing to the taste, and are good when salted: but as they are fat and oily it requires much care to preserve them, and they are never as white as the herrings that are salted on our coasts. There are but very few shotten ones found amongst them. The greatest part of them have milt or eggs, which are only beginning to be formed.

Of the Herring Fishery near Shetland.

The Dutch usually set out for this fishery towards the middle of June, but never begin it until the evening of St. John's day. They do not fish in the day-time, and the manner of fishing there is nearly the same as that of the Yarmouth fishery. The best situation for this north fishery is from the small Island of Fairhill to the north-west of the Orkneys and round Shetland.

OF THE YARMOUTH FISHERY.

The Dutch and French carry on this fishery as well as the English; with this difference, however, that they are not allowed to come near the coast of England, in the vicinity of which the English fish themselves. It is called the Yarmouth fishery, because a great part of the herrings that

that are caught by the English are brought fresh to Yarmouth, where they are cured. This fishery is generally more profitable to the English than that of green or dry cod; and therefore to encourage it they have exempted it from all sorts of duties. The fishermen take only a licence. As the Dutch and French are not allowed to bring their herrings to England, they salt them on board their busses.

Description of the Yarmouth Herrings.

They are not as large or as oily as the pee or North sea herrings, although they are originally the same. But they are firmer, their milts are larger, and the eggs better formed; on which account they are much better for salting and keeping than the pecs. For this reason the English and Scotch do not fish for herrings at a great distance from land, where they are very fat. In fact, the Yarmouth herrings are the best of all for salting.

It is easy to conceive that herrings lose their fat and oil through the change of climate, water, and food. The different qualities, however, of cured herrings depend very much upon the care that is taken in salting them, as will appear hereafter. For instance, as it is a matter of great importance that herrings should be put in salt on their coming out of the water, those that the Dutch and French take in the Yarmouth fishery have this advantage, because such as are caught at night are salted on board in the daytime; which is not the case when herrings are carried fresh into port, on account of the contrary winds, or other accidents, that prevent the landing and delivering them as soon as would be requisite.

Of the Herring Fishery on the Coasts of Ireland and Scotland.

The herring fishery of Ireland is very like that of Yarmouth, and the Irish sea abounds with herrings from August to October. In Scotland, instead of smoking their herrings, as was formerly the custom, they make white herrings, either because, on account of the herrings having removed from the coast, they are obliged to salt them on board their vessels, or because white herrings are preferred in Italy.

Of the Salting of Herrings at Sea.

The English engaged in the Yarmouth fishery keep very near the coast, and therefore bring their herrings to land soon after they are caught. But the fishers of the Channel,

as

as they often go out far from land, and are therefore apprehensive the fish may be spoiled before they can return to port, take with them some barrels of salt for the purpose of at least corning the herrings, so as that they may keep for some days: however, this sort of preparation is not sufficient for the herrings that they take in the North and Yarmouth fisheries; they must be at least casked, and even barrelled as far as possible. The Dutch and French that go out on these fisheries practise this preparation, and the method of doing it is generally as follows:—The Norman fishermen place the herrings in different compartments upon the deck: they open their necks a little with a small knife, and take out the gills, and at the same time draw out the stomach and intestine; this is called dressing the herrings; they are then put into baskets, and carried behind to be poured into large vats with a quantity of salt. In these the herrings and salt are stirred about, after which the herrings are put into tubs: but in this state they could not keep many days; and therefore when the men cannot return soon to port they put them into barrels, pressing them together as close as possible. They are often obliged to go through these operations in too great a hurry, on account of bad weather, or for the purpose of clearing the deck, &c.; so that sometimes they corn or barrel herrings that were not dressed. There is an order of parliament against salting or barrelling such herrings. But, whatever precautions may be taken at sea, the barrels must be emptied on land, and the herrings made up again with greater care, as will be explained hereafter.

Of the Salt used in the various Methods of curing.

In whatever manner herrings are to be cured, salt must be used; but there are different sorts of salt, some of which are not good for this purpose.

The sorts of salt that the French use are those of Poitou, Saintonge, Britany, and Normandy. Every one allows that of Brouage to be the best of all. It is made in the salt marshes of Brouage, Marans, the Isle of Ré, and other parts of Saintonge and Poitou.

When the Brouage salt is old, and has become dry and sweet, it leaves to the herrings their good taste, without communicating any sharpness, or breaking them, or making them tough or shrivelled. As to the salt of Britany, besides what is used in the province, the Flemings and Picards take some of it, which they refine and make white. This refined salt is thought to be more sharp and corrosive than the

the gray salt of Brouage: however, for this very reason some people think it is advantageous to mix some of it with that of Brouage, when the herrings are fat and oily. Some use the salt brought back from Newfoundland. The reader may see what we shall say of this salt in the Essay on Cod Fish. Provided it be not old salt that fell from the heaps of cod, it may do very well, particularly if care has been taken to dry it well in the sun upon sails.

The neighbouring nations use white Spanish and Portuguese salt, in which the English and Dutch carry on a considerable trade. The greatest part of the salt used by the northern nations is brought from St. Ubes in Portugal.

This salt looks infinitely finer than that of Brouage, but is of a much inferior quality; and the Dutch, who know this well, sometimes mix Brouage salt with Spanish or Portuguese salt, which mixture is allowed to be preferable to pure Brouage salt, when the fish is fat and oily; and it is said that it contributes to the superiority of the Dutch salt herrings. This may be true: we shall see, however, in the sequel, that the perfection of the Dutch herrings in general is owing to the great care they take during the whole process of curing them.

In Holland all the salt to be used in curing herrings must be examined, before it is embarked, by juries of the respective places, to show that it is of a good quality and clean. The fishermen must get a certificate to this purpose, under the penalty of paying a fine of twenty-five florins.

Of the Barrels for Salt Herrings.

There is an order in Holland that the barrels must be marked with the cooper's mark, and then examined in public by juries, who reject such as are not of good wood, or which might give a bad taste to the fish; after which the mark of the city is put upon them. There are also in France many regulations relative to the size, condition of barrels, &c.

[To be continued.]

XXXVIII. *Improved Method of preparing Black Oxide of Mercury.* By M. Schulze, *of Kiel**.

Though several methods have been proposed for preparing black oxide of mercury since that substance was

* From Scherer's *Allgemeines Journal der Chemie*, no. 47.

used as a medicine, it must, however, be allowed that each of these methods is attended with inconveniences, and that the best, even when the materials are of the first quality, does not produce that advantage which might be expected. Without enlarging further on the processes hitherto employed in the preparation of this article, I flatter myself it will not be considered superfluous if I here make known a very convenient method founded on true chemical principles, which, besides its great simplicity, gives a rich and pure product: advantages which must certainly recommend it to the notice of every apothecary.

In the description of the process I hope I shall be pardoned for being circumstantial, as minuteness is often of great utility, and, in regard to a matter of so much simplicity, can be attended with no hurt.

Mix one part of pure concentrated nitric acid with four parts of distilled water in a narrow-necked retort; and having added four parts of pure mercury, place the vessel in warm sand of the temperature of from 120° to 140° of Fahrenheit. Maintain this heat till the action of the acid on the metal has apparently ceased; that is to say, till no more bubbles arise.

When the operation has been carried this length, the heat of the sand must be raised to from 200° to 210° of Fahrenheit; and this temperature must be maintained for three or four hours. Then bring the fluid to a slight state of ebullition, and, having continued it without interruption for half an hour, pour the whole, boiling hot, into a glass vessel containing fifty parts of distilled water, with which it will mix exceedingly well by continual stirring.

In the above operation the following circumstances are to be remarked:

1st. Should a commencement of crystallization manifest itself during the digestion or boiling of the solution, a little warm water must be immediately added, to prevent the complete crystallization of the matter, because the solution acquires a strong propensity towards it as soon as too large a quantity of the water has been evaporated during the process.

2d. Some metallic mercury must remain at the end of the operation. Should all the mercury, however, be dissolved, it will be necessary to add some more of the metal, and to complete the solution as before directed.

The diluted solution obtained in this manner is then filtered, and the mercury remaining on the filter is collected and put into another clean vessel.

3 From

From the clear fluid a black precipitate is gradually thrown down by means of ammonia, and more ammonia must be dropped into it till no more precipitate is formed. By these means the precipitate from the beginning to the end of the operation will be uniformly black, and more black oxide will thus be obtained than by the methods hitherto employed. Should the precipitate be of a brighter colour towards the end of the operation, which, however, will not be the case when the above prescription is closely followed, the fluid must be separated from the precipitate before the precipitation is completed, and the remaining fluid must then be precipitated by itself. The last precipitate is to be kept for a future preparation, or for any other use.

Wash the black precipitate which has been obtained, in a glass vessel with cold distilled water, and place it on a paper filter, where in a few hours it will be freed from the greater part of its moisture. Then twist together the extremities of the filter, so that none of the precipitate can escape from it; and having wrapped it up in a few folds of blotting-paper, subject it to a press, or place weights over it: but this must be done with great care, lest the paper should burst: it must, however, be well pressed at last, in order to free it as much as possible from water.

When this is done, take the filter from the press; and having freed it as speedily as possible from the wrapping paper, spread it out carefully on some solid supporter, extending the dry precipitate in a thin stratum. Suffer it to dry completely in a temperature which must not exceed 70° of Fahrenheit. By these means you will obtain a preparation which will stand every proof in regard to its purity.

I shall conclude this account with a few observations on the process in general, and on some individual parts of it.

1st. The principle on which this method is founded is experience, which shows that acids in general are capable of taking up any metallic oxide, according as it is more or less oxidated.

2d. When mercury and nitrous acid exposed to heat are suffered to exercise an action on each other till the disengagement of air-bubbles ceases, a combination will be obtained in which the oxide of mercury has experienced a stronger degree of oxidation than is necessary for black oxide of mercury, as this solution is precipitated white by ammonia. But if mercury not oxidated remains in contact with the solution during the continuance of the exposure to heat, a part of the oxygen passes from the dissolved oxide of mercury to the metal not oxidated, which, according to the above principles, must be abundantly taken up. This effect continues till all the oxide of mercury in the solution is brought to the utmost degree of oxidation.

3d. By this process, therefore, the whole of the dissolved oxide of mercury is reduced to a uniform low degree of oxidation, and the solution thereby rendered proper for producing, from the beginning to the end of the precipitation, black oxide of mercury.

4th. The reason why the boiling solution is immediately poured into a large quantity of water is, because on cooling most salts crystallize from their solution, and are then difficult to be dissolved. But should the whole solution crystallize during the process by too great evaporation of the water, it would be necessary to add some nitrous acid, diluted with the necessary quantity of water, to dissolve the whole by boiling, and then to proceed as before.

The whole cannot be again dissolved by water, because during crystallization a part of the nitrate of mercury is decomposed, and the separated oxide of mercury is so much oxidated that the remaining nitric acid is not in a condition to bring it to a clear solution.

5th. The pressing of the precipitate contributes in a considerable degree to the speedier conclusion of the whole process, because during the operation of drying a strong heat, in consequence of the reasons before mentioned, cannot be employed. When the moist as well as the dry black oxide of mercury is exposed to a temperature which approaches that of boiling water, its black colour is changed to gray, and if the temperature be still further raised it becomes entirely white; nay, by a still higher temperature it soon assumes an orange colour: which, however, is an evident sign of increasing oxidation. The before-mentioned degree of heat must, therefore, not be exceeded in the operation of drying, and the precipitate must not even be washed with hot water if it be required to obtain this preparation in the proper state.

XXXIX. *On the Stones said to have fallen from the Atmosphere.* *By* J. Delalande.

The stones which fell near Laigle on the 26th of April 1803 have afforded considerable occupation to philosophers. As a globe of fire which burst with a great noise had been seen, it appears to me that this phænomenon may be referred

referred to fire-balls, of which I have mentioned thirty-six instances in the *Connoissance des Tems* for the year 8 and the year 10. The work of M. Izam entitled *Lithologie Atmosphérique* contains many details on this subject.

These stones being of a species not to be found on the earth, it has been concluded that they are formed in the atmosphere; but several chemists consider this as impossible. M. Delaplace has examined what would be the case if they were projected from a lunar volcano; and N. Poisson, an able geometrician, professor in the Polytechnic School, has given a learned memoir on this subject in the *Bulletin des Sciences* *, published by the Philomatic Society; from which it results, that if a body were projected from the moon with a velocity of 7600 feet per second, or five or six times that of a cannon ball, it would reach the earth in two days and a half, and its velocity when it arrived at the surface would be 31500 feet per second, making allowance for the resistance of the air.

But as the height of the atmosphere may be considered as very small in comparison of the earth's semidiameter, this velocity would be nearly equal to that which the same body would have on entering into this atmosphere; but the air then acting upon it by the resistance, which increases in a proportion much greater than the velocity, would soon lessen the rapidity of this motion, which would become sensibly uniform, like that of bodies which fall into a resisting fluid of considerable depth.

M. Biot, who was at Laigle to collect all the circumstances of this phænomenon, presented to the Institute a very long and satisfactory report on this subject, which has been printed. From the circumstances which he relates, it appears to me difficult not to believe that these stones were formed at the same time as the globe of fire. The number which fell was two or three thousand: they were exceedingly hot, scorched at the surface, and almost friable; but they became hard on cooling.

M. Izam has made no mention of the stones which fell on the 16th of June 1794, seven leagues to the south-west of Sienna in Tuscany, and respecting which there is a work entitled *Sopra piogetta di sassi accaduta nella sera de* 16 *Giugno* 1794, *Dissertazione del P. D. Ambrozió Soldani in Siena* 1794, 8vo. Fifty or sixty fell in the compass of a mile: they were hot and burning at the surface, like those

* No. 71.

which fell at Ensisheim, November 7, 1742; at Bourg, in Bresse, September 1753; at Agen, July 24, 1790; in Yorkshire, December 1795; at Salles, near Villefranche, in Beaujolais, March 12, 1798; and at Benares, December 1798.

M. Lesage explains their formation in the atmosphere *; but even if this should not be explained by the chemists, I shall, till the philosophy of meteorology is further advanced, consider them as an atmospheric production.

XL. *Extracts from the third Volume of the Analyses of M.* Klaproth.

[Continued from p. 83.]

Grayish White Phosphated Ore of Lead.

According to M. Klaproth's analysis, this gray ore of lead, crystallized in thin and very brilliant prisms, is composed of 4½ oxide of lead and one part phosphoric acid. He is not acquainted with the matrix of this ore, which he very much regrets, as white phosphated ores of lead are exceedingly rare. This species of ore proves how uncertain are the signs borrowed from colours for the classification of minerals. It is proper to remark that the muriatic acid discovered in phosphated ores of lead is always found in them in nearly the same proportions.

Analysis of the Phosphated Lead Ore of Anglesey.

The sulphated lead ore of the Parisle Mountain of the Island of Anglesey is found in small insulated crystals, the form of which appears to be an inclined pyramid of four faces. They are always inclosed in a hard stratum of brown ochre, sometimes uncoloured and without spots; but often embrowned by a slight tint of ochre: in the inside they have great brilliancy.

Their specific gravity is 6300: exposed on charcoal to the blowpipe they decrepitate as soon as the flame touches them. When reduced to powder they fuse into a brilliant scoria, which is at length converted into a button of metallic lead.

* Journal de Physique, Messidor, an. 11.

This

This ore contains

Oxide of lead - - -	71
Sulphuric acid - -	24·80
Water of crystallization -	2
Oxide of iron - - -	1
	98·80

The oxide of iron must be considered rather as a mechanical mixture of the ochrey crust with this ore, than as one of its constituent principles.

Analysis of the Sulphated Lead of Leadhills.

The sulphated ore of lead of Anglesey was the only one known till the discovery of that of Leadhills in Scotland; the chemical principles of which are the same; but they differ in their external characters, since it crystallizes in tablets. These crystals are colourless, in several places transparent, and have a very brilliant splendour.

The vein of this ore is situated at Wanloch-head, near Leadhills.

When exposed on charcoal to the blowpipe it exhibits the same phænomena as that of Anglesey.

A hundred parts of these crystals of sulphated lead of Leadhills contain

Oxide of lead - - -	70·50
Sulphuric acid - - -	25·75
Water of crystallization -	2·25
	98·50

Analysis of the White Lead Ore of Leadhills.

The preceding sulphated lead ore crystallized tablets must not be confounded with the white lead ore of the same place; though it is crystallized also in hexaëdral tablets, in which the lead is found combined with carbonic and not with sulphuric acid.

The specific gravity of this ore is 6480. It contains

Lead - - - -	77
Oxygen - - - -	5
Carbonic acid - - -	16
Loss and water of crystallization	2
	100

Analysis of the Native Antimony of Andreasberg.

Hitherto native antimony has been found in three places only:

1st. In the silver mine of Sala and Weestmannland, where Swab discovered it in a matrix of calcareous spar.

2d. In the mines of Challenges, near Allemont, in the department of Isere. For the analysis of it we are indebted to M. Sage.

3d. In the mine of Catherine Neufung, at Andreasberg, in the Harz, where it is found in considerable masses.

It has the white colour of tin, inclining to leaden gray. It is compact, and has a great deal of metallic splendour. On the fracture it is foliated. The fragments exhibit a grain sometimes fine and sometimes coarse. It has a mean hardness, and is soft to the touch. Its specific gravity is 6720. The matrix of it is calcareous spar, quartz, &c.

It exhibits the same phænomena with the blowpipe as regulus of antimony extracted from its ores. It fuses very speedily into globules, and is dissipated in gray inodorous fumes, which adhere to surrounding cold bodies. If the metallic button be left to cool slowly, it is found to be covered by and surrounded with white brilliant argentine crystals. After total volatilization it leaves a small globule of silver.

A hundred parts of native antimony of Andreasberg contain

Antimony - - - -	98
Silver - - - -	1
Iron - - - -	0·25
	99·29

It is probable that the silver is combined with it only accidentally.

Analysis of the Argentiferous Antimony of Andreasberg.

This is one of the richest and oldest silver ores in that country. It was formerly considered as arsenical silver, which is found there also, but much more rarely.

M. Klaproth in his analysis employed a variety which has been dug up for several years past. It is of a hard grain, crystallized, and foliated on the fracture. By its external characters, and the considerable quantity of silver it contains, it approaches near to the antimoniated silver of Altwolfach, in Furstemberg. Its specific gravity is 9820.

Exposed

Exposed on charcoal to the blowpipe it requires a pretty strong heat to be fused; the antimony is dissipated in fumes, and leaves a button of pure silver.

Twenty-five grains of this ore, treated in a cupel with four grains of lead, gave a button of silver weighing 19½ grains.

A hundred parts, treated by the nitric and muriatic acids, gave

Silver - - -	77
Antimony - - -	23
	100

Analysis of the Red Fibrous Ore of Antimony of Braunsdorf, in Saxony.

The matrix of this ore is gray quartz; it is generally found with ore of gray antimony, and some insulated crystals of white antimony.

This ore has a beautiful *mordoré* and crimson colour, on which account it has been called native mineral kermes. It sometimes exhibits varied colours at its surface. It forms small needly or capillary crystals, sometimes single, and sometimes united in bundles: they have a silky splendour, and are opake.

It is difficult to determine their specific gravity, on account of the air-bubbles which are collected in the tufts of the small capillary crystals, and which it is difficult to expel. According to M. Klaproth it is 4090. This ore contains

Antimony - - -	67·50
Oxygen - - - -	10·80
Sulphur - - - -	19·70

Native kermes mineral differs then from gray sulphuret of antimony only by the greater degree of the oxidation of the antimony.

Analysis of the White Ore of Antimony of Przibrem, in Bohemia.

This ore, lately discovered, is composed of crystals in parallelopiped laminæ. They are white, brilliant and radiated at the surface. The largest are nine lines in length and three in breadth. Strong compression is sufficient to make them separate into small needles, which resemble those of amianthus.

amianthus. They have for matrix crystals of galena, to which they slightly adhere.

They exhibit the same phænomena with the blowpipe as white oxide of antimony precipitated by an aqueous solution of muriate of antimony; which is also susceptible of crystallizing by rest, when slowly precipitated, by a small quantity of water.

As this white oxide retains muriatic acid, M. Hacquet presumed that this acid formed a part also of the white ore of antimony. But the analysis of M. Klaproth proves that this ore is a pure oxide of antimony without muriatic acid.

Some crystals of this oxide are found also in very small insulated tablets in the red fibrous ore of antimony of Braunsdorf, in Saxony.

Analysis of the Olive Ore of Cornwall.

The only ores of this arsenical copper, hitherto known, are found in Cornwall. M. Klaproth, having obtained from all the varieties of this ore the same results, except a few slight differences in the proportions, gives here only an analysis of the Carrarac arsenical copper in needles.

This ore, when exposed to the flame of the blowpipe, detonates. White arsenical fumes are disengaged from it; and it fuses into a grayish red globule, which when fused with borax gives a button of pure copper. Arsenical copper contains

Oxide of copper - -	50·62
Arsenic acid - - -	45
Water of crystallization -	3·50
	99·12

The foliated olive ore crystallized, in beautiful hexaëdral tablets, of an emerald green colour, of Tincroft, near Redruth, had before been considered as muriate of copper. M. Klaproth, however, has found it to be composed, like the preceding, of copper and arsenic acid. He had not a sufficient quantity of it to determine exactly the proportions of its principles.

It decrepitates speedily when heated on charcoal or in a small crucible, and flies off in small scales; which must be ascribed not only to the lamellated texture of its crystals, but also to the great quantity of the water of crystallization it contains.

Arsenical

Arsenical Iron Ore.

This ore, which is exceedingly rare, is found also at Carrarac, in the county of Cornwall. M. Klaproth had only one very small cubical crystal of it, with brilliant and polished facets, of a meadow green colour, in a piece of copper ore in quartz.

He does not indicate the proportions of its component parts; but he analysed a variety of this iron ore crystallized in large cubes of an olivin green colour, extracted from a newly opened pit, and found that it did not contain a single atom of copper.

Analysis of the Ore of Muriate of Copper.

The combination of muriatic acid with copper, announced by Berthollet and Proust, in their analyses of the green sand of Peru or of Acatamit, proves that muriatic acid is one of the mineralizing substances of this metal.

M. Proust has since given an analysis of the green copper ore found at Los-Remollinos, in Chili, which is also composed of muriate of copper.

M. Klaproth repeated this analysis on a very large quantity of this fossil, which is still rare. This ore, after being reduced to powder, and freed by washing from the ochre with which its crystalline texture was penetrated, had a beautiful dark green colour.

Exposed to the blowpipe on charcoal, it communicated to the flame a bright blue and green colour. The muriatic acid is soon volatilized, and there remains on the charcoal a button of pure copper.

If the ore be heated in a crucible it soon assumes a black colour; but it gradually becomes greenish in the air. It loses from six to seven per cent. when moderately heated; and from fifteen to eighteen when brought to a red heat.

Water boiled with a portion of pulverized ore, and then filtered, passed without any colour; and a solution of nitrate of silver produced only a slight white precipitate, which became black in the light. This proves that the muriatic acid was not found in it in that proportion which is necessary to be very soluble in water.

A hundred parts of this ore contain, according to M. Klaproth,

Oxide of copper - - -	73
Muriatic acid - - -	10·1
Water of crystallization -	16·9
	100

And,

And, according to M. Proust,

Oxide of copper - -	$76\frac{28}{47}$
Muriatic acid - - -	$10\frac{30}{47}$
Water - - - -	$12\frac{36}{47}$
	100

These two analyses vary so little in their proportions that they serve to confirm each other.

Acatamit, according to Mr. Proust, contains

Oxide of copper - -	$70\frac{40}{83}$
Muriatic acid - - -	$11\frac{37}{83}$
Water - - - -	$18\frac{6}{83}$
	100

Analysis of the Ore of Phosphate of Copper.

The natural combinations of phosphoric acid hitherto known are those of the phosphate of lime in apatite and its varieties; and those of some species of phosphate of lead, of phosphate of iron, and of blue ferruginous earth.

To these must be joined that of copper discovered in this new mineral, as a new species of copper ore.

It is found at Firneberg, near Rheinbreidbach, on the banks of the Rhine. Its green colour and its radiated texture made it be taken, at first, for a kind of malachite.

When exposed to the blowpipe on charcoal it fuses into a dark brown scoria, which at first assumes a round form; but it soon divides and separates. After cooling it has a dull metallic splendour, and a reddish gray colour.

A hundred parts of this ore are composed of

Oxide of copper - -	68·13
Phosphoric acid - -	30·95
	99·08

PITCH STONE.

Analysis of the Pitch Stone of Cyarsebaeh, near Meissen.

Under this name were formerly comprehended several species of stones, which at present are placed more conveniently among the semi-opals. This fossil is found in entire masses of the mountains: it exhibits several varieties of colour. There are some yellow, green, gray, reddish brown, and blackish. It is compact, and in the inside has the lustre of pitch. Its fracture is conchoid. Its substance is penetrated by a very fine-veined tissue which binds it together, as may be distinctly seen by immersing the fossil in water.

Its specific gravity is 1645. M. Klaproth, in his analy-

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sis, employed the pitch stone of Meissen, which is pellucid and yellow, inclining to olive green.

A hundred parts of this fossil contain

Silex - - -	73
Alumine - - -	14·50
Lime - - -	1
Oxide of iron - -	1
Oxide of manganese -	0·10
Soda - - - -	1·75
Water - - -	8·50
	99·85

Analysis of the Pumice Stone of Lipari.

Fixed alkalies, in consequence of their solubility, had long escaped the researches of chemists in the analysis of stones. But as they are now known to exist in a number of fossils, they ought always to be supposed to exist when a sensible decrease is experienced in their decomposition.

This induced M. Klaproth to repeat the analysis of the pumice stone of Lipari, in which he had observed a loss of three per cent. These parts he found again in the soda and potash, which enter, as constituent parts, into the composition of this fossil. He obtained by nitric acid very regular rhomboidal crystals of nitrate of soda; and, by the addition of tartareous acid, crystallized grains of acidulous tartrite of potash.

A hundred parts of the pumice stone of Lipari are composed of

Silex - - - - -	77·50
Alumine - - - - -	17·50
Oxide of iron containing a little manganese - - - -	1·75
Soda and potash - - -	3
	99·75

Analysis of the Zirconia of Norway.

The discovery of this fossil, so valuable on account of the elementary earth it contains, is the more interesting to mineralogists, as this is the first time it has been found in its matrix. We are not yet acquainted with that of the zirconia and hyacinth, which are stones of transportation. The gangue from which it is extracted at Friedrichswarn is a compound of red feld-spar and amphibolite, in which it

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is found interposed in an insulated state, in light brown pellucid crystals.

The specific gravity of this zirconia is 4485.

It is perfectly infusible, and does not lose its colour by calcination. It contains

Zirconia - - - -	65
Silex - - - -	33
Oxide of iron - -	1
-	99

Analysis of Madreporite.

Madreporite, belonging to the class of calcareous stones, found by M. de Molle some years ago at Russbachthal, in the country of Salzbourg, is a stone of transportation. Some specimens weigh from twenty to thirty pounds.

Externally it resembles basaltes so much that some mineralogists considered it, at first, to be the same. Others have believed that it was produced from madrepores. But it exhibits no certain characters of a primitive organic formation. Besides, it has such a great resemblance to the real madreporites that it has thence borrowed its name. It is of a gray colour: it is composed of divergent prisms, brilliant on their transverse fracture, and of a black and duller colour on the longitudinal fracture. The fracture exhibits a tissue of small bent laminæ. It is entirely opake, brittle, rough to the touch, and of moderate hardness. The intervals between the bundles which compose it are in part filled with small white leaves of calcareous spar.

According to the analysis of M. Molle, a hundred parts of this madreporite contain

Lime - -	$63\frac{4}{10}$
Alumine -	$30\frac{2}{10}$
Iron - -	$10\frac{15}{10}$

According to M. Klaproth,

Carbonate of lime - -	93
Carbonate of magnesia -	0·50
Carbonate of iron - -	1·25
Charcoal - - - -	0·50
Sandy silex - - -	4·50
An atom of oxide of manganese	
	99·75

Analysis

Analysis of Pharmacolite.

This fossil is found in the cobalt ore of Wittichen, in Furstemberg, in small white crystals, for the most part capillary; sometimes collected in tufts, sometimes united in clusters, and rarely prismatic. They have a silky lustre. They are sometimes covered with a red crust of cobalt. M. Karsten has given an exact description of this new fossil in his mineralogical tables.

The specific gravity of pharmacolite, in clusters, is 2640.

A hundred parts of pure pharmacolite, separated from the cobalt and siliceous matrix with which it is accidentally mixed, contain

Arsenic acid - -	50·54
Lime - - -	25
Water - - -	24·46
	100

Analysis of the Sand of Muska, near the River Aranyos; called Scorza by the Wallachians.

Among the interesting productions of Transylvania we ought not to forget a sandy fossil, of a pistachio green colour, inclining to tarin green, composed of small round grains, entirely dull. It is found in small cavities of a gray argillaceous stone of the valley of Muska. M. Muller, who sent it to M. Klaproth, adds, that this sand, in regard to its grain and colour, has a resemblance to several kinds of gold ore. That grains of gold might easily be adulterated by mixing it with them, if its specific gravity were not much lighter: it is 3135.

It is mixed with white grains of quartz, so fine, though visible, that it is not possible to separate them. This sand contains

Silex - - -	43
Alumine - - -	21
Lime - - -	14
Oxide of iron - -	16·50
Oxide of manganese -	0·25
Loss by calcination -	2·50
	97·25

Analysis

Analysis of the Fibrous Brown Sulphate of Barytes.

The fossil of Neu-Leiningen, in the Palatinate, confounded with calamine, seemed worthy of being analysed; and it now appears to be a sulphate of barytes, and not an oxide of zinc. Its external characters, so different from those of the other species of the sulphate of barytes, ought to make it be considered as a particular species.

The description given of it by M. Karsten is as follows:

Fibrous sulphate of barytes is of a chestnut brown colour on the fracture, when fresh.

Its form holds a mean between that in rognons and that in clusters. Its surface and lustre cannot be determined, because the fossil seems to have been exposed to friction.

Internally it is not very brilliant. It has a greasy aspect.

Its fracture is fibrous; and the fibres diverge like the beards of a quill.

The fragments are irregularly angular, and the edges are pellucid.

It is soft and heavy: its specific gravity is 4080.

Three hundred grains of this pure sulphate of barytes, the lime adhering to which had been separated by acetous acid, pounded, and boiled with 600 grains of the carbonate of potash, decomposed and redissolved in muriatic acid, crystallized in tablets of muriate of barytes.

When redissolved in water and remixed with the first solution of potash, which contained the sulphuric acid of the decomposed fossil, and in which the excess of potash had been saturated by acetous acid, the sulphate of barytes was precipitated. When washed and collected it weighed 297 grains.

A solution of prussiate of potash, poured into the water of the washing, gave a slight indication of iron.

Analysis of the Manganese Ore of Sleseld, in the Harz.

This ore, which has for matrix a white sulphate of barytes, is distinguished from other ores of manganese by a greater metallic splendour, and by the size of its prismatic crystals with four planes, which are sometimes more than two inches in length. It was formerly believed that this metallic splendour arose from a considerable quantity of iron; but the analysis of M. Klaproth has proved that it contains none of that metal.

A hun-

A hundred parts of his ore are composed of

Blue oxide of manganese, at the maximum of oxidation it can retain in the fire, -	90·50
Water - - - - - - -	7
Oxygen $4\frac{1}{2}$ cubic inches, or in weight -	2·25
	99·75

This small quantity of oxygen in excess announces tha this ore is of no value for the purpose of extracting oxygen gas from it, or for preparing oxygenated muriatic acid.

The seven per cent. of water constantly found in several analyses is too large a quantity to be interposed only hygroscopically in the mineral. It ought certainly to be considered as the water of crystallization of that ore.

Analysis of the Manganese of Moravia.

This ore is of a steel gray colour on the fracture when fresh: it has a metallic lustre. It is composed of short needles united in bundles, or diverging from a common centre, and forming a compact mass.

A hundred parts of the manganese of Moravia contain

Black oxide of manganese, at the maximum of oxidation it can retain in the fire, - -	89
Water - - - - - - -	0·50
Oxygen $20\frac{1}{2}$ cubic inches, or in weight -	10·25
	99·75

The gray radiated ores of manganese are those, therefore, which furnish the greatest abundance of oxygen.

Analysis of the black earthy Ore of Manganese.

This ore of the Harz is found in the fissures of the rocks, like soft mud. But it soon dries in the air, and is converted into fine black dust.

A hundred parts of it contain

Brown oxide of manganese -	68
Oxide of iron - - - -	6·50
Charcoal - - - -	1
Barytes - - - - -	1
Silex - - - - -	8
Water - - - - -	17·50
	102

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The excess in the sum of the products of the analysis arises in all probability from the oxide of manganese having absorbed, during the calcination, a greater quantity of oxygen than it contained in the fossil. Nature employs this muddy manganese to delineate and colour those dendrites, often so beautiful, which are found in calcareous stones, in marly schists, and in the meagre kinds of quartz. The water of the mountains, charged with oxide of manganese, attracted by the veins and cracks of the stone, as by capillary tubes, deposits it on evaporating in all the ramifications through which it has passed.

Analysis of the Asphaltum of Albania.

The asphaltum or bitumen found in thick strata near Avlona, in Albania, is of a blackish gray colour. This fossil is compact without transparence, of a moderate lustre on the surface as well as on the fracture, and of a greasy polish. When scratched the traces are dull; its fracture is imperfectly conchoid, and the edges and fragments are acute.

It is light and somewhat greasy and soft to the touch. Its specific gravity is 1205.

It burns with a bright and brilliant flame; and it is believed that it formerly entered into the composition of the Greek fire.

Asphaltum is soluble only in oils and in ether. It dissolves very well in rectified oil of petroleum. Five parts of this oil dissolved without heat one part of asphaltum in 24 hours. The saturated solution had a brown colour. When evaporated in a gentle heat it deposited the asphaltum, under the form of a blackish brown brilliant varnish. Asphaltum dissolved also very well in sulphuric ether, and the solution had a reddish brown colour. The ether deposited by evaporation the bitumen, inspissated under the form of a reddish brown extract. Alcohol cannot redissolve them.

Acids and caustic alkaline solutions, even concentrated and in a state of ebullition, cannot dissolve it properly.

A hundred grains of asphaltum of Avlona analysed in the dry way, distilled and calcined, are composed of

36	cubic inches of hydrogen gas
32	grains of bituminous oil
6	of water faintly ammoniacal
30	grains of charcoal
7½	of silex
7½	of alumine
¾	of lime

1¼ oxide

$1\frac{1}{4}$ oxide of iron
$\frac{1}{2}$ oxide of manganese.

Analysis of the Pearl-stone of Hungary.

The mountains of Tekelbart in Hungary, from which so many rare fossils are extracted, among which are the beautiful changing opals, furnish that also which Werner has classed in the system next to Pitch-stone, under the name of Pearl-stone.

That which M. Klaproth subjected to analysis is of an ash gray colour, traversed by yellow bands. It is found between Kerestur and Tokai, in alternate strata separated by others of argillaceous porphyry.

The specific gravity of this fossil is 2340. It swells up by the blowpipe like zeolite; but it does not fuse into a globule.

A piece calcined for two hours in a moderate fire lost nothing of its form. Its colour had become reddish brown. It had experienced $4\frac{1}{2}$ per cent. loss.

Pearl-stone was completely vitrified in a porcelain furnace in a clay crucible, as well as in a crucible lined with charcoal.

A hundred parts of the pearl-stone of Hungary, treated successively by soda and by acids, gave in their analysis:

Silex - - -	75·25
Alumine - - -	12
Oxide of iron - -	1·60
Lime - - -	0·50
Potash - - -	4·50
Water - - -	4·50
	98·35

[To be continued.]

XLI. *Examination of the Red coloured Water of a Lake near Lubotin, in South Prussia. By Professor* KLAPROTH *.

THE South Prussian gazette of the 8th of February 1800, and the Berlin gazette of the 13th, gave an account of a phænomenon

* From Scherer's *Allgemeines Journal der Chemie*, No. 33.—About twenty years ago Mr. Achard examined water tinged in a similar manner, which he obtained from a lake near Strautzberg. In the month of December, 1737, the ice of this lake was coloured red, and continued so all the month

phænomenon observed in the water of a lake near the village of Lubotin, in the department of Poren in South Prussia. The most remarkable particulars of which were as follows:

The water of this lake had appeared for some time to be covered with red spots, like drops of blood: in other places of considerable extent it was of a violet red colour; in others of a grass green colour, and large masses of a red matter floated on the surface of it. When the lake in consequence of the severe cold became frozen, the ice for three lines in thickness was of the same red, blue, and green colour which the water had exhibited. The lower part of the ice, however, was uncoloured: a green and red matter inclining to blue was found below the ice to the thickness of a quarter of a yard.

A manuscript account of the same phænomenon gives the following account:—About the middle of December the fishermen, on breaking up the ice in order to fish, observed that not only the ice but also the water of the lake was coloured red, blue, and green, in two places. The lake is about a quarter of a mile in length, four hundred paces in breadth, and is completely surrounded by mountains.

A wood stands close to the margin of the lake on one side, and on the other lies the village of Lubotin with its surrounding district: an arm of the lake, about a hundred feet in length and a few paces in breadth, extends to the village. In this arm, and for a certain extent on both banks of the lake, the water was coloured to half an ell in depth; but under this coloured stratum the water was in its usual state. The case was the same in a part at the extremity of the lake, about fifty feet in length and twelve or thirteen feet in breadth. The water in the remaining part of the lake was colourless. The ice which covered these places was marbled with green, blue, and red spots, of from one to two feet in length. The lower part of the ice, like the water below it, had no unusual colour.

Both these accounts coincide in regard to the principal points of the phænomenon; the small deviations arise no

month of March, when it appeared to be green. In the latter state the water could be used for painting. The red water, after it had stood for some time, deposited a red insipid matter, which, when viewed by the microscope, seemed to be composed of threads interwoven with each other. Mr. Achard concluded, from the few experiments he made with it, that the colouring matter was a vegetable substance. See his *Chymisch Physische Schriften*, Berlin 1780, p. 251—253.

 doubt

doubt from the observations having been made at different times.

It may readily be believed that superstition, as usual, converted this natural phænomenon into a wonderful prodigy, which was considered as the consequence of a shower of blood, and the forerunner of various misfortunes.

To the enlightened philosopher, however, such phænomena are of importance, as they afford him means of explaining, on true principles, what few men of science have made an object of their research.

It needs, therefore, excite no wonder that different opinions have been entertained in regard to the nature and cause of this phænomenon. Some ascribed it to mineral substances, and thence deduced proofs of the existence of veins of ore concealed in the neighbourhood. Others conceived that it had some connection with the earthquake which had a little before been experienced in several parts of Silesia and Bohemia. But, by the help of chemistry, this phænomenon has been found susceptible of another explanation much simpler.

Various authors, both antient and modern, speak of water being coloured and altered in its appearance. We are told by Pliny* that the water of the lakes near Babylon had a red colour for eleven days in summer, and that the Borysthenes, now called the Dnieper, was in summer of a blue colour. In 1668 Mr. Smith† found the water of the Mediterranean to be of a sky blue colour, and when the sun shone upon it this colour was changed to red or purple. The missionary Ferdinand Consag ‡, in the year 1746, observed in the open sea, near California, that the water for the extent of half a mile was of a bluish red colour. Navigators have often seen the water at the mouth of the river Plata, on the coast of South America, of a blood red colour. Schooten found the water at Cape Desiré coloured red, in consequence of a sea unicorn (*Monodon Monoceros*) having lost its horn.

Water is sometimes coloured red, not in reality, but apparently by aquatic insects, which at certain seasons cover the surface of ditches and ponds.

The present case, however, is different. The coloured water of the lake near Lubotin, a considerable quantity of which was sent to Berlin for chemical examination, excited great attention when first seen, by its agreeable changeableness

* Hist. Nat. lib. xxxi. cap. 10. † Acta Erudit. 1709.
‡ Hist. de Californie, tom. iii. Paris 1767.

ableness of colour. When viewed in a vessel of white glass and turned from the light, it appeared of a dark red colour, inclining to crimson, which rendered it entirely opake; but the froth with which it became covered on being strongly shaken was of a bright blue colour. When the glass was turned towards the light the redness vanished, and the water appeared of a sky blue colour. This change of colour took place for several days when the water was preserved in a close vessel.

The results of the different researches made in regard to this phænomenon were as follows:

1st. White paper which had been immersed in this water appeared, after being dried, of a blue colour. The colour suffered no perceptible change either from diluted acids or from alkaline salts.

2d. When poured into a porcelain saucer the water appeared red in the middle and blue at the edges. When placed on warm sand indigo-blue rings were deposited on the sides of the vessel during the evaporation: the last portion, however, was dried into a dirty blueish green mass. When put into water it was not redissolved, but merely divided into blackish scales. The water was again evaporated and digested, but the flakes still remained insoluble.

3d. Another part of the water was put into a glass vessel closed only slightly and deposited in a warm place. The water soon lost its colour, assumed a caseous appearance, and deposited tender blueish green flakes, which were collected and dried. When put on ardent coals, or held to the flame on the point of a knife, they puffed up and burned, emitting the smell of burnt animal substances.

4th. When mixed with alcohol the mixture gradually became turbid, and slimy blueish flakes were separated.

5th. By the addition of sulphuric acid the water, as soon as the first drop of acid fell into it, lost the property of becoming red even when turned from the light, and appeared when held in every direction of a bright blue colour. When exposed to heat, the water at first appeared of a light green colour; it then became completely coloured, and tender woolly thready flakes of a blue colour were deposited.

6th. When decomposed with sulphuric acid the colour of the water first became of a bright grass green colour, then of a lemon, and at last of a straw colour. The tender woolly flakes were of a dirty grayish green colour.

7th. When the water was decomposed with pure nitric acid it appeared throughout of a sky blue colour. When exposed to heat all the colour disappeared, the water not only

only became perfectly clear and colourless, but the caseous flakes which were separated appeared of a pale whitish yellow.

8th. Oxygenated muriatic acid destroyed the colour completely in the course of a few seconds. The water remained for some time turbid and whitish: when exposed to heat it suffered yellowish flakes to be deposited.

9th. By caustic alkali the colour of the water immediately became brownish. A few gray flakes were deposited; the greater part of which, however, were afterwards dissolved. When the clear solution was neutralized by muriatic acid, the part dissolved in the alkali was again separated in soft yellowish gray flakes.

These results are sufficient to enable chemists to determine with certainty the nature of the matter contained in this water. It consists of those component parts commonly comprehended under the name of the albuminous principle, and which in the present case served as the basis of a peculiar colouring matter of the nature of indigo. This vegetable albumen which is contained in a great many plants, and to which belong those component parts of vegetables known under the names of *gluten, materia vegeto-animalis*, &c., is, in regard to its component parts and chemical properties, of an animal nature, and has a near affinity to animal albumen, the caseous parts of milk, and the curdled part of serum. If those plants which among their intimate component parts contain this albuminous matter are abundant at the same time in colouring matter, the latter is commonly in close union with the former. We have an example of this in indigo, the basis of which is of the same nature as albumen.

The dispersion in water of this colouring matter, combined with albumen, can take place only at periods when the plants, to the component parts of which it belongs, are in a state of solution and decomposition by desiccation or putrefaction. The phænomenon, therefore, cannot be observed in summer, when the plants are alive and in a state of vegetation, but only in winter, when they are dead. By the successive decomposition of the dead plants under the water, the extractive matter, and such of its component parts as are susceptible of complete solution in that fluid, pass into it. The albumen is at first received by the water, but it does not enter into a constant, but only apparent and mechanical, solution; the particles exercise a mutual attraction, approach each other, and in that state form a flaky accumulation which floats on the water till they at length are converted into a sort of slime. The colouring matter combined with the albumen undergoes also essential changes, till, being gradually overloaded with oxygen, it is entirely decomposed. When left to itself in stagnant water this disappearance of the colouring matter takes place only very slowly. The coloration of the water by it may therefore, especially in winter, continue several weeks. On the other hand, when a speedier saturation with oxygen is effected the colour is immediately decomposed, as is the case when the coloured water is decomposed by nitrous acid or oxygenated muriatic acid.

Nothing further, therefore, seems necessary to explain this phænomenon than a botanical determination of those plants which after their death transmit these component parts to water. This task, however, I must leave to botanists who may have an opportunity of making such researches on the spot. But I must here observe, that a season of the year in which one can hope to find these plants in their living state ought to be chosen for this purpose.

From various grounds, however, it appears to me probable that these plants belong to the order of the cryptogamia aquatic plants, and are perhaps of the species of the *Conferva tremella, Ulva,* &c. Albumen seems to form a principal component part in these plants, because on their decomposition in the dry way, besides the usual products, they give also ammonia. It might therefore be of importance to examine whether this colouring matter, which manifests itself by the natural decomposition of the plant, could be extracted from it immediately by artificial means. I am inclined to think that this matter will be found in the *Ulva pruniformis,* Linn., because this singular plant, at the end of its vegetable life, is converted into a gelatinous substance, and in that state, before its total solution, floats for some time on the surface of the water. The phænomena I observed in my experiments on this coloured water exhibited a chemical analogy to those of the colouring matter obtained from the indigo plant, *Indigofera tinctoria; Ind. argentia; Ind. disperma;* and from woad, *Isatis tinctoria.* For though the water appeared of a dark red crimson colour, this colour was merely an optical illusion, occasioned by the refraction of the rays of light. The real colour was a pure blue. This property of indigo matter to assume an apparent red colour I have observed in the solid colouring matter itself, as the best sort of the West Indian indigo, as well as that extracted from woad, exhibits

hibits on its smooth surface, when exposed to the light, a cupreous colour. The phænomenon also observed in regard to indigo, that when strewed over coals the smoke which rises immediately from it, when viewed against the light, has a beautiful light red colour, may be connected with the same causes.

This phænomenon is not so uncommon as seems generally to be believed. A few years ago I had an opportunity of making similar experiments on water found in a lake at Strautzberg, not far from Berlin. The same circumstances were observed here, and in the same season, namely, the winter. The water of the lake was in some places coloured red, blue, and green; and masses of the same colours floated about in the parts of the water which were colourless. In flasks which were filled with the water and transmitted to me, the coloured part of the water gradually separated itself and ascended, while the water at the bottom remained colourless. The phænomena which took place in the course of my experiments were exactly similar to those which occurred in my researches respecting that of the lake near Lubotin. In January 1799 Mr. Achard had an opportunity to subject the water of this lake, supposed to be converted into blood, to some experiments also, from which he concluded that the colouring matter consisted of some vegetable substance, and floated in the water but was not properly dissolved in it. The small quantity which he had obtained of this water did not permit him to make any further experiments of a more decisive nature.

A similar phænomenon had been before observed several times in the lake near Strautzberg. According to an account published by Mr. Campe, a clergyman at Alt-Landsberg, in the *Physicalischen Belustigungen**, he saw in the year 1737 the water of that arm of the lake which proceeds towards the town entirely of a red colour. Fifteen years after, the lake in the same place appeared to be wholly green. In the course of two days the water had resumed its usual colour. The water put into flasks, which at first was somewhat red, gradually became putrid; soon after it was thick and muddy; and at the end of some weeks there was separated from it a dark red mass which floated on the surface. In the present case it appeared of two colours; when turned from the light, opake and dark red; when turned towards the light, dark green. This green colour observed by Campe is, however, not essentially different

* Part xi. Berlin 1752.

from

from the blue colour of the water which I examined: it only shows that the proportion of the oxygen combined with the colouring matter was less. For when that quantity of oxygen, which converted the original green colour of the water of the lake of Lubotin into blue, was extracted by means of bodies which had a greater affinity for oxygen, the green colour returned; as was the case when the water was decomposed with sulphuric acid, or with a solution of tin in muriatic acid.

A similar return of blue to green is observed in indigo when employed in the art of dyeing. To prepare it for that purpose it must be decomposed with such substances as deprive it of a part of its oxygen. The prepared indigo liquor appears then green, and the cloth dipped in it is taken out green. But while the cloth is spread out in the air the pigment has an opportunity of acquiring that oxygen which it lost in the bath, by which means the blue colour is produced and fixed.

This coincidence in regard to the phænomena observed in the water of the lake of Lubotin with those of indigo, affords a further proof that the colouring matter of that water was of a nature analogous to indigo.

XLII. *Explanation of the Inscription on a Brick from the Site of antient Babylon.* *By the Rev.* SAMUEL HENLEY, *M.A. F.A.S.**

On the face of Dr. Hulme's brick, over two rude figures of a *large dog, barking*, and *the head of a water-bird*, is the following inscription:

which, expressed in Hebrew characters, distinctly exhibits the words עגה אן, and literally signifies, A BRICK BAKED BY THE SUN.

That  עגה, in its primary sense, *placenta cocta* (Simonis Lexicon, by Eichhorn) is *a baked brick*, it is presumed no one will question; any more than that  אן, signifies the *sun*; when the ground for so rendering it is given.

That אן was the name of an antient city in Egypt, styled

* From *Archæologia*, or Miscellaneous Tracts relating to Antiquity, by the Society of Antiquaries,—just published.

in Greek Ἡλιούπολις, the version of the LXX will prove: ΩΝ, ἡ ἐστιν Ἡλιούπολις. (Exod. i. 2.) This city was built on a considerable hill in honour of the *sun*, (Strabo, lib. xvii. p. 1158,) who had there also a celebrated temple. Remains of these are still extant on their original site, now named Matarea, two hours N.N.E. of Cairo, consisting, as Shaw, Niebuhr, and later travellers relate, of a sphinx, obelisk, and fragments of marble, granite, &c. This temple is mentioned, not only by Strabo, but Herodotus, who also records, that *an annual assembly* was holden in it in honour of the presiding divinity (lib. ii. § 59). Of the city and its sacred monuments, the destruction by the king of Babylon, Nebuchadnezzar, Jeremiah expressly foretold, (xliii. 8—13):—*He shall break also the images of Beth-shemesh,* (or, *the temple of the Sun*) *that is in the land of Egypt.* Now, that Heliopolis received its original name from the Sun is indisputable, inasmuch as that, in antient Egypt, he was denominated ON. This is evident from Jablonski (Panth. Egypt. I. 137), Georgi (Alphabet. Tibetan. p. 87), and expressly from Cyril (in Hoseam, p. 145) who, on reciting the Egyptian fable which makes Apis the son of the Moon and offspring of the Sun, adds, "*that the* Sun *was called* ON *by the Egyptians:*"—ΩΝ δε εστι κατ' αυτους Ὁ ΗΛΙΟΣ, in perfect analogy with the Coptic ⲟⲉⲓⲛ, which, in the language of Upper Egypt, signified LIGHT, and the Arabic عين شمس *the eye* or *fountain of light.*

In perfect accordance with the inscription are the hieroglyphical figures on the brick. That SIRIUS, the chief of the stars, was symbolized by a DOG, a thousand monuments will evince, independently of the name Ἀστροκυων, or *Dog-star*, which to this day he retains. The origin and application of this symbol are in themselves sufficiently plain. The vigilance of a dog was significantly expressive of the star, which, by its heliacal appearance, gave certain notice that the sun had arrived at its greatest elevation. Hence the LATRATOR ANUBIS in Egypt, which, according to the rabbins, was the same with NIBCHAZ, the *barking watch-dog* of the AVITES. In 2 Kings, xvii. 24, we read that "the king of Assyria brought from Babylon, Cutha, *Ava*, and other cities, colonies to repeople the empty cities of Samaria, whose inhabitants this conqueror had carried away captive." In verse 31 it is added that, as these nations, in their new settlements, set up their gods, so the gods of the Avites were *Nibchaz* and *Tartak*. The precise form of the latter is hitherto unascertained; but commentators

tors explain it to have denoted, *the stated revolution of the Sun*; which perfectly agrees with the import of *Nibchaz*, literally signifying *the barking watch-dog*. (נבחז from חזה *to watch*, and נבח *to bark as a dog*. Kimchi.) Thus, Abarbanel: והעוים עשו נבחז, שהוא הכלב שנובח בעזות, *and the Avites made* Nibchaz, *by which is intimated* THE DOG THAT LOUDLY BARKS. Accordingly, about three hours from Berytus, towards Tripoli, the country these Avites occupied, is a high mountain, upon which was erected, on a column, a vast dog, which uniformly barked at the season. Though this monument be now overthrown, its remains are still visible in the neighbouring sea; whilst a river, that empties itself in it, still keeps the name of *the river of* THE DOG, نهر الكلب, נהר כלב. This river the Greeks and Latins styled *Lycus*, from the resemblance, as is conjectured, to those that sailed by, which the dog on the column might have born to a *wolf* (Eichhorn's Simonis, p. 965); but rather, as is probable, from both having a congruity in their hieroglyphic application; the wolf being sacred to the sun, as an animal of the dawn. Hence the wolf in the temple of Apollo at Delphi, and the epithet *Lycian*, ascribed to the same god; not to omit that the term ΛΥΚΑΒΑΣ for a *year*, properly expresses an *anniversary procession of light*.

Nor, so far as Egyptian hieroglyphics will go, is there any discrepancy in respect to the BIRD. The rise of the dog-star, or barking of Anubis, statedly proclaimed the overflow of the Nile; a constant concomitant of which was the IBIS. This bird, as such, is frequently seen on Egyptian coins; and, to express its relation to the Nile, with *two lotus leaves* on its head; which were the established characteristics on the head of that river when *personified* at the time of exundation: on the Nilometer also the same leaves appear floating upon the high-water line. Now, as to the like overflow with the Nile the Euphrates is annually subject, it is more than probable that Babylonia might have owed its deliverance from noxious reptiles to the same, or some similar bird. If so, the divine honours vouchsafed to the *Ibis* in Egypt for its anniversary good offices would afford at Babylon a sufficient reason for introducing the *bird* at this season, along with the *barking dog*, discriminative of it.

The inscription itself is in two views pertinent. This brick is unquestionably *sun-baked*, and therefore exhibited an effect of the intense power of the great "Αναξ πυρος;"

but

but it had, perhaps, still greater pertinence, as, in that part of the structure which bricks with this impress were designed to occupy, each one might serve to commence a new series in the annual order of astronomical records, which the entire pillar, or obelisk, might be destined to preserve. In Egypt, we know, one name of the *dog-star* was SETH, and that the most antient and wise of the Egyptian astronomers dated the commencement of their year from his heliacal rise (Jablonski, II. 51). How far this name extended, it is not easy to define: but Josephus mentions a tradition of the existence of two brick pillars of *Seth*, one of them *sun-baked*, which contained astronomical records *antecedent to the flood*. The true history of this might be, that on them were inscribed a relative register of solar, lunar, and sideral revolutions, adjusted to the series of antediluvian years. The Egyptians, however, dated the origin of the world from the first rise of the dog star, and a notion not unlike it occurs in the sublime poem of Job, who bordered on the confines of Chaldea, (chap. xxxviii.)

> Where wert thou when I laid the foundations of the earth?
> Whereupon were the sockets thereof set?
> Or who laid the corner stone of the same?
> When the *morning stars* sang together,
> And all the sons of God shouted for joy.

Though it were to a far less remote period that the astronomical observations extended, which were recorded on bricks at Babylon, and thence transmitted by Callisthenes to Aristotle, they, however, fix the first foundation of that city to the time of Nimrod, and most accurately agree with its history by Moses.

But here a consideration arises of no little importance. The inscriptions on the two sides of this brick essentially differ, the one being of *alphabetic* characters, the other *monogrammic*. Alphabetic characters of the same form may be seen, in frequent recurrence, upon both Egyptian and Phœnician remains; yet, as far as I can discover, are visible on no other of these bricks; whilst the *monogrammic* occur on them all. Dr. HAGER, who hath written on the Babylonian inscriptions with much erudition and acuteness, passes this topic unnoticed. By comparing, nevertheless, the bricks engraved in his work *, it will be seen, from the order in which particular characters recur, that sufficient scope is left to suppose the inscriptions of which

* For an account of Dr. Hager's work, see Philosophical Magazine, vol. xi.

they

they consist are rather NOTATIONS than NARRATIVES. Nor do I apprehend any evidence from the ruins of Persepolis, or the Persepolitan monument, I send herewith *, will militate in the least against this conjecture. The figures Dr. HAGER has given from the cylinders, appear to indicate festivals corresponding with the astronomical notices that accompany them; and the *goat* of the second may have a relative import with *that* in this present from M. MILLIN.

XLIII. *Eleventh Communication from Dr.* THORNTON.

To Mr. Tilloch.

No. 1, Hinde-street, Manchester-square,
December 20, 1803.

SIR,

IN the last letter that I had the honour of addressing to the philosophic world, through the medium of your excellent Magazine, I mentioned among my observations the consideration of the *balance* of *principles* as affecting health, and even the very existence of the animal œconomy. The following cases will further tend to illustrate this opinion:

Case of Mrs. Chapman.

Mrs. Chapman, æt. 65, a nurse employed in the first families, being upon a visit to the housekeeper, upon her coming to town, at the dowager lady Williams Wynne, was ordered by me thirty drops of laudanum, and an aperient draught in the morning, to prevent the constipating effects of laudanum. She took the same, and passed a very comfortable night. In the morning the maid servant came to give her the morning draught; but, by mistake, took up the bottle containing the laudanum, which she poured out, and the whole was drunk down, amounting to near two ounces. Some little time elapsed before the mistake was discovered, and I was immediately sent for. I ordered an emetic, and lemonade to be drunk plentifully, and the patient to be got up, and to be continually roused to take the acid drink. By this means there was only a sensation of great drowsiness produced by the opium, and the patient being at length allowed to sleep, this went off, and she was as well as ever in the evening.

* An engraving forwarded to Mr. Henley by M. Millin, superintendant of the National Museum at Paris. It exhibits the face of the celebrated Persepolitan monument brought lately to France by M. Michaux.

Case

Case of Mrs. ———.

When called to this lady, I found her stupified on the bed, with an unconquerable disposition to fall asleep in whatever position placed. She was six months gone with child; and from some disagreement with her husband, who had left her, she conceived the wretched project of ridding herself of an existence now become insupportable without that relief which religion affords, and which ever deters from suicide in the hour of affliction. As prior help had been called in, and the emetic sent had operated, I ordered upon my arrival vinegar mixed with water to be drank, which awakened our torpid patient, and being repeated at intervals, until the lemonade was substituted, took off the sedative powers of laudanum; and in the evening our patient was free from all danger.

Observations on these Cases by Dr. Thornton.

1. Laudanum and wine have been happily compared by modern physicians as to their effects on the animal œconomy.

2. As wine by distillation is made into brandy, and brandy, by another process, into ether, so do we explain the concentrated powers of laudanum dependent upon a few drops.

3. As there is first ill-directed action, then total loss of muscular power, and sleep, the kind provision of nature to recruit the irritable principle, taken away by the disoxygenating effect of too much wine or laudanum received into the stomach, the philosophic practice indicated is to add as a balance to the hydrogen the oxygenous principle.

4. That this last principle is greedily absorbed by the stomach under these conditions appears from the acid drinks being at first brought up free of the acid taste, and removing quickly the intoxication.

5. In the case of sir George Braithwaite Boughton, bart. (*Vide* my Philosophy of Medicine, vol. iv. p. 128), where, in addition to the lemonade, the inhalation of a superoxygenated air was employed, the cure was remarkably rapid.

6. In the West Indies, when the negro has put out the quantity of rum, he says to his master, "Masse, do you drinky for *drunky*, or drinky for *dry*;" and proportions the quantity of lime-juice accordingly, employing no difference as to the spirits or water.

7. The disagreeable effects of laudanum on the head, as with intoxication, the next day, is removed by the inhalation of

of vital air. (*Vide* my Philosophy of Medicine, case xxxiv. vol. i. p. 497.) This observation is worthy of regard to such as are obliged to have recourse to this remedy, as a solace during night, labouring under irremediable disease.

8. The sudden death produced by drinking of lemonade, when hot by dancing, shows that the oxygen is hastily absorbed; and no such effect being produced, if a little spirit be added, is a further proof how these principles (viz. hydrogen and oxygen) balance each other.

9. The practice of taking persons out who are swooning, or in a state of intoxication, into the open air for their recovery, depends upon the supply of oxygen to the system, then deficient.

Sir, I have been more anxious to record such cases, as the accidents by opium are much more frequent than from any other means. In the one case above recorded, the lady went to different shops and got a small supply from each, and then drank off the aggregate. Other poisons are not easily procured. I shall conclude in the memorable words of sir George Brathwaite Boughton*:—"*If it can be of any use in a science which has for its object the ease and happiness of mankind, I shall always look back with pleasure to these accidents which have afforded me an opportunity of giving you this detail.*"

I am, sir, your obedient servant,
ROBERT JOHN THORNTON.

[My next communication, will be the case of a physician cured by the inhalation of *vital air*, every other means having previously failed.]

XLIV. *A Contribution towards the assaying of Coins.* By *Professor* KLAPROTH.

In this essay I shall first give an account of the process I employed: I shall then exhibit the component parts of the coins I examined, and conclude with some observations deduced from my experiments.

I found by some previous experiments that on the earlier Greek coins, besides copper, the principal component part, I had to direct my attention to tin and lead as essential additions, and to iron and silver as accidental mixtures; and in the Roman coins to a considerable quantity of zinc. In con-

* In a letter written to and published by Dr. Beddoes.

consequence of these observations I made my docimastic researches in the following manner:

1st. After freeing the coin from its rust, the *ærugo nobilis*, I poured over it in a phial moderately strong nitric acid, and left it to spontaneous solution. Next day I poured the solution from the remaining part of the coin, and, having supplied its place by a new quantity of acid, repeated the same process till the coin was completely dissolved.

If it contained tin, which was the case with all the Greek coins, but only with some of the Roman, it remained behind in the form of a grayish white calx, and was collected on filtering paper. In regard to Roman coins which contained no tin, its absence was indicated by the perfect clearness of the nitric solution. A counter-experiment, in which I employed a mixture of copper with a quantity of tin exactly weighed, showed that 100 parts of the above calx of tin might be estimated as equal to 71½ parts of metallic tin. In order that I might convert the calx of tin separated from the coin into a metallic form, I boiled it with a quantity of muriatic acid sufficient for its solution, diluted the solution with two parts of water, and immersed in it a rod of zinc, by which means the metallic tin was precipitated.

But when the solution of copper containing tin was decomposed by nitric acid, the calx of tin was by these means combined with a greater proportion of oxygen, and thereby rendered unsusceptible of solution in muriatic acid. In this case I found the dry way more convenient, and effected the revivification of the metal in a well-closed charcoal crucible over a strong fire maintained by a pair of bellows. Of the gold supposed to be contained in the earlier antient coins, and which must have been found as a residuum in the nitric solution, I could discover no traces.

2d. I first examined the nitric solution which contained no tin, to find whether it contained silver. I mixed a portion of it with a saturated solution of muriate of soda, and put into another a plate of copper which I had weighed: I, however, found no certain traces of that metal, except in a coin of the Mamertines.

3d. To effect a separation of the lead, I decomposed the nitric solution with a saturated solution of sulphate of soda, collected the sulphate of lead separated from the mixture, reduced to a small quantity by evaporation, and either reduced it in a crucible with charred tartar, or calculated the quantity by counter-experiments. According to which, 100 parts of sulphate of lead might be estimated as equal to 70 parts of metallic lead.

 I effected

I effected the separation of the lead in another manner. I distilled the nitric solution in a retort till it was almost reduced to a dry mass, softened the mass again with diluted sulphuric acid, by which means the sulphate of lead was collected as a ponderous powder; after which I reduced it to metallic lead.

4th. The last method afforded me at the same time the means of detecting the small quantity of iron contained in some of these coins, as this metal, when the thickened mass was softened by diluted sulphuric acid, remained behind, as an insoluble calx of iron, along with the sulphate of lead, which appeared coloured by the iron of a yellow ochre colour. By digestion in muriatic acid, the sulphate of lead was freed from this calx of iron, and the latter was precipitated from the solution by prussiate of potash or by caustic ammonia.

5th. Nothing now remained in regard to the Greek coins but the separation of the copper, which I effected with most convenience by precipitating with polished plates of iron. The difficulty which attends the process of precipitating copper in a metallic form from a nitric solution by means of iron or zinc, as a part of oxidated metal is thrown down at the same time, did not occur in this case, as in the present solution of copper the nitric acid was combined with muriatic and sulphuric salts.

6th. The Roman coins may be divided into two kinds, the red and the yellow. The red consists of unmixed copper, in the examination of which nothing further was to be observed; in the yellow, however, the copper was mixed with a considerable quantity of zinc.

In order to find out a complete and accurate method of separating the zinc I prepared a nitric solution of three parts of copper and one part of zinc, divided it into four portions, and employed it for the four following experiments:

Exp. I. I decomposed one portion with sulphate of soda, and precipitated the copper from it by iron: after the copper was separated, I evaporated the solution to a dry mass and drove off nitric acid from it several times, till the calx of iron was perfectly insoluble. I then precipitated the tin from the solution freed from the iron by means of potash, and estimated the quantity by counter-experiments, according to which 100 parts of calx of tin gave 175 parts of dried, or 123 parts of ignited, precipitated calx of tin.

Exp. II. From the second portion I obtained the tin in the following manner:—When the copper was separated and

and precipitated as before, by iron, I mixed the solution to complete saturation with caustic ammonia, which again dissolved the precipitated calx, and the calx of iron remained behind. When the latter had been separated, I saturated the superabundant ammonia with sulphuric acid, and precipitated the calx of tin by mild potash.

Exp. III. I employed a shorter process with the third portion of the solution containing zinc. I evaporated it to dryness, redissolved the mass in diluted sulphuric acid, precipitated the copper by a rod of zinc accurately weighed, and after its separation, precipitated the dissolved zinc by mild potash; and from the quantity of the calx of zinc which I found, I deducted that portion which the rod of zinc employed for the precipitation had contributed.

Exp. IV. In regard to the fourth portion I endeavoured to accomplish what I had in view by the following means: I diluted it with four parts of water and poured it into a flat dish, the bottom of which was covered by a thin plate of lead. At the end of a few days I found the solution completely decomposed, and the copper precipitated in a metallic form without being rendered impure by a quantity of precipitated metallic calx, as is commonly the case when zinc and iron are employed for the precipitation of copper from pure nitric acid. After the copper was separated, I reduced the fluid, which was of a straw colour, to a small quantity by evaporation, mixed it with a saturated solution of sulphate of soda, separated from it the sulphate of lead which was formed, and precipitated the pure zinc by carbonate of potash. Of these four ways of detecting the tin contained in the mixture, the last appeared to me to be the best: I therefore employed it chiefly in my examination of coins.

That the calx of zinc which I obtained was actually that substance I assured myself by mixing it with charcoal powder, putting small plates of copper along with it in a covered crucible and bringing it to a proper degree of heat. After cooling, I found that the copper was converted into brass.

I dissolved another part in acetous acid, and left the solution to spontaneous evaporation, by which means the acetite of zinc shot into that crystalline form peculiar to it, that is to say, tablets of six planes with equal angles.

The solutions of the Roman coins after the separation of the zinc, when any of that metal was present, I divided into two parts. I employed one of them to examine whether

R 2 they

they contained silver or lead, and then to precipitate the copper by iron: the other part I employed in order to discover the zinc.

The following Greek coins were subjected to analysis according to the preceding methods.

I. GREEK COINS FROM MAGNA GRECIA AND SICILY.

No. 1. A Syracusan coin of king Hiero. On the one side the head of a young man, ornamented with a diadem: and on the reverse a horseman with a couched lance, and the inscription Ἱερωνος. The metal had a red colour, inclining to pale yellow, was exceedingly brittle, and on the fracture fine grained and dull. The coin weighed 267 grains, and consisted of

Copper	- - -	233 grs.
Lead	- - -	20
Tin	- - -	13
Iron	- - -	1
		267

No. 2. A Syracusan coin also. On the one side the head of Apollo: on the reverse the Delphic tripod, with the inscription, Συρακοσιων. The metal was pale yellow, brittle, on the fracture fine grained and dull. It weighed 74 grains, and the component parts were:

Copper	- -	61½ grs.
Lead	- - -	8
Tin	- - -	4½
		74

No. 3. A Neapolitan coin. On the one side a head of Apollo, ornamented with a laurel crown: on the reverse a minotaur, crowned by victory, hovering over it. The subscription Νεαπολιτων. The metal was merely pale yellow, exceedingly brittle, fine grained, and of a steel gray colour on the fracture. It weighed 78 grains, and contained

Copper	- - -	54 grs.
Lead	- - -	17
Tin	- - -	7
		78

No. 4. A coin of the Centuripini. On the one side a head of Jupiter Tonans, with a bushy beard, ornamented with

with a crown; on the reverse a winged thunderbolt with the inscription Κεντοριπινων. The metal approached a golden yellow colour, and was somewhat tougher than that of the preceding coins. It weighed 167 grains, and contained

Copper	-	-	-	142 grs.
Tin	-	-	-	14
Lead	-	-	-	11
				167

No. 5. A coin of the Brutii. On the one side a beautiful bearded head of Mars, with a helmet: on the reverse a soldier standing, with the inscription Βρεττιων. The metal was pale yellow, brittle, and fine grained on the fracture. The coin weighed 258 grains, and consisted of

Copper	-	-	-	218 grs.
Lead	-	-	-	28
Tin	-	-	-	12
				258

No. 6. A coin of the Mamertines. On the one side a beautiful head of Apollo, with a laurel crown: on the reverse a soldier sitting, with the inscription Μαμερτινων. The metal was pale yellow, somewhat tough, fine grained on the fracture, dull and reddish gray. The coin weighed 195 grains, and contained

Copper	-	-	-	165 grs.
Tin	-	-	-	15
Lead	-	-	-	14
Silver	-	-	-	1
				195

As I did not find any traces of silver in the rest of the coins, the small quantity found in the above case was present, it is probable, only accidentally.

II. ROMAN COINS OF THE FIRST CENTURY OF THE EMPIRE.

1. *Copper.*

No. 7. On the one side the head of Augustus, with the inscription *Divus Augustus Pater*; which shows that this coin was struck after the apotheosis of that prince: on the reverse a square altar, with its steps, and the subscription *Providentiæ.*

Providentiæ. In the field the letters usual on the earlier Roman copper coins, namely, S. C. (*Senatûs consulto*). The coins weighed 144 grains, and consisted only of copper.

No. 8. On the one side the head of Caligula: on the reverse a Vesta sitting. The coin weighed 141 grains, and consisted also of pure copper.

No. 9. On one side the head of Vespasian, with a laurel crown: on the reverse a winged Victory, standing on the beak of a ship and holding out a laurel crown. The inscription *Victoria navalis.* It weighed 176 grains, and was merely of copper.

2. *Brass.*

No. 10. On the one side Castor and Pollux, under the form of two horsemen, with the inscription *Cæsar Augustus Germanicus:* on the reverse S. C. in the middle, with an illegible inscription. The coin was of a brass yellow colour. It weighed 150 grains, and consisted of

Copper - - -	119 grs.
Zinc - - -	31
	150

No. 11. A coin struck in honour of Nero and Drusus, the sons of Germanicus. On the one side a quadriga: on the reverse an indistinct figure, either a soldier standing, or a trophy. In colour and toughness it was similar to the preceding. It weighed 233 grains, and contained

Copper - - -	187 grs.
Zinc - - -	46
	233

No. 12. On the one side a head of Tiberius, behind which was an oblong impression (*Tudula*) |TIA/|. On the reverse a civic crown, with the inscription *Ex S. C. ob cives servatos.* This coin weighed 380 grains, and consisted of

Copper - - -	296 grs.
Zinc - - -	84
	380

No.

No. 13. On the one side a head of Vespasian: on the reverse a soldier sitting. It weighed 360 grains, and contained

Copper	-	-	-	293 grs.
Zinc	-	-	-	59
Lead	-	-	-	4
Tin	-	-	-	3
Iron	-	-	-	1
				360

No. 14. On one side the head of Trajan: on the reverse a sitting figure, which seemed to be a Vesta. It weighed 382 grains, and was composed of

Copper	-	-	-	326 grs.
Zinc	-	-	-	53
Tin	-	-	-	3
				382

No. 15. Another coin with the head of Trajan: and a similar figure on the reverse. It weighed 365 grains, and gave

Copper	-	-	-	294 grs.
Zinc	-	-	-	60
Tin	-	-	-	11
				365

It appears from these results that the Greeks, for their early coins, employed in general a mixture of copper, zinc, and lead. On the other hand, that the Roman coins are of two kinds, one of which consists only of copper, and the other of a mixture of copper and zinc.

The custom of mixing copper with zinc may be traced back to the remotest periods. It is well known that the oldest nations employed copper in general for their utensils, and even for their sharp cutting instruments. But as copper, and especially when cast, is not of itself sufficiently hard for that purpose, it may be readily conjectured that experiments were made at a very early period to communicate to it a greater degree of denseness and hardness by a mixture with other metals, none of which, except tin alone, were likely to answer the proposed end. Such mixtures of copper and tin were called by the Greeks χυτὸν, and by the Romans *æs caldarium*, as at present, according to the different uses to which it is applied: for statues, bells, and cannon, it is called bronze, bell metal, and gun metal.

But as copper by its mixture with tin becomes denser and harder, acquires a greater specific gravity, and becomes more sonorous, it is in the same proportion rendered more tender and brittle. It consequently ceases to be malleable. Pliny says* *Caldarium funditur tantum, malleis fragile.* The Greek coins, therefore, consisting of such mixed metals, do not seem to have been struck, but to have been cast, and the circumstance of their being generally concave on one side must be considered as a consequence of the contraction or warping occasioned by their cooling.

Among the mixtures (*temperatura*) of copper mentioned by Pliny, there is one in particular, which he calls *æs tenerrimum*, which is found in the Syracusan coins: it consists of 100 parts of copper, 10 parts of lead (*plumbum nigrum*), and 5 parts of tin (*plumbum argentarium*); of which mixture he says that it appears with that colour which he calls the Grecian (*color Græcanicus*). Under the term *plumbum nigrum* of the Roman writers we must understand our lead. Their *plumbum argentarium, album candidum*, however, is not lead, but the Κασσιτερος of the Greeks, or our tin; and Pliny clearly means by it tin fused from washed ore. The word *stannum* however occurs in Pliny, but this word was not used by the Romans to denote our tin but a mixture of silver and lead, or that substance which, in the language of the German miners, is called *werkbley*†, or merely the *werk*. In regard to the Roman copper coins, they consisted, as already seen, either of pure copper or of a mixture of copper and zinc, which was called by the Romans *aurichalcum*, or *orichalcum*, and also *æs Corinthiacum*, and seems to belong to the same class as our brass, pinchbeck, similor, &c. Metallic zinc however was at that time entirely unknown, and no traces of it are to be found before the 13th century, at which time it was mentioned by Albertus Magnus.

It clearly appears, from several passages in antient authors, that the antients employed a method for preparing this mixture of calamine (*cadmia fossilis*) similar to that which we employ for the preparation of brass. Festus says expressly, *cadmia terra aes conjicitur, ut fiat orichalcum.*

But it is proved, by a passage in Aristotle, that another people,

* Lib. xxxiv. cap. 20.

† Lead from which the silver contained with it in the ore has not been separated. EDIT.

people, the Mossinæci, who resided near the Euxine sea, understood and practised this art before the Greeks or the Romans. That author, in his work *De Mirabilibus Auscultationibus*, Paris 1619, says, *Aes Mossinœcum* (Μοσσυνοικῶν χαλκον) *splendidiore candore eminere ferunt, non adjecto stanno sed terra quadam istic nascente simul in coctum. Atque ejus adtemperaturæ primum inventorem celata arte, neminem docuisse, et proinde priorum temporum æramenta iis in locis posterioribus longe præstantiora deprehensa.*

Philologists seem entirely to have overlooked this passage, from which the etymology of the German word *messing*, or more properly, as it was formerly written, *moessing*, which signifies brass, may be clearly and simply deduced. It is improper to derive it from *mischen* or *maischen*, to mix, for the antients had no idea of mixture in the preparation of this metal. They did not know that a metallic substance is actually mixed with the copper, for they supposed that the calamine only possessed a secret property, by which it communicated to copper a golden yellow colour*. The terms *latun* (*laton*, *laiton*), deduced from the Arabs, and introduced into some of the languages of the western part of Europe, are of later origin.

It appears from the above passage of Aristotle, that the art of converting copper into *aurichalcum*, by means of calamine, was at first kept a secret; but it seems to have become more common about the time of the Roman empire. But the cause of this new alloy of copper, after it was made generally known, being mixed with tin and lead, and used in preference for coins, no doubt was its gold colour, which excelled that of the pale yellow *aurichalcum*, and its toughness and malleability, arising from the mixture of calamine, which rendered it fit to be struck into coins, whereas the old mixtures with tin could only be cast.

When I placed Corinthian brass in the same class as *aurichalcum*, this arrangement is in contradiction to the opinion that this metal was produced from the fused metal of the gold, silver, and copper statues, and other articles formed into one mass when the city of Corinth was taken

* I have since found that I am not the first person who has given this etymology of the word *messing*; for Mathesius says: The Latin Bible retains *Aurichalcum*, that is, *messing* (brass), which word is certainly derived from the name of the people called *Mossynœci*, mentioned by Aristotle.

 and

and destroyed by Lucius Mummius. It is however possible a similar metallic mixture may have been accidentally produced during the conflagration of that rich city, but no proof of this has ever been found by actual examination. It appears rather from Pliny, that the expression *æs Corinthium* was a term of art applied to a metallic mixture in high estimation among the Romans, and which, in consequence of a more careful choice in the ingredients, and more exactness in the proportions, may have been different from *aurichalcum*. But if the opinion of antiquaries, that the coins struck in the time of Tiberius of a gold colour were of real Corinthian brass be well founded, the mixture has now been determined by assaying*.

In regard to the small quantity of tin and lead contained in the coins of Vespasian and Trajan in mixture with the zinc, the addition of these does not appear to have been a rule. What Pliny says of the metal destined for statues and tablets, that a third part of old copper was added to it, was in all probability the case also in coins, and the mass must therefore have been different according to the different nature of the fragments of copper employed for the mixture.

My researches in regard to the metallic mixture of the antient coins was confined to a small number, and therefore are not sufficient to admit of general conclusions to be drawn from them respecting the coins of every nation at different periods, and according to the different changes in the mixtures. For this purpose a much greater number of docimastic experiments would be necessary.

They are, however, sufficient to excite doubts in regard to the abundance of gold and silver which are supposed by some to be contained in the antient coins, and to show that the hardness of the Greek coins, and of various edged and sharp-pointed instruments of the antients, cannot be ascribed either to any art now lost, nor to a supposed addition of arsenic or iron, but merely to a mixture of tin †.

XLV. *On*

* In order that I might observe the real colour and appearance which these coins had when first struck, I caused two of them to be struck anew. The first, which was a coin of Tiberius, with a Ceres in a sitting posture on the reverse, was fused, and then rolled flat, and struck into a coin. The other with the head of Vespasian, and on the reverse a sitting figure, with the inscription *Roma*, was only smoothed, and then struck anew. I then caused some artificial imitations of Corinthian brass to be struck also, that I might compare them with these antient coins.

† The latest chemical analysis of current coins with which I am acquainted

XLV. *On Cinis; a Kind of Alkaline Earth formed during the Incineration of Wood, not yet noticed by Chemists in their Nomenclature. Addressed to* George Pearson, *M. D. F. R. S. &c. by* Samuel L. Mitchill, *M. D. Member of Congress, &c. in a Letter, dated New York, September* 20, 1803, *and communicated to Mr.* Tilloch *at the particular request of the Author.*

The phænomena of combustion have by no means been examined to their full extent. The decomposition of wood by fire is a very complicated process. There is much more to be remarked in it than has been noticed in books. In particular the formation of a new kind of *alkaline earth* renders it remarkably interesting. In New York, where wood is the principal fuel of the inhabitants, and where great quantities of potash are manufactured from the fixed mass which remains after burning, I have availed myself of the opportunities afforded to find out some of the details. Those I have endeavoured to express in the following record of facts:

When a quantity of wood (in a solid, not a rotten state), oak or hickory for example, has received anticrouon (the repelling principle or caloric) enough to render it capable of decompounding the gaseous oxide of light (oxygenous air), it begins itself to lose its vegetable structure and to assume new forms. The anticrouon first dilates the wood by increasing the repulsion among its particles; then it repels the water which it contained to such a degree as to convert it into steam or aqueous gas. The moisture being thus exhaled, and the wood left shrunk, perfectly dry, and highly heated, its carbon attracts a portion of oxygen from the gaseous oxide of light with which it is closely invested. The immediate consequence of this is, that a portion of detached light becomes visible, and a quantity of extricated anticrouon spreads through and over the wood, and extends about the surrounding spaces. In proportion to the amount and rapidity of the oxygen, abstracted from the gaseous oxide of light, will the extricated light be vivid, and the separated heat be intense. While the liberated anticrouon and light, just nascent from their latent condition, are

quainted is that by Dize, in *Rozier's Observat. sur la Physique*, for the year 1790. But there seems to be great reason to doubt their being correct, because the author makes all the coins to consist of copper and tin, without saying a word of the *lead* found in the Greek coins, or the *zinc* found in the Roman.

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thus expending themselves upon the surrounding objects, a portion of carbon, repelled from its connections in the wood, flies off in connection with a portion of atmospheric oxygen in the form of carbonic acid air. No sooner has this happened than the phlogiston (hydrogen) of the fuel is repelled from its association in the timber, and forming a new association with the oxygen of the gaseous oxide of light, constitutes blaze; a meteor burning in an aërial form. This phlogiston and oxygen, after chemical union, turn to steam, and finally condense to oxide of phlogiston or water; while an additional quantity of anticrouon and light are shed around after detachment from the oxygen, which has just left them to combine with the phlogiston to form water. While these changes are going on, a portion of septon (azote) sometimes from the vegetable body, but more commonly from the septous (azotic) part of the atmosphere, connects itself with a part of the separated phlogiston and turns it to volatile alkali (ammoniac). A part of the oxygen also combines with the basis, whatever it is, of the pyrolignic acid, and this, by force of anticrouon, is repelled into gas.

Thus, during the time that wood, oxygenous air and azotic air undergo their *triple* decomposition, liberated light, liberated anticrouon, carbonic acid-gas, flame, oxide of phlogiston or water, ammoniacal gas and pyrolignic acid gas are quickly produced.

But these are only a part of the curious products of combustion. There are several *fixed* substances formed whose history is no less worthy of notice than that of the *volatile* ones already enumerated. These are contained in the caput mortuum, or residuary mass left on the hearth or in the fireplace after incineration, and called "ashes."

These ashes are a very heterogeneous collection of materials. They may be properly divided into two classes, to wit, those which readily dissolve in water, and such as with difficulty incorporate with that fluid. The former is the *saline* and the latter the *earthy* part of the ashes. And both of them, as they most clearly do not preexist in the wood, are produced by new combinations of particles during the act of burning.

Of the *saline* portion of wood-ashes, the predominating ingredient is the vegetable fixed alkali or *potash*. When recently formed, and fresh from the fire, this fixed salt is in a *caustic* state. By exposure to the air in a cool place for some time it attracts fixed air and becomes a *carbonate* of *potash*. Very commonly too this alkali, when exposed

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in foul and nasty places, turns to a *septite* of *potash*, by attracting and neutralizing the septic acid recently engendered in such situations. Very commonly too this alkali is found to be combined with sulphuric acid into a *sulphate* of *potash*; and lately on examining some curious samples of this salt from the manufactories, I found them to contain phosphoric acid.

In these two latter cases, sometimes external causes, and at other times the woods burned, furnish a quantity of sulphur and phosphorus, which acidifiable bases first turn to acids during the process of combustion, and then the newly formed acids connect themselves with the potash to constitute compound salts. Frequently likewise muriate of soda is discovered in wood ashes; but this seems to be derived from the culinary salt employed in cooking.

After these saline substances are extracted by water in the course of lixiviation or letching, a large quantity of earthy matter remains behind. The proportion of this varies in the ashes of different vegetables, but in that of sound oak and hickory perhaps amounts to eight-tenths of the whole. In this state it is called *letched*, *dead*, or *soap-boilers'* ashes, and is bought at a high price by farmers in the neighbourhood of New York for manure. In its crude condition, as taken from the vats or letch-tubs, it abounds with charcoal, soot, and other half consumed vegetable substances which had escaped the destructive force of the fire. Particles of silicious and argillaceous earths are generally present, derived in all probability from the sweepings of floors, the crumbling of chimneys, and other external sources. Besides these there is found a quantity of iron; though I have not found any of the manganese which some experimenters talk of. But above all, this residuary mass abounds in lime, which is intentionally added, in its caustic state, to attract carbonic and phosphoric acids from the potash, and thereby to render that alkali quick and active; or, in maritime situations in America, a large admixture of calcareous earth is derived from the roasting of clams, oysters, and other testaceous animals, and the addition of their shells to the ashes. But by far the greatest proportion of letched ashes consists of a peculiar kind of earth, which remains after all the before-mentioned materials are separated. This earth is of a whitish colour and alkaline quality, as you will see by the sample I herewith send you for experiments. I think it differs materially from lime, barytes, magnesia, strontian, or any other known species of earth.

earth. And yet plentiful, common, and important as it is, science has not dignified it with a name.

To judge of the excellence of soap-boilers' ashes for manure, the following facts may give you the requisite information :—After all the salts are extracted it sells for ten cents the bushel *, or for one dollar and thirty-seven cents the cart load of fourteen bushels, deliverable at the city wharf. When this is delivered to the farmer at his own landing, the additional cost of freight to the country (as from the city of New York to Plandome, 25 miles) amounts to twenty-five cents a load; making in the whole one hundred and sixty-two cents. To this must be added the expense of drawing and spreading it on the land. All this the farmers pay; and yet such is the competition for these refuse ashes, that it is not uncommon for the farmer who buys to advance the cash to the soap-boiler six or twelve months beforehand. When scattered over sterile ground and ploughed in at the rate of twelve loads the acre, it produces great crops of wheat, clover, and other sorts of grass and grain; and its effects are so durable, that the fertilizing operation of it may be often discerned for seven, ten, or sometimes even twenty years. It is this disposition of dead *ashes* to endure which makes it cost so much more dear than *street dirt*; a material which, though very valuable, is by far more transient.

Now, on considering the value and efficacy of letched ashes it would appear, that though some of its virtue was derived from the charcoal, soot, and other undecomposed vegetable matter, lime, and the remnant of carbonate of potash which has escaped the lixiviating process, yet that its principal worth was derived from the *peculiar earth* which constitutes the chief part of its bulk. It is time to give it a name, and to introduce it into the nomenclature. And in case you should agree with me in opinion as to the facts, I flatter myself you will agree with me also in distinguishing it by the word *Cinis*, or the earth of wood-ashes. And I must own such a coincidence would be very flattering to me with one who has distinguished himself so much in improving the logical as well as the physical department of science as Dr. Pearson. Under that title it has as good a right to stand conspicuous, and be known and talked of, as either magnesia or lime, potash or soda; all of which are to be, like cinis, considered as compounds, but retained

* Our bushel is the same with your Winchester measure.

nevertheless in the list of simples until their constituent facts can be ascertained by analyses.

It is worthy of remark, that this earth which is so prized in America for a manure, was esteemed of old in Asia as an ingredient in a cement: among the antient Syrians it was one of the materials forming the plaster of their walls; and as it holds an intermediate place between lime and pot-ash, it can easily be conceived how it may act both as a cement and a manure. It is to be hoped chemists will turn their attention more particularly than has been heretofore done to this important but neglected subject.

XLVI. *Account of a Shower of Stones; in a Letter from the Prefect of the Department of Vaucleure to the French Minister of the Interior, dated November* 10, 1803.

"On the 8th of September, between ten and eleven in the morning, being at Bastidonne, a village situated between Perthuis and Mirabeau, I heard a very extraordinary noise, which appeared to proceed from the mountains of Luberon. My mind being preoccupied, and following, at no great distance, the drums of the national guard of the commune which I was going to visit, I paid very little attention to the foregoing circumstance, and therefore I can say nothing of the effect of this noise from my own particular observation; but I have since found that it was heard at the same moment by the inhabitants of the several communes which I have since visited, as far as Gordes. The municipal officers, and various other persons with whom I have conversed in these communes, agree in declaring that the noise appeared to them severally to be at the distance of a quarter of a league from the place in which they then were; all adding, that after a sound that appeared to be thunder, which might last above five or six minutes, they distinctly heard a whistling in the air, which some compared to a swarm of flies passing near them, and others to the whistling of bullets.

"In the commune of Gordes some persons imagined they perceived a trembling of the earth between six and seven in the evening of the same day.

"I requested the municipal officers, who mentioned this phænomenon to me, to endeavour to discover the cause, and to send me whatever information they could procure; but have hitherto received only the single *proces verbal*, a copy of of which I send you. It was accompanied with a stone, which I cannot yet transmit to you, because the owner is unwilling to give it up. I shall write to him, and I do not doubt that his answer will authorize me to send it *. This stone, which nearly resembles those used in paving, is about a foot in circumference. It is heavier than flint, is covered with a black crust, its interior colour being light gray, mingled with iron colour. It appears to contain particles of iron, and some brilliant grains like silver.

"The *proces verbal* ascribes the noise, heard in the morning of Saturday the 8th of September, to a volcanic explosion; and this was the first idea which I entertained of the matter. But this idea was not confirmed by the existence of any crater; beside, is it to be presumed that the noise of an explosion could be heard at different places within twelve leagues distance from the spot, at the same moment, and attended with the same circumstances? Is it to be supposed that an explosion could cast a shower of stones over twelve leagues of circumference? Now the stone which fell near Apt explains the whistling that followed the first noise, which, it is very certain, could be only the effect of the fall of like stones, which, by the rapid motion produced by their weight, were invisible to the eye. I leave it to the learned to explain this phænomenon; and in the mean time I shall write to all the communes in the neighbourhood of Luberon, requesting that more particular researches into this matter may be made.

"Letters from Aix state that the noise of the 8th of September was heard at that place, where it was supposed that the powder magazine of Avignon was blown up.

"(Signed) M. A. Bourdon.

"P. S. I forgot to say, that the stone mentioned in this letter has a fœtid smell which resembles that of sour milk. Struck with steel it yields very few sparks."

A true copy. The Minister of the Interior, Chaptal.

Proces Verbal.

"On the 8th of September, 12th year of the republic, about half past ten in the morning, there appearing only a few light clouds in the heavens, and the weather being remarkably calm, a noise resembling that of a cannon fired at the

* This stone has been since transmitted to the Minister of the Interior, and was presented to the National Institute on the 28th of Brumaire, and is now deposited in the Museum of Natural History. It is exactly of the same kind as those which have been gathered after similar phænomena.

the distance of a quarter of a league, was heard with the same force, and attended with the same circumstances, by a number of individuals in various places; but more particularly in the country, at the distance, at least, of seven or eight leagues from Apt, the principal town of the fourth district of the department of Vaucluse. This noise, however, could be the effect only of an unusual explosion; because it is certain that throughout the whole extent above mentioned, and at that hour, no cannon was fired, nor was there any explosion of gunpowder. It produced, by the repetition of the sound in some of the mountains, the same effect as the explosion of a cannon which differs in this respect from claps of thunder. This circumstance, which at first surprised all who were witnesses of it, was accompanied with a phænomenon still more extraordinary. On the same day, and at the same hour, citizen Joseph Jully, a farmer in the district of Apt, and his wife, being about five hundred paces from the country-house of citizen Bartholomew de Vaux, situated north of the town of Apt, at the distance of about a quarter of a league, in the limits of Saurette, having heard the noise above mentioned, immediately afterwards heard, for the space of six or seven minutes, a whistling which increased in sound as it approached, and announced the fall of some solid body. Being terrified, and casting their eyes upward, the wife of Jully perceived a black substance, whose fall on the ground both she and her husband heard distinctly; after which the whistling ceased. The wife of Jully states that this black substance must have fallen in the vineyard of citizen de Vaux. The wife of the latter, being then in the fields, at the same moment heard the same noise and subsequent whistling, but being alarmed she ran into the house, and neither saw nor heard the fall of the above substance. Her son, being then at work three or four hundred paces from the house, also heard the noise, the whistling, and the sound of the fall of a body, which, however, he did not see. At the same instant, Marguerite Hugues, widow, and Marie Jean, wife of Jacques Julien, being on the road from Villars to Apt, heard the same noise, the whistling and the fall of some substance in De Vaux's vineyard, which adjoins the said road. After the sound of the fall, the whistling ceased. It appeared to them that the above substance did not fall at more than thirty paces' distance from them.

"As soon as the report was spread that some considerable large substance had fallen in the above vineyard, a great eagerness was manifested to search for it. The attempt was at at first fruitless; but on the 10th, De Vaux's son, in crossing the vineyard, perceived, at the distance of about thirty paces from the house, a large hole newly made between two rows of vines, which denoted the place where the substance must have fallen. He was confirmed in this opinion when he perceived that some small pebbles at the mouth of the hole were ground to powder. He then dug, and found an extremely hard stone weighing seven pounds six ounces, and could no longer doubt that this was the substance the fall of which had so alarmed the neighbourhood.

"On the rumour of these facts, I, the sub-prefect of Apt, having sent for the stone, which had been given to citizen Joseph Brun, merchant of the town of Apt, by De Vaux's son, proceeded, in company with several of the public functionaries, on the 18th of September, to De Vaux's country-house, and having examined the place from which the stone was dug up, we showed the stone to De Vaux's son, who instantly knew it to be that which he had discovered and dug up as above mentioned, it being buried in the earth to the depth of ten inches; which stone he had stated to us he had given to citizen Joseph Brun. We also took down the statements of the persons before mentioned, as already given: in consequence whereof we have drawn up this present *proces verbal*, which we send to the prefect of the department of Vaucluse, together with the said stone, upon which we have placed our seal, to the end that he may make the above circumstances public, if he shall think proper to do so, that an explanation may, if possible, be obtained of this phænomenon.

"Done at Apt, on the 19th of September 1803:

"The Sub-prefect of Apt, (Signed) Terras.

"P. S. It is to be observed, that in citizen De Vaux's vineyard there is no stone of this species, nor any stone of equal size. The persons accustomed to traverse both the mountains and the vallies of the district of Apt, do not remember ever to have seen, in any part of it, a stone of this kind.

"True copy. (Signed) The Prefect of Vaucluse,
"C. A. Bourdon.

"True copy. (Signed) The Minister of the Interior,
"Chaptal."

XLVII. *An*

XLVII. *An improved Method of heating Boilers; being an Account of the Way in which the Fire is applied to one of the large Boilers in Messrs. Meux's Brewery.*

The best method of applying fire to boilers has only very lately been made a subject of inquiry; and it may with great truth be asserted, that till within these few years by far the greater part of the fuel was entirely wasted. It was customary to have a fire under the whole bottom of every boiler, and the grating which carried the fire was generally made of nearly the same size as the bottom of the boiler; sometimes even considerably larger. The consequence was, that the principal part of the heat was discharged by the chimney instead of being communicated to the contents of the boiler, and even a great quantity of the fuel was sent away, unconsumed, in the form of dense smoke.

Count Rumford's writings have tended very much to turn the attention of individuals to this subject, and to economize the consumption of fuel. The winding flues he has so strongly recommended to be put under large boilers may be considered as highly preferable to the method that prevailed so generally before; nor in bringing forward the present article have we any intention to depreciate an improvement highly valuable in itself; but having been permitted to inspect the large boilers at Messrs. Meux's, and having witnessed their effects, we think we shall render an essential service to people engaged in different manufactures, in which boilers on a large scale are employed, by laying before them the arrangements that have been adopted in setting (as workmen term it) the boilers at their brewery, where proper comparative experiments are made in every thing that regards the economy of so important a concern under the direction of an able and experienced engineer, and at an expense which would be ruinous to any undertaking of less magnitude.

In constructing a boiler two objects ought to be kept in view: first, that a large portion of the heat produced by the combustion of the fuel may be communicated to the boiler instead of being uselessly expended by the chimney; this is what is aimed at, and in some measure attained, by the winding flues recommended by count Rumford: secondly, that the heat may be communicated to the boiler as rapidly as the nature of the business may require; this is what has been attained at Messrs. Meux's, and with a less consumption of fuel than by any former arrangement, count Rumford's not excepted.

The merit and success of the construction seems to depend on making the flame and heated air impinge, and as it were press against the boiler, instead of merely passing along easily to the flue. For this purpose Mr. Woolf, the engineer at the brewery, keeps his fire forward and forces the flame, by interposing a wall or breast-work A (fig. 1. Plate VII.) between it and the flue, to play against the bottom of the boiler, to which a large portion of heat is given off before the current of flame and heated air, which is next carried round the boiler, can find its way to the chimney.

In fact, there are two fire-places under each of Messrs. Meux's large boilers, separated from each other by a party-wall B, fig. 2. In this figure one of the fire-places only is shown, and the party-wall; that is, a little more than one-half of a horizontal section of the furnace. The wall AB, besides answering the purpose of separating the furnaces, as already mentioned, serves to support the bottom of the boiler C, which carries an immense weight when filled with liquor. The upper part of the boiler is not shown in the engraving. It is not an open boiler but finished in the form of a dome, the summit of which rises from the centre of the bottom to a little more than twice the height of the part shown in the figure. At a convenient part it is furnished with a man-hole, to which a steam-tight cover is fitted, for the convenience of admitting the workmen to clean it out when necessary, and another hole, also fitted with a cover, for admitting the hops.

The extremity of the bottom, or the lag, as it is called, of the boiler, rests on brick-work *a* (fig. 2.), and that part of it which comes immediately over the fire is defended by brick-work *a* (fig. 1.), as experience showed that this precaution was necessary.

After the flame has passed from the bars of the furnace over the breast-work A, striking with force against the bottom of the boiler, it finds its way into the circular flue D, which goes round the boiler to the place where it is joined to the chimney E, by the opening or door F, which is furnished with a vent and register in the usual method, and which is shown in the figure. The flame and heated air is not allowed, however, in passing into the circular flue D, to keep in contact with the copper, but is forced first to descend and pass under a little arch *m*, by which contrivance that part of the boiler, which otherwise would soon be cut away, as it were, by the intense point of the flame, is defended from injury.

In these furnaces Mr. Roberton's contrivance for burning the smoke is made use of, which is found completely to answer the purpose intended. Having in a former number of our work given an account of this invention, we need not here repeat it. We think, however, that there will be no impropriety in pointing out an addition which has been made to it since its first adoption, and which is a considerable improvement, namely, a method of getting rid of the clinkers or vitrified scoriæ, invented by Mr. Woolf. This contrivance, which is very effectual, has at the same time the merit of being extremely simple. The combustion of the fuel commences, and is chiefly carried on, on the horizontal part of the bars: from this the fuel is pushed back from time to time to the inclined part, and at last the vitrified portions fall from the lower end into a cavity *o*, the bottom of which is furnished with sliding horizontal iron doors. These from time to time are drawn out a certain length by putting an iron hook into a hole *z*, in the handle of the sliding door and drawing it outward, which discharges the clinkers into the ash-pit.

The contrivance we have just described is found also to answer another very good purpose. These boilers are filled and emptied several times a-day, and between each time it is necessary for people to go in and clean them out. To enable them to do so the whole of this large apparatus must be reduced to a moderate temperature; a circumstance that used formerly to take a considerable portion of time, with every possible care at the same time to damp the fire. The introduction of these sliding doors behind the bars has been found to present a mean for cooling the boiler very rapidly. When they are all drawn out at once, while the contents of the boiler are discharging, such a draft of cold air takes place through that opening as absolutely to drive down the flame through the bars, and to cool the boilers so effectually, that by the time it is empty, which takes about twenty minutes, the people are able to go instantly into it.

To give as much room as possible about the front of the fire-place, and at the same time to insure sufficient strength to the structure of brick-work inclosing the furnace and boiler, which from the bottom of the ash-pit to the top of the dome of the boiler is about twenty-one feet; the front stands on pillars made of cast iron.

Fig. 3. is a front view of one-half of the erection; (that is, enough of it to show the front of one of the two furnaces.) The air which is admitted above the fuel, to inflame the smoke, as described in our account of Mr. Roberton's invention (vol. xi.), enters by the two small quadrangular apertures on a line with the lower ornament of

 the

the capital of the iron column. These apertures grow wider in two of their sides, and closer in the other two, as they approach the furnace, till at last they throw in a thin plate of air of the whole width of the fire. The mouths of these apertures are made of this form for the convenience of more easily shutting them when the fire is to be at any time damped. The coals are introduced immediately below these apertures over the inclined iron plate, which may be better seen in the vertical section, fig. 1.

The plate, illustrating the present article, which is engraved by Mr. Lowry, is executed in such a masterly manner as to render any further description of the parts unnecessary. A bare inspection of the plate will show them sufficiently, without the necessity of our blotting it over with more letters of reference. The letters A, B, *m*, and *o*, in fig. 1 and 2, refer to the same things in both.

These furnaces answer the purpose so well, that though the two are both lighted to bring the worts to boil, one of them is soon after damped out, and the remaining one only kept burning till the process is ended. And it is no uncommon thing for the workmen to be under the one-half of the boiler, making necessary repairs in the furnace, while there is a fire under the other half, from which they are only parted by the wall B before described.

We mentioned in a former number, that the new boiler on Mr. Woolf's principles now constructing is intended to be employed in generating steam, to be thrown into the large boilers in this brewery, instead of heating them by fire applied directly to the boilers themselves. The very boiler we have been describing is one of these. But the present arrangement is still to remain, that fires may be employed as heretofore at any time that the new boiler or furnace may need repairs. Besides, there are many businesses which do not admit of the boilers being heated by steam; and to the proprietors of such, the present article cannot fail to prove highly acceptable.

The liberality of the proprietors of the extensive brewery where this boiler is erected, in admitting the public to participate in the beneficial result of economical experiments, ascertained at a very great expense, cannot be sufficiently praised. No person to whom a view of their improvements can be any way serviceable is refused admission into their premises; and we are confident that the public, those at least to whom the economical and beneficial expenditure of fuel is an object, will feel, as we do, the weight of the obligation.

XLVIII. *Account of the Meteor seen on the Evening of Sunday, November 13th. 1803; with some Observations on the best Means of ascertaining the Altitude, Bearing, Magnitude, Distance, and Velocity of such Phenomena.* By Mr. T. FIRMINGER.

I WAS at first advertised of the appearance of this meteor by a very strong light which rendered all the surrounding objects visible: it was, indeed, so very bright that I could have read a newspaper by it without the least difficulty. I no sooner saw this light than I was apprehensive of the cause which produced it, and upon looking up saw the meteor to the south of the zenith, and about twenty-five degrees in azimuth to the east of the meridian; it was then moving with a great velocity towards the west in a rather north-westerly direction; its course, however, was very nearly in a line perpendicular to the meridian.

At its first appearance it seemed quite round, and well defined, except the part opposite to the direction in which it was moving, which seemed to project a little, and to terminate in a tail that extended to a small distance from it (see uppermost figure, Plate VI.) On each side of this tail there were two or three smaller balls, tinged at their extremities with yellow and orange colours, and one or two with purple. The whole body continued to move together without any sensible difference in either its colour or shape till within about a second or a second and a half before its disappearance, when it suddenly altered its figure to something like the shape of an egg, (see the lower figure, in which AB represents the direction of its motion.) At this moment its light became so strong that it was not without much difficulty I was able to keep looking at it. I should think its light was full two-thirds as intense as that of the sun when upon the meridian. It seemed at this time as if the meteor had before been covered with one external coat, which now burst or separated in the middle the whole length of its longest diameter, and exposed a surface with a brightness far surpassing its former lustre. I may, however, have overrated its light, by supposing it equal to two-thirds of that of the sun when upon the meridian, for it is to be observed that the pupil of my eye must have been before much dilated from the darkness of the night, to which it had been exposed at least a quarter of an hour; but the comparison relates to the effect it produced upon my

 eyes

eyes at that moment, when compared to what the direct rays of the sun would produce in the middle of the day.

The diameter of the large ball at its first appearance, by comparing it with the moon, (which is the best object I know of for that purpose) I should think subtended an angle of at least twenty minutes of a degree; the smaller balls, which appeared all nearly of the same size, were about a fifth part of the diameter of the large one, and I should suppose subtended angles of about four or five minutes of a degree. The altitude of the meteor was about 50 or 55 degrees, and continued nearly the same during the whole time of its appearance, which was about four seconds and a half or four and three quarters; it vanished instantaneously with an azimuth of about 75 degrees to the west of the meridian.

The azimuth and altitude were afterwards estimated by means of a needle and compass and a small Gunter's quadrant, which I took to the place where I stood when I saw the meteor, and they are I believe pretty correct, as the surrounding objects assisted me very much in making these estimates. I also measured with a sextant the apparent path which it described, and found it about 85 degrees. Its disappearance was at $8^h\ 30^m\ 39^s$ mean time, which I had an opportunity of ascertaining by an excellent chronometer of Mr. Earnshaw's construction which I happened to have with me.

In two minutes after the appearance of this meteor I heard a noise which sounded like a distant clap of thunder, or like the rumbling of a coach heard at a quarter of a mile's distance going over a stone pavement; it was pretty loud at first, but got gradually fainter until it was no longer audible, and, what was very surprising, it seemed to follow the very same track the meteor before had appeared to move in: it lasted a minute and forty seconds.

The appearance of the meteor as it moved along had a very great resemblance to that of a skyrocket seen at the distance of about a mile. I have also since met with persons who have seen meteors, and they have generally described their appearance as very much resembling that of a skyrocket, which may have induced some observers of these phenomena to think they heard a hissing noise something like what these rockets occasion; for the imagination is so forcibly impressed by such comparisons, and the duration of the appearance of meteors so very short, that it is not at all surprising we should be misled in our ideas, and

combine

combine appearances with sensations which have no other existence than in the imagination.

The noise that followed after this meteor was particularly noticed by several people, who, although they saw nothing of the appearance, yet were alarmed by the singularity of the noise: some conjectured it to be occasioned by the over-setting of a coach, others by the rattling of a fire-engine, and others by a distant clap of thunder.

With respect to the height of this meteor, or its dimensions, nothing more can at present be inferred than what is derived by comparing the interval of time elapsed between seeing the meteor and hearing the noise which it occasioned in its passage through the upper regions of the atmosphere. By that interval of time, its distance from me when first observed would appear to have been about six and twenty miles; and its perpendicular height about three and twenty miles above the earth's surface.

This method of obtaining its distance, however, must be liable to great uncertainty, and can only be adopted as an approximation, where better means are not to be obtained; for although the velocity of sound is pretty well ascertained at distances near the earth's surface, yet its velocity at the height of twenty-three miles above the earth may be very different from what our calculations give it. The real distance, therefore, can only be obtained, with any degree of accuracy, by observations made at different places at a considerable distance from each other. It is much to be wished that people, who happen to be so situated as to have an opportunity of observing a meteor, would take all possible pains in the first place to obtain its altitude as correctly as they can, which may oftentimes be done with great accuracy; for although the mind at the moment may be altogether engaged in admiring the beautiful and curious appearance of such a singular phenomenon, yet I believe it will be generally in our power to remember the precise place where we were when such a circumstance happened: for people in general stand still when any thing chances to strike them with surprise, and before they proceed to remove from that place take notice of the objects that surround them: and hence it very naturally follows, that when we give an account of the appearance of any phenomenon, we are always particular in our description of the spot from whence we saw it. If, therefore, at a considerable time after, we were to go to the place where we saw a meteor, the strong impression left on the imagination of its apparent situation would enable us to ascertain its altitude without being

being liable to a mistake of more than about ten degrees; and in a close situation, as in a street, or among houses, it will oftentimes happen that some object will intercept part of its course from the observer's sight, and then he may ascertain its altitude to a much greater degree of accuracy; I should think, in such a case, he will seldom be liable to an error of more than five degrees, and in general will be able to come nearer; but even where the surrounding objects are not so favourably situated, *they* will, if *they* happen to lie in the direction in which the meteor is seen, be always found of great service in assisting the necessary estimates afterwards.

Those, therefore, who have had an opportunity of observing a meteor, should, as soon as possible, repair to the place where they stood when they saw it, and by means of a common or Gunter's quadrant, or any other instrument that will measure altitudes, endeavour to obtain its height as correctly as they can; and at the same time, with a needle and compass, take its bearing at that part of its course where its altitude was measured. If, however, the observer should not happen to be furnished with any instruments for measuring altitudes or bearings, yet if he has been so fortunate as to have compared it with any fixt object, or has seen its course intercepted by the top of a house, a church, or any other body, and can recollect the place where he stood at the time, its situation may be pretty correctly ascertained; for if he measures the distance from the place where he stood to the object, and then measures the height of the object behind which it disappeared, its altitude may be easily inferred: and by comparing the direction of such object with the north and south, or east and west, points, its bearing at that time will be had sufficiently near to be of considerable service, as it is not necessary to be so correct in this respect as in obtaining its altitude, though the nearer we can come at both the better.

If the observer should happen to be in a field, or any open place where there are no neighbouring objects to assist him in his estimation, he will, however, be able to obtain its altitude and bearing, in the following manner: Let him go to the place where he stood when he saw the meteor, and there having fixed up a rod or stick perpendicular on the ground, of a sufficient length, according to the height at which the meteor appeared, let him recede from the stick until, by looking over the top of it, he see the top in a line with the place in which he before observed the meteor to appear: if he then measures his distance from the stick,

stick, and the height of his eye from the level with the bottom, and lastly the length of the stick, he will be able to obtain its altitude pretty correctly; and also, by observing the direction the stick bears from him, will obtain at the same time its azimuth. For this purpose the stick should be chosen of such a length that he may be able to recede from it to the distance of six or eight feet at least. Many people, however, who may have an opportunity of seeing meteors and putting the above method in practice, for want of mathematical information, may not be able to make the necessary calculations; but no loss will be sustained in this case, provide such gentlemen would be careful to take their measures as correctly as possible, and publish an account of them, with a sketch of the method they made use of, which would enable others to draw such conclusions as might be necessary for their purpose, or at least be of great use to them.

The altitude and bearing at the time are the most necessary to be known. The apparent diameter, time of duration, and extent of the track through which the phenomenon move may, however, be of great service when they can be obtained with any tolerable degree of accuracy. But here I must observe, that all estimations of altitudes without instruments or any means of measuring are too fallacious to be depended on, and can seldom or ever be admitted into computation. Let any one go out in the evening, and endeavour to estimate the altitude of a star, or any other object, and he will soon find himself liable to an error of twenty or thirty degrees, generally estimating the altitude too high. This I particularly instanced in the appearance of the meteor I have here described; for, before I measured its altitude with a quadrant, I had estimated it fifteen or twenty degrees higher than it was. In ascertaining the apparent magnitude of meteors it has been, I believe, the most usual way to compare their appearance with that of the moon; and if the moon is visible at the time, it will afford a pretty good object for that purpose; but if the moon should not be visible, it must be liable to a considerable degree of uncertainty.

The apparent diameter of the meteor here mentioned I have supposed to subtend an angle of not less than twenty minutes of a degree, which, with the distance deduced from the interval between the appearance of the meteor and hearing the sound, gives its real diameter nearly 280 yards, or almost half a mile in circumference; and also, by comparing the extent of track through which it moved with the time

time of its duration, its velocity will appear to have been between seven and eight miles in a second:—a velocity which more than twenty times exceeds the greatest velocity of a cannon ball, and can only be compared to what we at present know of the amazing velocity of electricity.

In accounting for the nature and production of meteors, it is evident that nothing can help us in our inquiries so much as a knowledge of their dimensions, their distance, and the extent of space through which they move; and these are only to be obtained by good observations. Although their appearance and the manner in which they burst are very curious, and should as much as possible be observed, yet an attention to these circumstances alone are not sufficient to throw much light upon them, when unassisted with any knowledge of their real situation and dimensions.

XLIX. *Account of New Publications.*

A Treatise on the Culture and Management of Fruit-Trees, in which a new Method of Pruning and Training is fully described, &c. &c. By W. Forsyth, *F. A. S. and F. S. A. &c. &c. Third Edition.* 8vo.

This work is so well known to the public already that any account of it from us would be superfluous. We only take notice of the present edition for the purpose of mentioning a new way of treating diseased trees, and to extract from it a testimonial highly creditable to Mr. Forsyth.

"I avail myself of this opportunity (says Mr. F.) to add a discovery which I have recently made, and which, as being calculated to save time and labour, may deserve attention.

"Instead of paring away the bark, as had heretofore been the practice, and covering the stem with the composition, I now merely scrape off the loose bark, and apply a mixture of cow-dung and urine only (made to the consistence of a thick paint) with a painter's brush, covering the stem carefully over. This softens the old scabrous bark, which peels off during the following winter and spring, and is succeeded by a fine smooth new bark."

"*To Mr. Forsyth, Royal Gardens, Kensington.*

"SIR,

"As you had the goodness lately to give us an opportunity of examining several trees in Kensington gardens in the

the various stages of renovation, or filling up with new wood; and as reports have been circulated, tending to discredit the efficacy of your process;—we feel it an act of justice, not only to you, but to the country, which is deeply interested in your discoveries, thus publicly to declare, that the statements you have published on the subject contain nothing more than the truth.

John Coakley Lettsom, M. D. F. R. S. &c.
William Woodville, M. D.*
James Sims, M. D.†
William Norris.‡
Joseph Hart Myers, M. D.§
Astley Cooper.||
Edward Coleman.¶
H. N. Willis, F. R. S. &c."

London, Nov. 17, 1803.

L. *Proceedings of Learned and Economical Societies.*

ROYAL INSTITUTION OF GREAT BRITAIN.

The lectures for the ensuing season commenced on Thursday the 22d of December, with a course on Mechanics and Physics, by Mr. Dalton. In the latter end of January the other lectures and the public experiments of the Royal Institution will begin: those on Chemistry by Mr. Davy, and those on Natural Philosophy by Mr. Allen. The public experiments will be made, partly in the lecture-room, and partly in the new laboratory, which has been fitted up so as to accommodate 120 persons. The new library of reference is in a state of forwardness, and, it is hoped, will be opened in the course of next month for the accommodation of all the proprietors, life subscribers, and annual subscribers.

THE BOARD OF AGRICULTURE

Has offered the following Premiums:

I. *Cottage.*—To the person who shall build, and describe to the board, the cheapest cottage, being at the same time durable and comfortable, with not less than two rooms above,

* Physician to the Small-Pox and Inoculating Hospitals; and author of a work on Medical Botany.
† President of the Medical Society of London.
‡ Surgeon to the Charter-House, &c
§ Physician to the General Dispensary, Aldersgate-street.
|| Surgeon of Guy's Hospital.
¶ Professor of the Veterinary College.

above, and the same number below,—the gold medal. A plan, elevation, and account of the materials and expense, verified by certificates, to be produced on or before the first Tuesday in May, 1804.

II. *Cottage.*—To the person who shall produce to the board the model of the best and cheapest cottage, on a scale of one inch to a foot; with estimates of the expense of erecting it,—from five to ten guineas, according to merit. To be produced to the board on or before the first Tuesday in December, 1804.

[To be continued.]

PHILOSOPHICAL SOCIETY, GLASGOW.

It is with much satisfaction we notice at any time new institutions intended for the promotion of science and the arts; for the tendency of all such institutions is to increase the comforts of mankind. On the 9th of November this society elected its office-bearers for the ensuing year, viz.

William Mickleham, L. L. D. Professor of Natural Philosophy in the University of Glasgow, President.
John Robertson, esq. Vice-president.
Wm. Duncan, esq. Secretary.
John Lindsay, esq. Treasurer.

DIRECTORS.

Geo. M'Intosh, esq.	Mr. Peter Nicholson,
Geo. Birkbeck, L. L. D.	Mr. John M'Caulay,
James Monteath, esq.	Mr. John Napier,
John Geddes, esq.	Mr. Wm. Dun,
Alexander Drummond, esq.	Mr. John Smith,
Robertson Buchanan, esq.	Mr. Robert Hastie.

LI. *Intelligence and Miscellaneous Articles.*

VOYAGE OF DISCOVERY.

Extract of a Letter from Dr. TILESIUS, *Naturalist, belonging to the Russian Ships now on a Voyage of Discovery round the World.*

Santa Cruz, in the Island of Teneriff,
October 25, 1803.

I HAVE just returned from a tour to the bottom of the peak. At this season of the year it is impossible to reach the summit of it, for one half of it is covered with snow and ice. I have, however, been well rewarded for the fatigue I experienced in my laborious excursion. I have made the most astonishing discoveries. In particular I have found

found an animal which has hitherto been considered as a plant, because we were acquainted with it only in its dry state. I have also seen mummies found in caverns near St. André, and which must have belonged to the former inhabitants of the country. For three days past I have been riding up and down the mountains. The sea shore at Orotrava has furnished me with several interesting objects, as well as that of Poa, Sausal, and Santa Cruz. The greatest number of new species I found among the sea hedge-hogs, sea stars, polypes, and other mollusca.

The soil of the island is entirely volcanic. There are here a great many varieties of lava. The marquis of Cassicahigal, the governor of the island, who resides at Santa Cruz, received us with great kindness and hospitality, and gave us letters of recommendation to Orotrava. He showed us his two gardens at Santa Cruz, where we found many rare plants, some of which our ambassador, M. Resanof Samercyen requested for his imperial majesty. The great botanical garden, however, formed by the marquis de Nova, who resides at Laguna, in this island, exceeded our expectation; it was laid out in the year 1795, close to the town of Orotrava. The marquis sent for an experienced gardener from England, named Cornelius Macmanus. This intelligent man amused us a whole forenoon with showing us proofs of his industry; he is a good botanist and has studied Linnæus: he makes frequent excursions to the interior parts of the country, and has already discovered several new African species. I have written a catalogue of them. In regard to the history of the country I have collected some excellent materials towards it: I have delineated an antient monument, and copied an inscription which relate to the history of Teneriff.

The old Guanches, the former inhabitants of the Canary islands, whose mummies are still found sewed into sheep's skins, in holes of the rocks of mount Altobasso, Sausal, and St. André, and also in the Grand Canary are in their original dress, each with a thigh bone in its hand, and the head crowned with flowers; they are clothed in the skins of animals each at the side of its monument. At the top of the monument stands the Santa Maria de Candellera. I have also delineated several picturesque and remarkable objects, such as landskips, dresses, towns, and productions of the island, and constructed maps which will be completed on my return. The greater part of the rarities I collected myself, and the productions of the peak were given to me by the captain of an American ship, who made

made a journey to the summit of the peak in the month of August. We sailed from Falmouth on the 5th of October and arrived here a few days ago. In four days at furthest we shall proceed to Rio de Janerio, in Brazil, from which I will write to you again.

INOCULATION FOR THE VACCINE AND THE PLAGUE.

Extract of a Letter from Dr. De Carro, *of Vienna, to a Physician in London.*

Dr. Valli who inoculated himself with the plague, in order to try whether the vaccine is a preventative of that disease, has, as appears, at length taken the plague, but it is expected he will recover.

The question relating to dogs has not been resolved in a manner favourable to the assertion of Dr. ———, but as it does not affect the principal point of the doctrine of the vaccine inoculation it is of little importance, and the doctor has written to me that he has not been fortunate in his zoonomical researches.

The question relative to the *claveléé* is now quite resolved, the cow-pock does not preserve sheep from future infection, as the inoculated small-pox preserves men from future variolic infection. The practice of *clavelisation* is now extending very widely. Some assert that they have produced the cow-pock pustule on sheep, but hitherto no experiments have proved that it is a preventative against the *clavelée*. The celebrated and ingenious Dr. Sacco has produced the cow-pock on most domestic animals, among others sheep, and reproduced the disease in men and animals. Dr. Sacco has had the same success with *equine* as with vaccine matter. I have no knowledge of the experiment made in Ukraine which you mention. I imagine the journalist alluded to has mistaken *clavelisation* for vaccination.

PALLADIUM.

To Mr. Tilloch.

SIR,

As it is said in one of your Magazines that the new metal I have called *palladium* is not a new noble metal, as I have said, but an imposition, and a compound of platina and quicksilver, I hope you will do me justice in your next; and tell your readers I promise a reward of twenty pounds to any one that can make only twenty grains of real palladium; and that the money is already in Mr. Forster's hands, and that I have begged Mr. Nicholson will name three proper chemical gentlemen as umpires. P.

LII. *Chemical Examination of an antient Speculum. By Professor* KLAPROTH, *of Berlin**.

THAT the history of the antient metallurgy depends on a proper explanation of the different passages relating to it, which are to be found in antient authors, requires very little proof. Though various men of learning who have made this point the particular object of their research have collected these scattered fragments, and have endeavoured to exhibit them in a more conspicuous point of view by arranging them in order, every thing belonging to this subject has not yet been properly cleared up; and, notwithstanding the diligence of the old philologists, many circumstances are still left in a state of doubt and obscurity, the cause of which seems chiefly to be the insufficiency of the means employed for that purpose. On the other hand, the critics and antiquaries of the present day are in possession of many helps which were wanting to the former; and in this respect chemistry and mineralogy may be considered as of the greatest utility when it is necessary to determine the nature and component parts of the antient metals.

Under a conviction that every contribution towards enlarging our knowledge of these compositions is of considerable importance, I have already directed my attention to the numismatic part of the antient metallurgy, and given an account of the result of the experiments I made to determine the alloys which the Greeks and Romans employed for their earlier coins †. The object of the present essay is, the chemical examination of the metallic mass of an antient speculum. When the wants of mankind were increased in consequence of their improved state of civilization, that natural mirror the smooth surface of a piece of water was no longer sufficient; artificial speculums which they might always have at hand, and which they could use with more convenience, became indispensably necessary. The only materials which they could employ to construct them were metals; for as soon as men began to work them they could not help observing and turning to advantage their susceptibility of a fine polish, which exhibited a distinct image of such objects as were presented to them.

I do not know whether there be any mention of metallic mirrors earlier than that in Exod. c. xxxviii. v. 8., where we

* From Scherer's *Allgemeines Journal der Chemie*, No. 33.

† See page 256 of this volume.

we are told that the mirrors used by the Israelitish ladies at their toilet were put in requisition by Moses, in order that they might be cast into a large bason for washing the feet of the priests. In our common German translation of the Bible, no mention is made in this passage of mirrors; for Luther translates it—"And he made the hand-bason of brass, and its stand also of brass, in the presence of the women who served before the door of the tabernacle." Luther consequently has considered the word *maroth* in the original as the plural of *marah*, which is deduced from *raah*, and which therefore signifies, "in the sight of the women." Luther, however, is the more inexcusable in this passage, as the word *maroth*, a mirror, occurs in the Bible only in this passage. The Septuagint, the Vulgate, the English and Dutch Bibles, all, however, agree in translating *Beramoth* "of the mirrors," as being more correct: and we find by Pliny* that the Pagan women, when attending the worship of their deities, were ornamented with metallic mirrors. We are told also by Cyrillus Alexandrinus † that the Israelitish women adopted the same custom, which they borrowed from the Egyptians.

A passage in Job, c. xxxvii. v. 18, makes mention also of the solidity of cast mirrors. But the authority of this passage as a proof of the great antiquity of metallic mirrors is much lessened by the doubts which some of the modern critics entertain respecting the period when this book was written: being considered as not older than the time of Solomon, it is ascribed to that sovereign or to some of his cotemporaries. Menard, in his *Recherches sur les Miroirs des Anciens*, makes Cicero ascribe the invention of metallic mirrors to Æsculapius: "The first mirrors," says he, "were of metal; and Cicero ascribes the invention to the first Æsculapius." But must it not appear singular that Æsculapius, a deity who exerted himself so much for the benefit of mankind, should be the inventor of mirrors? The passage of Cicero, translated by Menard, is to be found in the treatise *De Natura Deorum*, and is as follows: *Æsculapiorum primus, Apollinis, quem Arcades colunt, qui specillum invenisse, primusque vulnus dicitur obligavisse.* But it may be readily seen that Menard has here committed a most egregious blunder, as he took the word *specillum* which signifies a probe, for *speculum* which expresses a mirror; and therefore was guilty of a more serious offence

* Lib xxxiii. cap. 9; lib. xxxiv. cap. 17.

† Lib. ii. vol. i. p. 64, De Adoratione in Spiritu.

towards

towards the Roman consul, who certainly would not have extolled at the same time the person who first bound up wounds, and the inventor of that appendage of the toilet called a mirror.

In the earliest periods a mixture of copper and tin was employed for the composition of mirrors. We are told by Pliny that those manufactured at Brundusium were considered as the best, but in the course of time a preference was given to silver mirrors which were made by an artist named Prasiteles, who lived in the time of Pompey the Great. That these consisted of hammered plates of pure silver appears from the following words: *Lamina duci et specula fieri non nisi ex optimo (argento) posse creditum fuerat.* The silver, however, was sometimes mixed with other metals: *Id quoque jam fraude corrumpitur.* These silver mirrors were afterwards plated with gold, in order to render the image more distinct. This, at least, seems to appear from the following passage, which, however is involved in some obscurity: *Nuper credi cœptum, certiorem imaginem reddi auro opposito averso.*

Mirrors in general formed part of the household furniture of the Roman ladies of the first rank. This is confirmed in particular by Seneca, who satyrizes the great extent to which the luxury of the apparatus of the toilet had been carried among the female part of his fellow citizens.

What this excellent moral philosopher says in another place * respecting the wise purpose for which mirrors might be employed is so beautiful that I cannot forbear quoting it: *Inventa sunt specula ut homo ipse se nosceret. Multo ex hoc consecuta, primo sui notitia, deinde et ad quædam consilium. Formosus, ut vitaret infamiam: deformis, ut sciret redimendum esse virtutibus quidquid corpori deesset: juvenis, ut flore ætatis admoneretur, illud tempus esse discendi: senex, ut indecora canus deponeret, et de morte aliquid cogitaret. Ad hoc rerum natura facultatem nobis dedit, nosmet-ipsos videndi.* But for this purpose artificial mirrors of great price were not necessary; as, *fons cuique pellucidus, aut læve saxum, imaginem reddit.* After observing that mirrors, in consequence of the increasing luxury of mankind, had been applied to the worst purposes, to gratify pride and voluptuousness, he adds, that they were made of the full length of a man, covered with gold and silver and set round with precious stones:—"One mirror of this kind," says he, "costs more to a lady than in for-

* Natural. Quæst. lib. i. 17.

mer times the dowry given by poor generals to their daughters: the dowry which the senate gave to the daughter of Scipio would not purchase at present a mirror for the daughter of a freed-man."

Beckman, in his History of Inventions, is of opinion that those mirrors which were so large that people could see themselves in them at full length were made of plates of polished silver; for he observes, that to cast mirrors of such a size from copper and tin would require more art than can be allowed to that period. "I do not know," adds he, "whether our artists would succeed in such an operation." But it appears more probable from the above passage that the mirrors in question were not of silver but of iron, as Seneca says that they were covered with gold and silver; but the covering with silver would have been superfluous had the mirror itself been of that metal.

Though it evidently appears from Pliny and other authors that the composition of mirrors in general consisted of a mixture of copper and tin, my late colleague M. Möhsen, in his Description of a Cabinet of Coins*, asserts that the union of these two metals was unknown to the antients; for he says, "It is found by the examination of antient coins, made with the severest tests, that before the time of Septimius Severus none of the coins were mixed with lead or with tin." That this assertion is unfounded has been fully proved by my chemical experiments on this subject, which I had the honour of laying before the Academy of Sciences.

Hitherto, however, it has not yet been determined by certain analysis whether the component parts mentioned by Pliny are contained in the antient mirrors; and, if this be the case, in what proportion. A fragment of an antient mirror found with other antient vessels in a grave, afforded me an opportunity of examining it chemically, and of comparing my experiments with those of Roux, the only ones of the kind ever before made. Roux's experiments were made on an antient mirror found also at Naples, and may be seen in the *Recueil d'Antiquités* of count Caylus†. The author describes the metallic mass as exceedingly brittle and tender, and of a white colour inclining to gray: when put into the fire it continued a considerable time in a state of ignition before it fused. It did not inflame, and neither emitted an arsenical odour nor vapours of zinc. So far this description corresponds with that of the mass which I exa-

* Beschreibung seiner Berlinischen Medaillen-Sammlung, part i. p. 280.

† Part v. p. 174.

mined;

mined; but the component parts which I found are considerably different from those given by Roux; who thinks that, besides copper and lead, he discovered also antimony: on the other hand, he found no zinc.

Professor Beckman, in his History of Inventions, considers it very probable that antimony was known at that period, and that it was employed in metallic compositions. He therefore requested the opinion of M. Gmelin on this subject, and the latter informed him that it was not improbable that the mass of the metallic mirror examined by Roux might have contained antimony: he was not, however, convinced that it contained no tin.

On the other hand, the results of my experiments gave me, as the component parts of the antient mirror, copper, tin, and lead.

The fragment subjected to analysis consisted of a metallic plate, both sides of which were covered with a flat stratum of verdigris, composed of tender fibres, arranged concentrically in a radiated form. The mass was compact, very hard and brittle; on the fracture, when fresh, of a grayish white colour, and by polishing acquired the beautiful splendour of a mirror. The specific gravity of the metallic mass, when freed from the green rust, was to that of distilled water as 8580 to 1000.

1st, A hundred grains of this mass being put to digest with nitric acid, gave a blue solution, and after repeated digestion left a whitish gray powder, which weighed 39 grains.

2d, The nitric solution being evaporated to a small quantity was subjected to proof with a saturated solution of muriate of soda, but no alteration was produced. The mixture being then decomposed with sulphate of soda, it became turbid and deposited a white heavy precipitate, which consisted of sulphate of lead. The whole quantity of it, when collected, was equal to 6 grains of metallic lead.

The copper was then precipitated from the solution by iron. The whole quantity of the metallic copper consisted of 62 grains.

4th, Muriatic acid being poured over the 39 grains left by the nitric acid, the whole was exposed to slow digestion. It gradually dissolved into a clear fluid of a straw-colour. It was then diluted with three parts of water, and a rod of zinc being immersed in it, metallic tin was by degrees deposited in a dendritic form, which when collected weighed 32 grains.

 A hun-

A hundred parts of the metal of this antient mirror consisted therefore of

		Grains.
Copper	- - -	62
Tin	- - -	32
Lead	- - -	6
		100

From this analysis it appears that the antients, in the composition of their mirrors, employed the same kind of mixture as that used at present for the specula of telescopes. The quantity of lead is here so small that it is hardly worth notice, since it would produce no alteration of any importance. Besides, it is probable that the lead found in this case, did not belong to the formula of the component parts, but arose merely from the adulteration of the tin, as tin no doubt was sold at a much higher price among the antients than it is among us. Pliny complains of this adulteration of tin in the following passage (lib. xxxviii. cap. 6.) : *Plumbum candidum.* That this expression means tin has been mentioned already—*quod æri incoquebatur improbiores nigro temporabant.*

The proportion of the metals also in these antient mirrors corresponds nearly with that used at present for the specula of telescopes, and consisted usually of two parts copper, and one part of tin.

Our artists, however, are accustomed to employ other metallic additions, such as silver, zinc, antimony, arsenic, but these substances are added in so small quantities, that they cannot be considered as essential to the composition : the intention of adding them is partly to render the metal more secure from rust, and partly to make the mixture more fusible. It is with the latter view that arsenic is added, and it in some measure answers the purpose. The antients, who were not acquainted with arsenic, could derive no benefit from its quality of rendering metals more fusible.

Metallic mirrors, since the invention of glass ones, have been entirely disused as articles of furniture. But a glass mirror, properly speaking, is metallic ; for it is not the glass but the amalgam of tin, placed at the back of it, which reflects the image of the object presented to it.

LIII. *An*

LIII. *An Account of some Experiments and Observations on the constituent Parts of certain astringent Vegetables; and on their Operation in Tanning.* By HUMPHREY DAVY, Esq., *Professor of Chemistry in the Royal Institution.*

[Concluded from p. 217.]

IV. *Experiments and Observations on the astringent Infusions of Barks, and other Vegetable Productions.*

THE barks that I examined were furnished me by my friend Samuel Purkis, esq., of Brentford: they had been collected in the proper season, and preserved with care.

In making the infusions, I employed the barks in coarse powder; and, to expedite the solution, a heat of from 100 to 120° Fahrenheit was applied.

The strongest infusions of the barks of the oak, of the Leicester willow, and of the Spanish chestnut, were nearly of the same specific gravity, 1·05. Their tastes were alike, and strongly astringent; they all reddened litmus paper; the infusion of the Spanish chestnut bark producing the highest tint, and that of the Leicester willow bark the feeblest tint.

Two hundred grains of each of the infusions were submitted to evaporation; and in this process the infusion of the oak bark furnished 17 grains of solid matter, that of the Leicester willow about 16½ grains, and that of the Spanish chestnut nearly an equal quantity.

The tannin given by these solid matters was, in that from the oak bark infusion, 14 grains, in that from the willow bark infusion 14½ grains, and in that from the Spanish chestnut bark infusion 13 grains.

The residual substances of the infusions of the Spanish chestnut bark, and of the oak bark, slightly reddened litmus paper, and precipitated the solutions of tin of a fawn colour and those of iron black. The residual matter of the infusion of the willow bark, did not perceptibly change the colour of litmus; but it precipitated the salts of iron of an olive colour, and rendered turbid the solution of nitrate of alumine.

The solid matters produced by the evaporation of the infusions, gave, by incineration, only a very small quantity of ashes, which could not have been more than $\frac{1}{150}$th of their original weights. These ashes chiefly consisted of calcareous earth and alkali; and the quantity was greatest from the infusion of chestnut bark.

The infusions were acted on by the acids and the pure alkalis in a manner very similar to the infusion of galls. With the solutions of carbonated alkalis they gave dense fawn-coloured precipitates. They were copiously precipitated by the solutions of lime, of strontia, and of barytes; and, by lime water in excess, the infusions of oak and of chestnut bark seemed to be deprived of the whole of the vegetable matter they held in solution.

By being boiled for some time with alumine, lime, and magnesia, they became almost colourless, and lost their power of acting upon gelatine and the salts of iron. After being heated with carbonate of lime and carbonate of magnesia, they were found deeper coloured than before; and, though they had lost their power of acting on gelatine, they still gave dense olive-coloured precipitates with the salts of iron.

In all these cases the earths gained tints of brown, more or less intense.

When the compound of the astringent principles of the infusion of oak bark with lime, procured by means of lime water, was acted on by sulphuric acid, a solution was obtained, which precipitated gelatine, and contained a portion of the vegetable principles and a certain quantity of sulphate of lime; a solid fawn-coloured matter was likewise formed, which appeared to be sulphate of lime united to a little tannin and extractive matter*.

The solutions were copiously precipitated by solution of albumen.

The precipitates they gave with gelatine were similar in their appearance; their colour at first was a light tinge of brown, but they became very dark by exposure to the air. Their composition was very nearly similar; and, judging from the experiments on the quantity of gelatine employed in forming them, the compound of tannin and gelatine from the strongest infusion of oak bark seems to consist,

* M. Merat Guillot proposes a method of procuring pure tannin (*Annales de Chimie*, tome xli. p. 325), which consists in precipitating a solution of tan by lime water, and decomposing it by nitric or muriatic acid. The solution of the solid matter obtained in this way in alcohol he considers as a solution of pure tannin; but, from the experiments above mentioned, it appears that it must contain, besides tannin, some of the extractive matter of the bark; and it may likewise contain saline matter.

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in the 100 parts, of 59 parts of gelatine and 41 of tannin; that from the infusion of Leicester willow bark, of 57 parts of gelatine and 43 of tannin; and that from the infusion of Spanish chestnut bark, of 61 parts of gelatine and 39 of tannin.

Two pieces of calf-skin, which weighed when dry 120 grains each, were tanned; one in the strongest infusion of Leicester willow bark, and the other in the strongest infusion of oak bark. The process was completed, in both instances, in less than a fortnight; when the weight of the leather formed by the tannin of the Leicester willow bark was found equal to 161 grains, and that of the leather formed by the infusion of oak bark was equal to 164 grains.

When pieces of skin were suffered to remain in small quantities of the infusions of the oak bark, and of the Leicester willow bark, till they were exhausted of their tanning principle, it was found, that though the residual liquors gave olive-coloured precipitates with the solutions of sulphate of iron, yet they were scarcely rendered turbid by solutions of muriate of tin; and there is every reason to suppose that a portion of their extractive matter had been taken up with the tannin by the skin.

I attempted, in different modes, to obtain uncombined gallic acid from the solid matter produced by the evaporation of the barks, but without success. When portions of this solid matter were exposed to the degree of heat that is required for the production of gallic acid from Aleppo galls, no crystals were formed; and the fluid that came over gave only a brown colour to the solution of salts of iron, and was found to contain much acetous acid and empyreumatic oil.

When pure water was made to act, in successive portions, upon oak bark in coarse powder, till all its soluble parts were taken up, the quantities of liquor last obtained, though they did not act much upon solution of gelatine, or perceptibly redden litmus paper, produced a dense black with the solution of sulphate of iron: by evaporation, they furnished a brown matter, of which a part was rendered insoluble in water by the action of the atmosphere; and the part soluble in water was not in any degree taken up by sulphuric ether; so that, if it contained gallic acid, it was in a state of intimate union with extractive matter.

Two pieces of calf-skin, which weighed when dry 94 grains each, were slowly tanned; one by being exposed to a weak infusion of the Leicester willow bark, and the other by by being acted upon by a weak infusion of oak bark. The process was completed in about three months; and it was found that one piece of skin had gained in weight 14 grains, and the other piece about $16\frac{1}{2}$ grains. This increase is proportionally much less than that which took place in the experiment on the process of quick tanning. The colour of the pieces of leather was deeper than that of the pieces which had been quickly tanned; and, to judge from the properties of the residual liquors, more of the extractive matters of the barks had been combined with them.

The experiments of Mr. Biggin* have shown that similar barks, when taken from trees at different seasons, differ as to the quantities of tannin they contain: and I have observed that the proportions of the astringent principles in barks vary considerably according as their age and size are different; besides, these proportions are often influenced by accidental circumstances, so that it is extremely difficult to ascertain their distinct relations to each other.

In every astringent bark, the interior white bark (that is, the part next to the alburnum) contains the largest quantity of tannin. The proportion of extractive matter is generally greatest in the middle or coloured part: but the epidermis seldom furnishes either tannin or extractive matter.

The white cortical layers are comparatively most abundant in young trees; and hence their barks contain, in the same weight, a larger proportion of tannin than the barks of old trees. In barks of the same kind, but of different ages, which have been cut at the same season, the similar parts contain always very nearly the same quantities of astringent principles; and the interior layers afford about equal portions of tannin.

An ounce of the white cortical layers of old oak bark, furnished, by lixiviation and subsequent evaporation, 108 grains of solid matter; and of this, 72 grains were tannin. An equal quantity of the white cortical layers of young oak produced 111 grains of solid matter, of which 77 were precipitated by gelatine.

An ounce of the interior part of the bark of the Spanish chestnut gave 89 grains of solid matter, containing 63 grains of tannin.

The same quantity of the same part of the bark of the Leicester willow produced 117 grains, of which 79 were tannin.

An ounce of the coloured or external cortical layers from

* Philosophical Transactions for 1799, p. 299.

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the oak, produced 43 grains of solid matter, of which 19 were tannin.

From the Spanish chestnut, 41 grains, of which 14 were tannin.

And, from the Leicester willow, 34 grains, of which 16 were tannin.

In attempting to ascertain the relative quantities of tannin in the different entire barks, I selected those specimens which appeared similar with regard to the proportions of the external and internal layers, and which were about the average thickness of the barks commonly used in tanning, namely, half an inch.

Of these barks, the oak produced, in the quantity of an ounce, 61 grains of matter dissolved by water, of which 29 grains were tannin.

The Spanish chestnut 53 grains, of which 21 were tannin.

And the Leicester willow 71 grains, of which 33 were tannin.

The proportions of these quantities, in respect to the tanning principle, are not very different from those estimated in Mr. Biggin's table *.

The residual substances obtained in the different experiments differed considerably in their properties; but certain portions of them were, in all instances, rendered insoluble during the process of evaporation. The residuum of the chestnut bark, as in the instance of the strongest infusion, possessed slightly acid properties; but more than 3-4ths of its weight consisted of extractive matter. All the residuums in solution, as in the other cases, were precipitated by muriate of tin; and, after this precipitation, the clear fluids acted much more feebly than before on the salts of iron; so that there is great reason for believing that the power of astringent infusions to precipitate the salts of iron black, or dark coloured, depends partly upon the agency of the extractive matters they contain, as well as upon that of the tanning principle and gallic acid.

In pursuing the experiments upon the different astringent infusions, I examined the infusions of the bark of the elm and of the common willow. These infusions were acted on by re-agents in a manner exactly similar to the infusions of the other barks: they were precipitated by the acids, by solutions of the alkaline earths and of the carbonated alkalis:

* Philosophical Transactions for 1799, p. 263.

and they formed, with the caustic alkalis, fluids not precipitable by gelatine.

An ounce of the bark of the elm furnished 13 grains of tannin.

The same quantity of the bark of the common willow gave 11 grains.

The residual matter of the bark of the elm contained a considerable portion of mucilage, and that of the bark of the willow a small quantity of bitter principle.

The strongest infusions of the sumachs from Sicily and Malaga, agree with the infusions of barks in most of their properties; but they differ from all the other astringent infusions that have been mentioned in one respect, they give dense precipitates with the caustic alkalis. Mr. Proust has shown that sumach contains abundance of sulphate of lime; and it is probably to this substance that the peculiar effect is owing.

From an ounce of Sicilian sumach I obtained 165 grains of matter soluble in water, and of this matter 78 grains were tannin.

An ounce of Malaga sumach produced 156 grains of soluble matter, of which 79 appeared to be tannin.

The infusion of myrobalans* from the East Indies, differed from the other astringent infusions chiefly by this circumstance, that it effervesced with the carbonated alkalis; and it gave with them a dense precipitate, that was almost immediately redissolved. After the tannin had been precipitated from it by gelatine, it strongly reddened litmus paper, and gave a bright black with the solutions of iron, I expected to be able to procure gallic acid, by distillation, from the myrobalans: but in this I was mistaken; they furnished only a pale yellow fluid, which gave merely a slight olive tinge to solution of sulphate of iron.

Skin was speedily tanned in the infusion of the myrobalans; and the appearance of the leather was similar to the appearance of that from galls.

The strongest infusions of the teas are very similar, in their agencies upon chemical tests, to the infusions of catechu.

An ounce of Souchong tea produced 48 grains of tannin.

The same quantity of green tea gave 41 grains.

Dr. Maton has observed that very little tannin is found in cinchona, or in the other barks supposed to be possessed of

* The myrobalans used in these experiments are the fruit of the Terminalia Chebula.—Retz. *Obs. Botan.* Fasc. v. p. 31.

3 febrifuge

febrifuge properties. My experiments tend to confirm the observation. None of the infusions of the strongly bitter vegetable substances that I have examined give any precipitate to gelatine. And the infusions of quassia, of gentian, of hops, and of camomile, are scarcely affected by muriate of tin; so that they likewise contain very little extractive matter.

In all substances possessed of the astringent taste, there is great reason to suspect the presence of tannin; it even exists in substances which contain sugar and vegetable acids. I have found it in abundance in the juice of sloes; and my friend Mr. Poole, of Stowey, has detected it in Port wine.

V. *General Observations.*

Mr. Proust has supposed, in his Paper upon Tannin and its Species *, that there exist different species of the tanning principle, possessed of different properties and different powers of acting upon re-agents, but all precipitable by gelatine. This opinion is sufficiently conformable to the facts generally known concerning the nature of the substances which are produced in organized matter; but it cannot be considered as proved, till the tannin in different vegetables has been examined in its pure or insulated state. In all the vegetable infusions which have been subjected to experiment, it exists in a state of union with other principles; and its properties must necessarily be modified by the peculiar circumstances of its combination.

From the experiments that have been detailed it appears that the specific agencies of tannin in all the different astringent infusions are the same. In every instance it is capable of entering into union with the acids, alkalis, and earths; and of forming insoluble compounds with gelatine and with skin. The infusions of the barks affect the greater number of re-agents in a manner similar to the infusion of galls; and that this last fluid is rendered green by the carbonated alkalis, evidently depends upon the large proportion of gallic acid it contains. The infusion of sumach owes its characteristic property, of being precipitated by the caustic alkalis, to the presence of sulphate of lime; and that the solutions of catechu do not copiously precipitate the carbonated alkalis, appears to depend upon their containing tannin in a peculiar state of union with extractive matter, and uncombined with gallic acid or earthy salts.

* *Annales de Chimie*, tome xli. p. 232.

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In making some experiments upon the affinities of the tanning principle, I found that all the earths were capable of attracting it from the alkalis: and so great is their tendency to combine with it, that, by means of them, the compound of tannin and gelatine may be decomposed without much difficulty; for, after pure magnesia had been boiled for a few hours with this substance diffused through water, it became of a red brown colour, and the fluid obtained by filtration produced a distinct precipitate with solution of galls. The acids have less affinity for tannin than for gelatine; and, in cases where compounds of the acids and tannin are acted on by solution of gelatine, an equilibrium of affinity is established, in consequence of which, by far the greatest quantity of tannin is carried down in the insoluble combination. The different neutral salts have, comparatively, feeble powers of attraction for the tanning principle; but that the precipitation they occasion in astringent solutions is not simply owing to the circumstance of their uniting to a portion of the water which held the vegetable substances in solution, is evident from many facts, besides those which have been already stated. The solutions of alum, and of some other salts which are less soluble in water than tannin, produce, in many astringent infusions, precipitates as copious as the more soluble saline matters; and sulphate of lime, and other earthy neutral compounds, which are, comparatively speaking, insoluble in water, speedily deprive them of their tanning principle.

From the different facts that have been stated, it is evident that tannin may exist in a state of combination in different substances, in which its presence cannot be made evident by means of solution of gelatine; and in this case, to detect its existence, it is necessary to have recourse to the action of the diluted acids.

In considering the relations of the different facts that have been detailed, to the processes of tanning and of leather-making, it will appear sufficiently evident, that when skin is tanned in astringent infusions that contain, as well as tannin, extractive matters, portions of these matters enter, with the tannin, into chemical combination with the skin. In no case is there any reason to believe that gallic acid is absorbed in this process; and M. Seguin's ingenious theory of the agency of this substance in producing the deoxygenation of skin, seems supported by no proofs. Even in the formation of glue from skin, there is no evidence which ought to induce us to suppose that it loses a portion of oxygen; and the effect appears to be owing merely to the

the separation of the gelatine, from the small quantity of albumen with which it was combined in the organized form, by the solvent powers of water.

The different qualities of leather made with the same kind of skin, seem to depend very much upon the different quantities of extractive matter it contains. The leather obtained by means of infusion of galls is generally found harder, and more liable to crack, than the leather obtained from the infusions of barks; and, in all cases, it contains a much larger proportion of tannin, and a smaller proportion of extractive matter.

When skin is very slowly tanned in weak solutions of the barks or of catechu, it combines with a considerable proportion of extractive matter; and, in these cases, though the increase of weight of the skin is comparatively small, yet it is rendered perfectly insoluble in water; and is found soft, and at the same time strong.

The saturated astringent infusions of barks contain much less extractive matter, in proportion to their tannin, than the weak infusions; and, when skin is quickly tanned in them, common experience shows that it produces leather less durable than the leather slowly formed.

Besides, in the case of quick tanning by means of infusions of barks, a quantity of vegetable extractive matter is lost to the manufacturer, which might have been made to enter into the composition of his leather. These observations show that there is some foundation for the vulgar opinion of workmen concerning what is technically called the *feeding* of leather in the slow method of tanning; and, though the processes of the art may in some cases be protracted for an unnecessary length of time, yet in general they appear to have arrived, in consequence of repeated practical experiments, at a degree of perfection which cannot be very far extended by means of any elucidations of theory that have as yet been made known.

On the first view it appears singular that, in those cases of tanning where extractive matter forms a certain portion of the leather, the increase of weight is less than when the skin is combined with pure tannin; but the fact is easily accounted for, when we consider that the attraction of skin for tannin must be probably weakened by its union with extractive matter; and, whether we suppose that the tannin and extractive matter enter together into combination with the matter of skin, or unite with separate portions of it, still, in either case, the primary attraction of tannin for skin must be, to a certain extent, diminished.

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In examining astringent vegetables in relation to their powers of tanning skin, it is necessary to take into account, not only the quantity they contain of the substance precipitable by gelatine, but likewise the quantity and the nature of the extractive matter; and, in cases of comparison, it is essential to employ infusions of the same degree of concentration.

It is evident from the experiments detailed in the third section, that of all the astringent substances which have been as yet examined, catechu is that which contains the largest proportion of tannin; and in supposing, according to the common estimation, that from four to five pounds of common oak bark are required to produce one pound of leather, it appears, from the various synthetical experiments, that about half a pound of catechu would answer the same purpose*.

Also, allowing for the difference in the composition of the different kinds of leather, it appears, from the general detail of facts, that one pound of catechu, for the common uses of the tanner, would be nearly equal in value to $2\frac{1}{4}$ pounds of galls, to $7\frac{1}{2}$ pounds of the bark of the Leicester willow, to 11 pounds of the bark of the Spanish chestnut, to 18 pounds of the bark of the elm, to 21 pounds of the bark of the common willow, and to 3 pounds of sumach.

Various menstruums have been proposed for the purpose of expediting and improving the process of tanning, and, amongst them, lime water and the solutions of pearl-ash: but, as these two substances form compounds with tannin which are not decomposable by gelatine, it follows that their effects must be highly pernicious; and there is very little reason to suppose that any bodies will be found which, at the same time that they increase the solubility of tannin in water, will not likewise diminish its attraction for skin.

* This estimation agrees very well with the experiments lately made by Mr. Purkis upon the tanning powers of Bombay catechu in the processes of manufacture, and which he has permitted me to mention. Mr. Purkis found, by the results of different accurate experiments, that one pound of catechu was equivalent to seven or eight of oak bark.

LIV. *Letter*

LIV. *Letter from* J. Hume, *Esq. on the Formation of Nitrous Ether, by Means of Nitrate of Mercury, and on other Discoveries supposed to be modern.*

DEAR SIR, *To Mr. Tilloch.*

From reading a paper which appeared in a late number of the Philosophical Magazine, I am induced to conclude that the process for obtaining nitrous ether, by means of nitrate of mercury and alcohol, published above forty years ago, is not so generally known as it deserves; it is, therefore, but fair, in order to do justice to its author, to take the most effectual method to assert the priority, by referring to the work itself; and that I may more certainly gain your concurrence to give an early insertion to this communication, I shall be as brief as possible.

I know not the exact period when the work to which I allude was published, as there is no date affixed; but as the author speaks of several of his contemporaries, particularly of the celebrated anatomist Cheselden, it must have been written at least forty years ago—the title is "*Miscellanea verè utilia.*"

From some particular expressions of the author I am inclined to believe that, without his being aware of it, he was in possession of the fulminating mercury; for his attention seems to have been chiefly absorbed in the formation of the ether, or, as he terms it "*a spirit prodigiously volatile,*" and, consequently was not so much, if at all, applied to investigate the powder or "*milky*" appearance in the mixed fluids, which has since been proved to be the most important, or rather wonderful, part of the produce.

I suspect, were we industrious enough to search for them, that many of what are stated to be the modern discoveries were well known to, and probably described by, our ancestors. An instance of this, amongst others, has lately occurred to me, viz. a chemical lamp, in all respects similar to Argand's, but with *two* concentric wicks; the invention of this is said to be of very modern date, and is ascribed to Webster. I have now in my possession a lamp of this description, made more than twelve years ago, for it was then bought by an eminent brass-founder in Hart-street, Covent-garden, as old metal. From its magnitude it must have been employed in a light-house. It has two concentric wicks attached to a single rack, which are

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moved by a small pinion, in the ordinary way; the diameter of the interior wick is 0·9 of an inch; the other measures 3 inches, and the whole seems to be made of brass.

Long Acre, Jan. 14 1804.

I remain, dear Sir,
With much esteem, yours,
J. HUME.

LV. *A Method of affording Relief to Persons injured by Lightning. Communicated in a Letter from Mr.* ISAIAH GILBERT *to the Rev. Mr.* STEELE*.

HAVING heard by common report that the house of Mr. Martin, of Augusta, was struck with lightning on the night of the 25th of June 1803; and that he and his wife were much injured by the shock; and that by some means or other they were relieved, but could not learn how, I sent to them, requesting them to write to me a statement of the facts which attended that event with as much precision as possible. In due time I received a letter from Mr. Gilbert, who is father-in-law to Mr. Martin, in which he wrote as follows:—

"On the night of the 25th of June the house of Mr. Wm. Martin was struck with lightning at the north ridge. It shivered the stud which stood directly under the ridge, rent the boards at the gable-end, entered the room where Mr. Martin and his wife were asleep, and dashed a looking-glass to pieces which hung at the foot of the bed. The lightning passed from where the looking-glass hung in a direction to the axis. Mrs. Martin was affected across her loins, and particularly her right arm; the other arm also was affected, but in a less degree. Mr. Martin was affected in his head and shoulders: they were both asleep. A child which lay on the back side of the bed, it is supposed, was awakened by the thunder, and, being greatly frightened, cried out. This awakened Mrs. Martin, and she found herself in a situation in which she was unable to move her limbs; but after two or three exertions she rolled herself off the bed, and then discovered the curtain over her head to be on fire. Before she got off the bed she discovered that her husband was speechless and senseless. When she had got off the bed to the floor, and the child also, she crawled to the foreside of the bed. Here, on the floor,

* From the New York Advertiser.

the

the water stood a small depth, being driven in at the door: upon putting her right hand, which was most affected, into the water, she felt immediate relief. Her arm and hand remained weak; but the insensibility and numbness were immediately taken away. By some extraordinary effort she now dragged her husband off the bed to the floor, but how she did this she cannot relate—and wonderful indeed it is, for she had not strength to stand upon her feet. She had called her two little sons, who slept in the chamber, and, having experienced relief from putting her hand into the water, as mentioned above, she ordered the oldest to fetch a bucket of water and to pour it on his father, which he did. This he repeated until Mr. Martin began to move, and raised himself on his hands and knees. The little boy then came in with the fifth bucket of water, which his mother ordered him to pour on his father's head. This he did, and then Mr. Martin got up and stood upon his feet, and, with wildness in his countenance, cried out, 'What are you doing?' Mrs. Martin informed him they were struck with lightning, and showed how the bed-clothes were burnt: he then became composed. He remained, however, in great pain in his head, neck, and shoulders, which continued for several days, but by degrees went off.

"It appears that the lightning, after going in the direction mentioned above, took a contrary course, being attracted, as it is supposed by a carpenter's iron square, which hung over a chest with drawers, standing on the side of the room opposite to the bed: it fell from the square on the chest and gouged out a piece near the bottom. In a drawer of the chest were some pewter spoons, on each of which a drop was melted, as if touched with a hot iron. In the same manner were marked two or three plates which stood on a shelf by the chest.

"These, Sir, are the particulars of that affecting scene, as nearly as I can recollect them, but incorrectly written. They are submitted to your perusal and for your use, as you think proper."

LVI. *Extracts from the Third Volume of the Analyses of* M. Klaproth.

[Continued from p. 243.]

Analysis of Fossil Elastic Resin.

Mineral elastic resin extracted from the lead ore of Odin near Castletown in Derbyshire, or the fossil caout-

 chouc,

chouc, possesses a remarkable property, from which it derives its name, and which distinguishes it in an eminent degree from all other combustible minerals. Messrs. Hatchett and Scherer have described fifteen varieties of it; the first of which are still impregnated in part with fluid oil of petroleum, and the latter have a resemblance to asphaltum, completely hard and brittle, while the intermediate varieties possess more or less the elastic property. We must still distinguish a new kind, found a few years ago in a small river situated near that mine, which differs from the preceding by a more spongy elasticity, and by other properties. It approaches to the nature of cork, and Mr. Hatchett found five varieties of it.

1st, The fossil elastic resin, in compact fragments, greenish brown olive, which, when looked through towards the light, is transparent, and appears of a bright red hyacinth colour. This fossil is soft, exceedingly elastic, and adheres to the fingers.

2d, Dark brown fossil elastic resin, which has for gangue crystals of sparry gray swinestone.

3d, Yellow and red bright hyacinth, inclosed in small masses in groups of sparry calcareous fluor.

4th, Dull reddish brown, of a spongy, or cork-like texture, containing blackish gray nuclei of impure caoutchouc.

The caoutchouc subjected to experiment by M. Klaproth was the first variety of this new species. This fossil is one of those bodies the analysis of which can be effected only in the dry way; and, consequently, the immediate principles of it cannot be extracted.

Exp. I. Fossil caoutchouc resists, in general, the action of all fluid solvents. The one which appears to have any is rectified oil of petroleum. Fragments of fossil caoutchouc, immersed in this oil, were at the end of some days swelled up a little and more transparent. The oil, which was colourless, had acquired a bright yellow colour.

The red vapours of fuming nitric acid, poured over another part of caoutchouc, heated in a sand bath, soon gave place to white vapours of nitric acid, which were disengaged till it was almost entirely evaporated; which proves that there was no reciprocal action between the fossil and the acid. The resin, when washed, showed no sensible mark of alteration.

The action of alkalies is as ineffectual as that of acids. Sixteen parts of concentrated solution of potash, boiled for some time with one part of this elastic resin till it almost acquired

acquired a thick consistence, produced in it no alteration. It retained the same characters of elasticity, consistence, and colour.

Exp. II. M. Klaproth kindled one part of elastic resin, and made it burn till it dissolved into black drops. In this state the fossil had not entirely lost its elasticity. It was still of a pitchy and clammy nature, and could be drawn out into threads between the fingers. This imperfect combustion, however, rendered it soluble in oils, and particularly in that of petroleum, to which it communicated a black colour.

Exp. III. Two hundred grains of pure elastic resin, placed on a sand bath in a small glass retort, communicating with a pneumatic mercurial apparatus, gave by distillation, which required a pretty strong and well-maintained fire, the following products:

1st, Eighty-four cubic inches of gas, which had a fetid odour of garlic. This gas, agitated in water, lost eight cubic inches of carbonic acid, which precipitated lime-water, and the remaining 76 cubic inches of carbonated hydrogen gas burned with a brilliant flame.

2d, One hundred eighty-six grains of a brown fluid oil of a disagreeable odour.

3d, Three grains only of a slightly acidulous water: the small quantity of this acid did not permit M. Klaproth to examine the nature of it.

4th, The porous carbonaceous residuum, which had a somewhat metallic splendour, weighed 24 grains.

5th, When calcined in a capsule, it left 13 grains of reddish brown ashes, which, when moistened with a little water, gave a red tint to blue turnsole paper, which in all probability was owing to the caustic lime it contained. When put to digest in muriatic acid there remained 4½ grains of a light gray earth, mixed with a little charcoal, which, by calcination, was reduced to three grains of pure silex. The sum total of the charcoal consumed, amounted, therefore, to 12½ grains.

6th, The muriatic solution, concentrated by evaporation, and edulcorated with alcohol, deposited a grain of crystallized sulphate of lime. When diluted with a larger quantity of water, it gave by solution of succinate of ammonia, a reddish precipitate, which, by calcination, was reduced to 1½ oxide of iron. The remaining solution, neutralized by that of caustic ammonia, deposited by the addition of carbonate of ammonia half a grain of alumine, and 7¼ grains of carbonate of lime, equivalent to 4 grains of caustic lime.

A hundred parts of elastic resin, analyzed in the dry way, were therefore decomposed into:

Carbonated hydrogen - - -	38 cubic inches
Carbonic acid - - - -	4 do.
Bituminous oil - -	73 grains.
Acidulous phlegm - -	1·50
Charcoal - - -	6·25
Lime - - - -	2
Silex - - - -	1·50
Oxide of iron - - -	0·75
Sulphate of lime - -	0·50
Alumine - - -	0·25

of which, however, the five last only are immediate principles of the fossil caoutchouc, while the other five exhibit products of the natural combination of the carbon, hydrogen, and oxygen contained in this fossil, but altered by the fire.

Nothing is found in the results of this analysis which can throw any light on the explanation of the elastic property possessed by this singular fossil: we must, therefore, adhere to the opinion of Mr. Hatchett, who ascribes it to small moleculæ of air, interposed in the pores of the resin, accumulated during its formation in a manner still unknown, and which communicates to its whole mass an elastic and spongy consistence.

Analysis of Peat Earth (tourbe).

Peat earth, formerly denoted by the name of *ligneous earth, bituminous earth*, is dug up in great abundance in the county of Mansfield, and in the circle of Saal, where it is found in considerable strata, almost always at a little depth below the vegetable earth. It has a blackish colour, and an earthy fracture. It communicates a little tint to bodies on which it is rubbed. It is dull, easily pulverised, and in the air falls almost into dust. It is a very useful combustible, which is prepared by softening it in water, moulding it like bricks in wooden moulds, and then leaving it to dry in the air.

Its appearance and texture prove that it has originally formed the fibrous part of a large quantity of wood, deposited by water, which has become altered in its immediate principles, but which has not entirely lost its structure.

The peat earth employed in the following analysis was dug up in the royal bailiwick of Schraplace.

Exp. I. Two hundred grains of this fossil, put into a

glass

glass retort brought to a red heat, and which communicated with a mercurial apparatus, gave for products:

1st, One hundred thirty-five cubic inches of elastic fluid (allowance being made for the air contained in the retort and the tube of communication), composed of 17 of carbonic acid gas absorbed by lime water, and 118 of carbonated hydrogen gas.

2d, Twenty-four grains of acidulous water. As the fossil when boiled in water communicates to it no acidity, this acidulous phlegm is therefore a product of the distillation, and probably composed of pyroligneous acid (empyreumatic acetous acid).

3d, Sixty grains of a brown, clear, fixed oil, which had a taste only slightly empyreumatic, and no resemblance to bituminous oils.

4th, The carbonaceous residuum taken from the retort weighed $77\frac{1}{2}$ grains. When burnt in a capsule they were reduced to 37 grains of light brown ashes, mixed with grains of sand: the charcoal had consequently lost $40\frac{1}{2}$ grains.

5th, Water boiled over the ashes, and then filtered, gave a slight tint of red to blue turnsole paper: it left by evaporation sulphate of lime, which, when roasted, weighed 5 grains. A small quantity of free caustic lime had restored the blue colour of the red turnsole paper.

6th, The lixiviated ashes being dissolved in nitro-muriatic acid, the insoluble sandy residuum weighed 23 grains.

7th, The caustic solution of ammonia produced in it a light brown deposit, from which were extracted by caustic alkalies, two grains of the oxide of iron and one grain of alumine.

8th, The rest of the solution, by carbonate of potash, gave carbonate of lime, which by calcination was reduced to four grains of pure lime.

Exp. II. Alcohol, put to digest on peat earth, extracted from it a reddish brown tincture, which by evaporation was thickened into a reddish dark brown extract, the taste of which was very bitter, without being disagreeable, and approached near to that of an extract from the common kinds of cinchona. It dissolved only imperfecly in water, which it rendered turbid.

Exp. III. Four ounces of peat earth, boiled at three different times with water, gave a clear reddish brown decoction, in no manner either acid or alkaline. Evaporated in a gentle heat it left a dry pulverulent extract, of a walnut colour, weighing 145 grains, having the same taste, but less bitter than the preceding. A little water imme-

 diately

diately dissolved it. The liquor was clear and of a dark brown colour, but it suffered to be precipitated at the same time a yellowish white deposit, composed of sulphate of lime, which when dried weighed 39 grains.

M. Klaproth tried to effect several combinations with the solution of this extract.

1st, It remained clear, and experienced no change of colour when mixed with solutions of animal glue, alkaline salts, alum, nitrate of lime, sulphate of copper, and sulphate of iron recently crystallized.

2d, But it was decomposed by barytes water. Solutions of muriate of barytes and zinc, of nitrate of silver and of mercury, of acetite of lead, of hyper-oxidated muriate of iron, &c. produced in it flaky deposits of a light brown wood colour; and the supernatant liquor became almost always colourless.

Exp. IV. The combustible part of peat seemed to dissolve almost entirely when put to digest in a highly concentrated alkaline ley. When diluted with from 12 to 16 parts of water and filtered, the water still retained a dark brown colour, inclining to black. When saturated with the sulphuric or nitric acid, it becomes brightened, and assumes a reddish brown colour. It precipitates by heat a voluminous brown deposit, which, when collected by the filter and washed, dries by heat into large, black, very brilliant grains, and which, when afterwards roasted in a capsule, leaves yellow ashes.

Exp. V. Two ounces of oil, obtained by the distillation of a larger quantity of peat earth, rectified in a retort with a gentle heat, in a sand bath, and of which $1\frac{1}{7}$ ounce was distilled, left a blackish gray residuum, which, on cooling, acquired the consistence of wax. The distilled oil was of a honey yellow colour, and became fixed in foliated crystals. The most fluid of the oily part of these crystals, imbibed by blotting paper, over which they had been spread, left them deposited there in scales or small leaves, easy to be separated, brilliant, and of a light brown colour.

When this oil is heated on a moderate charcoal fire, until the aqueous moisture is in a great measure evaporated, it acquires, by cooling, the consistence of soft cerat. In this state it has a great resemblance to the *maltha*, or *cire-des-saes* of Siberia*.

Oil

* The *cire-des-saes*, or *maltha*, is brought from the lake Baikal, on the banks of which it is extracted, near Bargusin. M. Klaproth observes, that the classification of this natural wax among the bituminous substances

Oil of peat dissolves in abundance in alcohol, by means of digestion. This solution, which is clear, becomes fixed by cooling. Maltha with alcohol exhibits the same phenomena.

LVII. *Analysis of the Human Teeth. By* W. H. PEPYS *jun. Esq. P. R. I., Member of the Askesian and British Mineralogical Societies**.

MR. CHARLES HATCHETT, in his valuable paper on shell and bone, (Philosophical Transactions for 1799,) enumerated the several substances which enter into the composition of the human teeth: it is to be regretted that the nature of his subject did not render it necessary for him to ascertain the proportions in which they are respectively found, as it could not have failed to have proved highly useful, and his known accuracy would have precluded the necessity of any other person undertaking such a labour. Several good analyses of bone have been published, but I believe no accurate analysis of the teeth has yet been offered.

Bone, it has been observed, when exposed to the action of acid menstrua, becomes dissolved; that is to say, the solid or constituent substance of them is abstracted, and a gelatinous matter is left of the form of the original bone.

Nitric, muriatic, and acetic acids are capable of producing this change, which is accompanied with a liberation of an aëriform fluid, that precipitates lime in lime water, changes vegetable blues red, and by its gravity is known to be carbonic acid gas. These acid solutions yield a copious precipitate with pure ammonia, which is again soluble in either of the acids. After the precipitation by pure ammonia, the solution of the carbonate of ammonia will still produce a new precipitate.

The precipitate of the first solution by pure ammonia, as noticed above, is soluble again in the acids before mentioned;

substances appears to him improper in various respects. Might not maltha be the product also of the distillation of a similar kind of turf effected by nature? As that which forms the subject of the preceding analysis can no longer be classed among the bituminous fossils, both on account of its chemical principles and of its mineralogical characters, its old definition of bituminous ligneous earth can no longer be applied to it.

* From a recent interesting publication, *The Natural History of the Human Teeth*, by Joseph Fox.

tioned: these solutions yield, with a solution of acetite of lead, a copious precipitate, proving the presence of phosphoric acid.

The precipitate obtained by the carbonate of ammonia is also soluble in either of the above acids, but with effervescence; and these solutions are not precipitated by acetite of lead; they fall, however, with oxalate of ammonia, carbonate of ammonia, or any precipitant of lime.

The great solubility of the phosphate of lime, in even the weakest of the acids, is very extraordinary. Phosphate of lime mechanically suspended in water is speedily and completely dissolved by passing a copious stream of carbonic acid gas through it.

With these facts before me, I have ventured to examine the several specimens of the human teeth; as the enamel, the bone, or roots, the teeth of adults, and the shedding teeth of children.

Previous to an account of the analysis it may not be uninteresting to notice the action of some of the articles of the *materia chemica* on the teeth.

Sulphuric acid of the specific gravity 1·83 appears at first to have no action; in the course of an hour small bubbles are perceived, the roots become blackened, and in twelve hours the enamelled part bursts, cracks, and separates, accompanied with an evident formation of selenite, by the action of the acid on the lime, which enters into the composition of the teeth.

Nitric and muriatic acids of the specific gravity of 1·12 act instantly on the tooth, accompanied with an evolution of a quantity of small air-bubbles from the whole of the surface: about eight times their weight of these acids are sufficient for the solution of the solidifying principles of the teeth. The mass left undissolved has nearly the original form of the tooth, is flexible, semitransparent, and easily divided by the nail.

The dilute acetous acid (distilled vinegar) has a very trifling action, but, when concentrated, acts both on the phosphate and carbonate of lime.

Boiling nitric acid acts strongly on a tooth with the evolution of carbonic acid and a considerable quantity of azotic gas. The gelatine and solid substance are dissolved as the surfaces present themselves; but the operation being stopped at any part of the process, the residuum is firm and hard, but reduced in size proportioned to the time the tooth has been acted upon.

Analysis

Analysis of the Enamel.

One hundred grains of the enamel of human teeth, carefully rasped, were placed in 600 grains of nitric acid of the specific gravity 1·12. Slight effervescence ensued, and after twelve hours 200 grains more of the acid were added. Allowing for the loss by evaporation in a corresponding vessel, after thirty-six hours it was found to have lost four grains and a half.

It was then diluted with four ounces of distilled water, precipitated by pure ammonia, and then filtered.

The precipitate obtained being dried in a water-bath at 212° weighed 102 grains. It was then ignited, after which it was found to weigh 78 grains.

The filtered solution was then precipitated by carbonate of ammonia in solution, and filtered.

The separated precipitate, being dried in a heat of 212° weighed six grains. Enamel, then, consists of

Phosphate of lime - -	78
Carbonate of lime - -	6
	84
Water of composition, and loss -	16
	100

A loss of 16 grains here takes place, which is easily accounted for, from the impossibility of directly ascertaining the state of dryness in which the ingredients existed originally in the enamel; for we have seen that, by drying the phosphate of lime in a heat of 212°, (after which it had the appearance of being as dry as possible,) it yet contained so much moisture as to yield a gain of eight grains in the analysis.

On the other hand, when ignited its state is driven to the opposite extreme, and there is a loss of 16 grains. It is impossible, however, that the materials could exist in the teeth, in a state of dryness to be compared with that produced by exposing them to such a high temperature. And it appears but reasonable to conclude, that the real quantity of moisture lies nearer to that given by the heat of 212° than to that given by ignition, and consequently that the 16 grains lost by exposure to such a high temperature were chiefly water,

Bone,

Bone, or roots of teeth, yielded by analysis in 100 grains,

Phosphate of lime - -	58
Carbonate of lime - -	4
Gelatine - - - -	28
	90
Water of composition, and loss -	10
	100

The teeth of adults yielded on analysis in 100 grains,

Phosphate of lime - -	64
Carbonate of lime - -	6
Gelatine - - - -	20
	90
Water of composition, and loss -	10
	100

Specific gravity of adults' teeth 2·2727.

The shedding or primary teeth of children, yielded on analysis in 100 grains,

Phosphate of lime - -	62
Carbonate of lime - -	6
Gelatine - - - -	20
	88
Water of composition, and loss -	12
	100

Specific gravity of children's teeth 2·0833.

In these analyses, as in the former, the phosphate of lime was also exposed to a red heat, and consequently was reduced to a greater degree of dryness than that in which it existed in the tooth.

In all of them the carbonate of lime was dried in a heat of 212°, (above which it would have been liable to decomposition), and the gelatine of the three last in the same temperature.

LVIII. *On Sharks.* *By* William Tatham, *Esq.*

To Mr. Tilloch.

SIR,

Observing in a shop window a print representing an accident which happened from the voracity of a shark in the harbour of Havannah, in the island of Cuba; and having frequently noticed the propensity of the vulgar to swallow extraordinary instances as matters of general existence (believing all the western hemisphere to be overrun with monsters and savages, because geographers have, in some instances, thought fit to ornament their productions with Indians, bears, and snakes, with hideous creatures and wild ferocity); it may not be unpleasant to communicate to you a fact or two, within my own knowledge, touching the scene of action in this print, which may not happen to be readily obtained from any other quarter.

In the year 1793 I was on board the Philadelphia ship Carolina, which was several weeks at anchor in the very spot which this print exhibits; and I have been at the bottom in the place where this accident happened: it is composed of a blue or greenish clay, indented with small holes as if made with the fingers, which I am inclined to think is the work of small fishes, wherewith the harbour abounds; and the clay is covered with a thin film, or skin, not unlike brown paper. The water (probably from the shade of the savannas adjoining) has a greenish appearance, and is replete with a small species of worm, or maggot, similar to the skippers in rotten cheese. I understood, however, that it is not this but another species of worm which renders it necessary to copper the bottoms of the ships; nor do the Spaniards ascribe to them any species of depredation, although the surface of the harbour at some times exhibits them as a kind of cream on the bason's contents. This subject may nevertheless merit the investigation of ship owners; and it may also deserve consideration how far chemical knowledge may be directed to the discovery of some cheap substitute for copper, which may be more generally applied to ships in the merchant service, thereby economizing the consumption of a material which constitutes the basis of a considerable portion of British manufacture and commerce.

I beg leave to state, in regard to the case of the shark, that it is by no means my intention to encourage further experiments at the bottom of the harbour of the Havannah: on the contrary, I observed the Spaniards frequently bathing near the shores, but never in the deep water, where the crew of of the Carolina were accustomed to jump overboard. I merely state this fact, to distinguish a casual from an unavoidable case, and to show that all dangers are not death, no more than it should be conceived necessary that travellers should be always killed in the Sierra Movena, or in Cumberland Mountain in America, because such accidents have been frequent antecedent to the period when civilization conquered the wilderness.

Not being acquainted with the natural history of fishes, I can only merely state another fact concerning sharks. In the harbour of Charleston, in South Carolina, I was astonished to see a boy fall from a ship's bowsprit into the water, without injury, where two or three sharks were playing about the ship a few minutes before; but I was still more so, at seeing two sharks playing about in the surf where a parcel of children were bathing in shallow water, who seemed to be noways concerned for their safety. On expressing my anxiety, and warning the children of their apparent danger, some of the inhabitants who stood on the beach laughed, and assured me that those two sharks were old playmates of the children, who were well acquainted with them; for that they had long frequented the place, and were not of a ravenous species; and that if one of the dangerous kind came in the way I should soon see the children scamper, as they were perfectly acquainted with the difference between the two. If you deem these facts worth public notice, you are at liberty to publish them, on the authority of, Sir, your humble servant,

December 3, 1803. WILLIAM TATHAM.

LIX. *On Vegetation; extracted from* C. HASSENFRATZ's *Paper on that Subject. By* G. J. WRIGHT, *Esq.*

SIR, *To Mr. Tilloch.*

THE fragment I enclose for your insertion is extracted from a memoir of Cit. Hassenfratz on vegetation *, a paper of some import, and frequently quoted by philosophical men, though not, that I have been able to find, inserted in any English publication. Imagining the subject of experiment of so respectable a philosopher would not be regarded as superfluous by your readers, I have in my leisure hours (and owing to the want of original matter, through the te-

* *Annales de Chimie*, tome xiii. and xiv.

diousness

diousness of experiments, and the pressure of other avocations) endeavoured to put the principal topics of the paper alluded to in as concise a method as may be; a species of relaxation which, if you approve of, I may be induced to repeat. The frequent similar labours of the enlightened character I quote form so respectable a precedent towards the like intent, that I am prone to trust the present will not be regarded by you as less valuable for its want of originality on my part, inasmuch as the desire of diffusing information forms the basis of my motives for forwarding it; an object not better to be obtained than will be accomplished by an insertion in your valuable publication, a work not less to be cherished as a national acquisition than the plan and perusal of it must be gratifying to the public, and among others to your obliged servant,

Kennington, G. J. WRIGHT.
Jan. 14, 1804.

The substances which bear the greatest proportion, as the constituent parts of plants (the ashes composing but a fractional part) are water, carbon, hydroden, and oxygen, of which the proportions are found to vary in different vegetables.

Van Helmont's experiment on the growth of a willow, which increased 60lb. in weight without diminution on the part of the earth in which it vegetated, is well known, as is also that of Duhamel, who observed the growth of an oak, in water alone, for several years successively. Add to these the numerous experiments of M. Tillet, who sowed grains of corn in various mixtures of sand, pounded glass, earths, &c. without being able to distinguish between the grains so produced, and those sown in the usual way; all which experiments appear to set forth air and water as being the matters essential to the nutrition of plants, and seem at the same time to suppose the effect of manures to be confined solely to the retention of the humidity necessary to vegetation, the production of a slight degree of heat for the easier developement of the young plant, and the more perfect division of the soil for the readier extension of the radical fibres.

That the increase of carbon in vegetables should be derived from the mere media air and water, appears indeed paradoxical; but Tillet's experiments to ascertain the fact are inconclusive, being conducted in perforated pots buried in the ground. The same processes, repeated by Hassenfratz, in insulated and unperforated vessels (that is to say, under such circumstances as totally precluded any contact with vegetable earth) showed that plants vegetating in the above-mentioned mixtures, perished after a while, and in no instance survived a sufficient length of time to perfect the parts of fructification. In fact, bulbs, cresses, and other plants, which vegetate in water only, contain, after their growth, rather less than the mean quantity of carbon that the original bulbs or seeds contained before their developement; and whatever carbon is contained in the leaves and branches of such plants, it has been furnished and carried up into them by the water as a vehicle; yet allowing such plants only to unfold their flowers, and no further. This is analogous to what we observe in the animal kingdom, as in eggs, which contain within them a portion of nourishment adequate to the life and growth of the embryo chick to a certain degree of perfection, beyond which it cannot exist or increase without the administration of newly applied nutriment. In like manner, every seed contains within itself a certain portion of the carbonic principle, which, by the sole aid of water, suffices to develop the young plant to a certain point, beyond which it cannot increase without the concurrence of fresh carbon.

The attraction of the roots easily accounts for the increase of water in plants; and the decomposition of a part of the water deposited within them, alike explains the increase of the hydrogen. The augmentation of their carbon has been endeavoured to be accounted for by some philosophers as arising from the decomposition of the carbonic acid in the air: an opinion founded on the fact that oxygen is disengaged from plants in the act of vegetation; and this in greater proportion when watered with water impregnated with carbonic acid gas. However this may be, the quantity of residuary carbon is not increased by the process mentioned; for plants reared in aërated water, afford on analysis no more carbon than if otherwise circumstanced. So also the supposition of the oxygen disengaged in vegetation being derived from carbonic acid decomposed by the plant is erroneous; for air long confined, night and day, over plants, undergoes no change either in volume or in goodness. And this consequence ought naturally to follow from the experiments of Ingenhouz, which show that whilst vegetables are under the influence of solar light, they give out oxygen; but, when deprived of that influence, they take up the before disengaged oxygen, combine with it a portion of their carbon, and give off the carbonic acid resulting from their union: and with respect to the disengagement

gagement of oxygen, during the presence of the light, and the change of the same into carbonic acid in the dark, we must allow there will be, between these gases, a certain ratio depending on the longer or shorter duration of their exposure to those extremes; consequently there will be, *cæteris paribus,* less oxygen and more carbonic acid given out in winter than in summer.

Carbon is susceptible of solution or suspension in water, as is evident from the coaly residue obtained on evaporating the drainings of dunghills. Carbon is also in a soluble state in all vegetable mould, as is shown by the brown tinge of a cold infusion of any fertile soil. Wherever heaps of dung are thrown, and water in the interim fallen, *there* subsequent vegetation is more vigorous; and so it ever will be where carbon is in a state of solubility by water. The infusions of long and of spit, or perfectly rotted dung, are of different hues, the former being but pale, as weakly charged with carbon. On applying them as manure, the spot fed with the latter produced the first year larger and more vigorous plants than the former; but in the second year (neither parcel being fresh manured) the part supplied with the long dung showed much the superiority; and so likewise in the third year this latter had somewhat the advantage: proving that, in the long dung, less of the carbon was (when first applied) in a state to be taken up by water than in the short and wholly putrified dung. The latter, therefore, gives out its coaly principle the first year, whereas the former requires more time for its carbon to be rendered in the state proper to be taken up by the plant. Nothing can better illustrate this than the effects of chips of wood as a manure. These having lain some time heaped up, so as to experience a beginning fermentation, were laid upon a portion of land: during the first and second years the earth so manured presented no better produce than other in its vicinity not manured. In the third year the production was more abundant. In the fourth yet more. In the fifth it appeared to have attained its maximum of production, and diminished till the ninth, in which the manure seemed wholly exhausted. In a word, all circumstances the same, vegetation is most strong and vigorous where the soil contains the greatest quantity of carbon in a state of solution. Yet, without doubt, there is a certain maximum with regard to the quantum required, beyond which the presence of superabundant carbon will prove unnecessary and expensive, but this proportion must in every case be relative to the nature of each plant, as to its exhausting power.

M. Baisse proved that plants growing in water tinged with madder become red; and Bonnet found them black on growing in ink. These prove that the roots of plants can take up coloured water, and deposit the colouring matter in the interior of the growing vegetable. On the same principle they take up water holding carbon in solution, and, depositing the same in the interior of the plants, contribute to their increase.

If we compare then this manner of increase of carbon in a plant, with the disengagement of oxygen in the light, carbonic acid in the dark, and the temperature of plants during vegetation, we shall find that, during that process, cold is produced when the plant is acted upon by the sun, and warmth when under contrary circumstances. In the former case, the decomposition and evaporation of the water cause absorption of caloric, while one cause only tends to its disengagement; namely, the combination of the carbon, hydrogen, and other constituent parts of the plant, whence it is probable cold is produced. While in the latter case, and in the absence of the sun, the formation of carbonic acid, by the carbon in the plant, and the oxygen of the atmosphere, must produce heat, owing to the different capacities of those gases for caloric: in other words, the quantity of combined caloric being greater in the oxygen gas than is required by carbon for maintaining its aëriform acid state, the superabundant portion becomes free, and sensible heat is produced.

It follows, from the above recited experiments, that carbon, in a state of solution in water, is taken up by the radical fibres of vegetables and deposited within the plant, in the same manner as colouring particles are found to be, thus constituting the real pabulum of the vegetable kingdom, without the presence of which in the soil no seed can of itself vegetate beyond that degree of perfection which its own innate carbon may allow of, as the crisis stamped by nature as that wherein it is in a condition to shift for itself, provided the food proper to that intent is within its reach. Exclusive of the mode of operation, and degrees of fertility of different manures dependent on the greater or less state of solubility of their contained carbon, another, not less important act of vegetation, deduced from the above, is the augmentation of the temperature of the atmosphere by plants when not exposed to solar light, as also the diminution

nution of the same whilst acted upon by that luminary; a law in vegetable economy equally tending to serve the wisest of intentions, and forming but another link in that chain of beautiful analogies which modern discoveries have served to unfold as eminently subservient to the welfare of the human race, whether displayed in the reciprocal services of the animal and vegetable kingdoms, the modification of climate, by planetary as well as local advantages, or the gift of those indigenous productions which constitute an important requisite to internal prosperity and commercial enterprise.

LX. *Observations on the Use of* STAHL's *alkalized Oxide of Iron* in Calico Printing.* By J. M. HAUSMAN †.

I MAKE great use of this dye in the preparation of printed calicoes, and I endeavour, as much as possible, to overload it with oxide of iron. I tie up the metal destined for solution into a bundle, that I may take it out at pleasure when the nitrous acid is ready to flow over. By employing this precaution I guard against precipitation, and easily suspend the solution; for when the bundle is taken out, (after the effervescence, which produces a great heat, has sufficiently subsided,) while an excess of acid still remains, which is certainly necessary, you will obtain a pigment without any deposit.

If a sufficient quantity of fluid, consisting of three parts calcined carbonate of potash of the shops, and two parts of water, be poured into the nitrous solution of iron, there will, on stirring the mass, by which means it effervesces a little in consequence of the excess of acid, be formed a magma, to which as much liquid carbonate of potash must be added as is necessary for its complete solution. This dye, or this solution of iron, gives, with a fifth or a sixth part of gum-water prepared from equal parts of gum-arabic and water and then thickened, ochry yellow colours, which can be easily purified. The addition of a twelfth part of a decoction of yellow berries, with a twenty-fourth part of a decoction of logwood, gives that tint known under the name of American colour, and a twelfth part of a de-

* Stahl calls this union *Tinctura martis alkalina.* It was afterwards known by the name of Stahl's *alkaline tincture of iron.* It is nothing else than a combination of oxide of iron with potash. See *Macquer's Chem. Worterbuch*, vol. vi. p. 550.

† From *Allgemeines Journal der Chemie*, No. 24.

 coction

coction of logwood, without yellow berries, gives a chocolate colour.

If this dye be diluted with a sufficient quantity of water, all the oxide falls to the bottom. When edulcorated, filtered, and brought to a white heat in a crucible, this oxide polishes steel as completely as the English colcothar.

Linen or worsted yarn imbibed with this dye, and then immersed in a dye-liquor prepared with caustic alkali, which precipitates the oxide of iron, acquires by this process a much darker yellow than when it is left at rest for twenty-four hours, and then dried and washed.

Every drop of a solution of caustic alkali applied to this dye precipitates from it a part of the oxide as it overcomes the carbonic acid. By these means it is completely decomposed; and this oxide, when washed and exposed to heat for a sufficient time, gives a very fine polish to steel.

This dye, as I have already said, is nothing else than a solution of hyperoxygenated carbonate of iron by an alkaline carbonate, which serves it as a vehicle; only care must be taken not to add too much when dark colours are required.

All solutions of iron sufficiently oxygenated, treated with an alkaline carbonate in the same manner as the nitrous solution of iron, are capable of producing a similar dye. I have convinced myself of this fact by employing the acetic, muriatic, and sulphuric acids for this purpose. The latter I obtained in two ways: in one I dissolved sulphate of iron in nitrous acid, and, when the effervescence and disengagement of nitrous gas had ceased, subjected it to evaporation: in the other, I proceeded according to the process which I gave in my paper on the artificial preparation of volatile alkali, published in the *Journal de Physique* for June 1787; that is, by suffering the solution of sulphate of iron to absorb nitrous gas. By both solutions I obtained a hyperoxygenated acetous solution of iron, as I decomposed it by acetate of lead.

A nitrous solution of copper, prepared from nine pounds green oxide of copper, nine pounds of water, and three pounds cream of tartar, with a solution of carbonate of potash, and treated as the nitrous solution of iron, produces the same effects. When mixed with gum, and imprinted on woollen or cotton stuffs, it deposits the oxide of copper of a beautiful green tint. A gummed ammoniacal solution of copper may be employed in its stead; for when the cloth is dried the ammonia is disengaged from it, and the

the green oxide remains united with it in consequence of its cohesion.

If linen or woollen yarn be imbibed in nitrous acid diluted with more or less water, or any other hyper-oxygenated solution of iron, and then be exposed for some minutes to a caustic alkaline ley, a beautiful nankeen colour will be produced. Instead of this nitrous solution, a solution more or less diluted of sulphuric acid may be employed. Many articles when taken from the caustic ley are dirty, but when they have attracted the oxygen of the atmosphere, they acquire the proper brightness. These colours pass to violet and black by maddering. They will acquire a deep black colour, as well as different shades of gray, when treated with gall-nuts, sumach, or logwood. Several blue shades may also be obtained from them, by employing a ley of alkaline prussiate, or calcareous earth, oxygenated by any acid. The various shades of morose gray are produced by stronger or weaker infusions of gall-nuts, which must be suffered to dry on the yarn impregnated with them; after which the yarn is immersed in sulphuric, nitric, muriatic, or acetic acid, diluted with water.

A nitrous solution of iron, when freed from its acid by evaporation, and when the residuum is brought to a white heat in a crucible, gives an oxide of iron which is an excellent polisher of steel. The case is the same with a solution of iron in sulphuric acid; but in this case the oxide must be longer exposed to heat. A muriatic solution of iron may be employed for the same purpose; but the acid, when evaporated by a strong heat, carries with it a large portion of the oxide. All methods in general, by which iron can be sufficiently oxygenated, will produce an oxide fit for the polishing of steel.

I must here mention an experiment which I communicated about ten years ago to my friends Wild and Arbogart. Having once tried to oxygenate oxide of iron as much as possible in order to convert it into acid, I mixed together, in the course of several unsuccessful experiments, a pound of a nitrous solution of iron and half a pound of concentrated sulphuric acid. When the mixture was evaporated to dryness in a porcelain dish, there remained a white residuum, entirely insipid. On examining it several weeks after, I found that it had attracted moisture, and had assumed an astringent taste. A few weeks after, when a certain portion of it had dissolved in the moisture which this residuum had attracted from the atmosphere, I poured off the liquid, which still had an astringent taste, and preserved it in a glass. After some time I found in it very beautiful colourless and transparent crystals, which resembled alum. Having immersed it in an alkaline solution of prussic acid, its surface became covered with the most beautiful Prussian blue, which suffered itself to be removed by washing without its colour being changed. This blue was reproduced as long as any of the crystals remained. In the air these crystals became yellowish, in consequence, no doubt, of the solar rays having disengaged from them a portion of oxygen; for when I examined them afterwards, I found that they were nothing else than hyperoxygenated sulphate of iron. This salt is insupportably astringent. When diluted with a great deal of water a precipitate is produced, and speedier when the mixture is exposed to heat. The filtered precipitate had a most beautiful yellow colour. A high temperature, however, deprived it of its rust colour, as it by these means lost its excess of oxygen.

On repeating this experiment I always obtained the same result; and when I exposed the white insipid residuum in a glass retort, combined with a Woolf's apparatus, to such a degree of heat as brought it to a state of ignition, the acid was disengaged from it in the form of sulphureous and sulphuric acid, accompanied with a mixture of oxygen gas. The oxide of iron obtained in the retort after the experiment was of a brownish red colour, and fit for polishing.

If the quantity of the sulphuric acid be lessened, there will be obtained, in like manner, a white pulverulent residuum, which, notwithstanding its insipidity, dissolves in an equal part of warm water, and after cooling, and being left some time at rest, produces crystals.

The hyperoxygenated oxide of iron, obtained by caustic alkali, from Stahl's tincture of iron, or any other acid solution of that metal, when precipitated and again dissolved in sulphuric acid, with some excess of the latter, gives also beautiful crystals of hyperoxygenated sulphate of iron.

The common sulphate of iron, which is oxygenated by nitrous acid, or by the absorption of nitrous gas, does not crystallize; and, when the evaporation is not continued to dryness, acquires the consistence of syrup or of honey. But if a fifth or a sixth part of concentrated sulphuric acid be added, a confused crystallization is immediately produced which forms a compact mass. This proves that hyperoxygenated crystallized sulphate of iron requires a greater quantity of acid than the common sulphate.

The muriatic acid becomes very strongly oxygenated when dissolved in hyperoxygenated sulphate of iron, which thereby acquires a yellowish colour.

The hyperoxygenation of iron increases its affinity for acids in such a manner that callico-printers make no use of an acetic solution of hyperoxygenated oxide of iron, as it does not readily give up its acid by drying.

LXI. *On an Improvement in the Form of Spectacle Glasses.* *By* Wm. Hyde Wollaston, *M.D. F.R.S.* *

It must have been remarked by persons who make use of spectacles, especially those who require glasses of short focal distance, that objects seen through them appear distinct only when viewed through the central parts of the glasses; that, when the direction of the sight E O, Fig. 1. (Plate IX.) is considerably inclined to the surfaces, objects appear distorted, and that this defect is greater in proportion to the greater obliquity of that line.

It is on this account that opticians have lately made and recommended spectacle glasses of less diameter than those formerly in use, thinking that the extreme parts of the field of vision, which from indistinctness were of little use, might be spared without much inconvenience. But this alteration in the size of the glasses could hardly claim the merit of an improvement, since for one defect it only substituted another scarcely less objectionable.

It seems indeed rather extraordinary that during five centuries which have elapsed since the invention of spectacles, neither theory nor accident should have produced any considerable variation from their original construction.

It was indeed conceived by Huygens †, that the glasses, instead of being equally curved on both sides, as is customary, should have the curvatures of their opposite surfaces in the proportion of 6 to 1, because he had demonstrated that such a form was best suited to the object-glasses of telescopes.

Dr. Smith also, in his Treatise on Optics (p. 258.), repeats this opinion of Huygens in the following cursory manner: "And consequently this figure of a glass is the

* Communicated by the author.

† Dioptr. Prop. 28.

best for spectacles, as the double concave of like figure is the best to help short-sighted persons."

But although it may be very true that such a form of glass was best calculated for the object-glass of a telescope, previous to the celebrated discovery of the achromatic object-glass by the late Mr. Dollond; yet, whatever advantages might at any time be expected from the telescopic object-glass so shaped, these were not to be obtained by a similar construction in spectacles, as may easily be seen by considering the different uses of the respective instruments.

In a telescope, in the first place, our view is necessarily confined to a very small distance on each side of the axis; and secondly, every part of the object-glass contributes to the distinctness of any object viewed.

It is under these circumstances alone that the proportion of the curvatures above mentioned might be proper for a single object-glass, as being capable of collecting into the same focus the rays that fall on every part of it parallel to the axis.

By spectacles, on the contrary, objects are to be viewed if possible in every direction in which they might be seen by the naked eye, which is often far removed from the centres of the glasses; consequently, a construction that is calculated to represent correctly central objects alone cannot be the most advantageous.

In these also the portion of the glass employed at once is scarcely larger than the pupil of the eye; so that any endeavour to procure the concurrence of *all parts* of a glass in any one effect is evidently superfluous, and may also be shown to be prejudicial.

It is therefore proposed to remedy the imperfections observable in the spectacle glasses hitherto generally used upon a principle suggested by this latter consideration, which presents an opportunity, by a different construction, of rendering objects in all directions distinct.

The alteration requisite for this purpose is extremely simple, and easily intelligible. Supposing an eye to be placed in the centre of any hollow globe of glass, it is plain that objects would then be seen *perpendicularly* through its surface in every direction. Consequently, the more nearly any spectacle glass can be made to surround the eye, in the manner of a globular surface, the more nearly will every part of it be at *right angles* to the line of sight, the more uniform will be the power of its different parts, and the

2 more

more completely will the indistinctness of lateral objects be avoided*.

According to this principle all spectacle glasses should be convex on their exterior surface, and concave within. The section of those for long-sighted persons will assume the form of a meniscus or crescent, Fig. 2. and those adapted for short sight will have their principal curvature on the concave side, Fig. 3.

It is only necessary to add, that the advantage of this improvement in the form of spectacle glasses has been confirmed by a sufficient number of experiments on different persons, and that those in particular, who are very long, or very short sighted, are much benefited by them.

The most advantageous proportions of curvature for obtaining the different focal lengths, now generally distinguished by certain numbers, have also been duly considered, and the manufacture of spectacles on this construction has been undertaken by Messrs. P. and J. Dollond, to whom the exclusive sale of them is secured by patent, and whose well-known skill in the construction of optical instruments ensures to this improvement every advantage of correct execution.

The opportunity afforded by these glasses of *looking round* at various objects, it is thought may not improperly be expressed by the name of *Periscopic Spectacles*.

LXII. *Of the general Relation between the Specific Gravities and the Strengths and Values of Spirituous Liquors, and the Circumstances by which the former are influenced.*

[Concluded from p. 210.]

Problems and Rules for the Adaptation of Mr. Gilpin's Tables to the present Standard.

§ 31. Problem I.—*The specific gravity of a liquor at any given temperature being given, to find that which it possesses at any other temperature.*

* To mathematicians it will be evident that any ray which does not pass through the centre of a lens cannot be at right angles to both surfaces; but they will also perceive, that when any *small* oblique pencil makes equal angles with the two surfaces of a thin lens, the inclination of it to each is so small, that its focal length B D, Fig 4. will not sensibly differ from A C, that of a central pencil.

Practical

PRACTICAL RULE.

Find the given specific gravity in the table adapted to the given temperature, and take out the correspondent numbers from Column I. Search for these numbers in Column I of the table for any other temperature, and the correspondent specific gravity is that which is required.

EXAMPLES.

If a liquor have the specific gravity of 864 at 77°, what will it have at 43°?

Solution.

Looking for 864 in Column II of the table for 77°, we find that the nearest numbers are 863·82 and 865·14 (or, which amounts to the same thing, ·86382 and .86514, Mr. Gilpin considering the specific gravity of distilled water as represented by unity instead of 1000 [see Note on § 5]); whilst 100 Sp. + 27 W., and 100 Sp. + 28 W., are also the correspondent numbers in Column I. Taking proportional parts, therefore, 864 in Column II answers to a liquor which, according to Column I, contains 100 parts of Mr. Gilpin's alcohol combined with 27·14 by weight of water; and again, looking for this same compound in Column I of the table for 43°, we find in like manner that the correspondent specific gravity at that temperature, as expressed in Column II of that table, is 879·85.

§ 32. PROBLEM II.—*To find the per-centage of any liquor whose specific gravity and temperature are given.*

PRACTICAL RULES.

Look into Column II of the table answering to the given temperature for the given specific gravity, and take out the correspondent number from Column VIII. Multiply 162·42 *by this number, and the product is the answer.*

Or, add 2·2106308 *to the logarithm of the number so found in Column VIII, and the sum will be the logarithm of the per-centage.*

EXAMPLES.

1. What is the per-centage of a liquor whose specific gravity at 48° is 887?

Solution.

We must here, firstly, look into Column II of the table marked "HEAT 48°" for 887. The nearest numbers are 886·00 and 887·16. The correspondent numbers in Column VIII are against the former ·8014, and against the latter

latter ·7965. Taking proportional parts, as before, ·7972 in Column VIII answers to 887 in Column II.

Therefore, by the first method, 162·42 × ·7972, or 129·48, is the per-centage required.

And, by the second method, to log. ·7972 = $\bar{1}$·9015673
Add the constant log. = 2·2106308

And 129·48, the natural number answering to the sum, is the per-centage required = 29·48 O.P. } 2·1121981

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2. What is the per-centage of a liquor whose specific gravity at 75° is 953¼?

Solution.

On looking into the Columns II and VIII of the table marked "HEAT 75°", we find that the number in the latter corresponding to 953¼ in the former is ·3827.

Therefore, by the first method, 162·42 × ·3827, or 62·16, is the required per-centage.

And by the latter, log. ·3827 = $\bar{1}$·5828585
Constant log. = 2·2106308

And the same number 62·16 answering to the sum, indicates the per-centage as before (= 37·84 U.P.) } 1·7934893

§ 33. PROBLEM III.—*The per-centage of a liquor at a given temperature being given, to find its specific gravity at that temperature.*

PRACTICAL RULES.

Multiply the per-centage by ·006157 ; *search for the product in Column VIII of the table adapted to the given temperature, and the correspondent number in Column II is its specific gravity.*

Or, add the constant logarithm $\bar{3}$·7893692 *to that of the per-centage; search for the correspondent natural number in Column VIII of the proper table, and the specific gravity against it is that of the liquor.*

EXAMPLES.

1. What is the specific gravity of a liquor at 48°, which is 129·48 (or 29·48 O.P.) at that temperature?

Solution.

Solution.

Here, 129·48 × ·006157 is = ·7972.

Or, $\bar{3}$·7893692 + 2·1122027 (= log. of 129·48) = 1·9015719 = log. of ·7972.

Which number being found in Column VIII of the table marked "HEAT 48°," gives 887 for the correspondent specific gravity in Column II, and which is accordingly that of the liquor.

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2. What is the specific gravity of a liquor at 75°, which is 62·16 (or 37·84 U.P.) at that temperature?

Solution.

In this case 62·16 × ·006157 (or the natural number answering to the logarithm 1·5828802, being the sum of 1·7935110, the log. of 62·16 and $\bar{3}$·7893692) is ·3827, which being found in Column VIII of the table marked "HEAT 75°," gives 953¼ in Column II for the specific gravity of the liquor at that temperature.

§ 34. PROBLEM IV.—*The per-centage of a liquor at a given temperature being given, to find that which it possesses at any other temperature.*

PRACTICAL RULE.

Multiply the given per-centage of the liquor by ·00·6157 *(either by means of natural numbers or by the addition of* $\bar{3}$·7893692 *to its logarithm), as in Problem III. Find the product in Column VIII of the table corresponding to its temperature, and take out the correspondent numbers from Column I. Enter the table adapted to the temperature at which its per-centage is required with these numbers; take out the correspondent number from Column VIII and multiply it by* 162·42, *as in Problem II. The product is the per-centage at that temperature.*

EXAMPLE.

What is the per-centage of brandy at 75°, which is 105 (or 5 O.P.) at 33°?

Solution.

105 × ·006157 = ·6465.

And ·6465, in Column VIII of the table for 33°, answers to a compound of 100 + 73·8 in Column I.

This same compound being found in Column I of the table for 75°, gives ·6337 in Column VIII; and this multiplied by 162·42 is = 102·93, the required per-centage at that temperature.

If

If the gallon of proof spirit at 60°, therefore, be taken as the standard, this liquor loses more than two per cent. in its real value per gallon by the elevation of its temperature from 33° to 75°.

§ 35. PROBLEM V.—*The per-centage and temperature of a liquor being given, to find the concentration per cent., or that diminution in measure which would take place on reducing* 100 *parts of it to proof, or proof to* 100 *parts of such liquor at the same temperature.*

PRACTICAL RULE.

Firstly, Look into Column I of the table adapted to the given temperature for the liquor answering to ·6157 *in Column VIII (this being proof in all the tables); divide the correspondent number in Column VI by that in Column V; multiply the quotient (which at the temperature of* 60° *is* ·027768*) by the given per-centage, and the product will be the concentration of the equivalent quantity of proof, or that contained in* 100 *parts of the given liquor, if it were made up from M. Gilpin's alcohol, according to the supposition on which his tables are founded.*

Secondly, Look for the given liquor in the same table (having first found its correspondent number in Column VIII by Problem III), and divide the number in Column VI (taking all the three figures as integers) by that in Column V, and the difference between the former product and this quotient will be the concentration required.

EXAMPLE.

What is the concentration per cent. on reducing rum of 145 (or 45 O.P.) to proof at 77°?

Solution.

Firstly, Against ·6157 in Column VIII (which, as before mentioned, indicates proof), in the table for 77°, the correspondent numbers in Column VI and V are 4.21 and 160·37; the quotient of the former by the latter is ·02625 and ·02625 × 145 is = 3·8065.

Secondly, Against ·8928 in Column VIII of the same table, the correspondent numbers in Column VI and V are 1·26 and 110·9 respectively, and $\frac{126}{110{\cdot}9}$ is = 1·14.

And 3·8065 − 1·14 is = 2·667, or $2\frac{2}{3}$.

The concentration, therefore, under these circumstances, would be $2\frac{2}{3}$ per cent. on the quantity of the over-proof reduced, and it would therefore require $47\frac{2}{3}$ per cent. of water to reduce it.

§ 36.

§ 36. Problem VI.—*The quantities by measure of any number of liquors of different strengths, and their per-centage, at a given temperature being given, to find the per-centage of the compound when reduced to that temperature.*

Practical Rule.

Firstly, Find the tabular specific gravity of each liquor at the given temperature by Problem III, and multiply such quantity by its respective specific gravity so found.

Secondly, Find the compound correspondent to each in Column I; multiply each product obtained as above by the weight of the spirit in its respective compound as found in that column, and divide the product by the sum of the weights of its spirit and water.

Thirdly, Find a liquor in Column I whose weight of spirit is to that of its whole composition as the sum of all the quotients obtained in the second step to that of all the products obtained in the first; and it will be that which is equivalent to the compound produced by the mixture of all the given liquors, whose per-centage may therefore be determined by Problem II.

Example.

Suppose we mix 556 gallons of brandy of 111 (or 11 O.P.), 942 of 93 (or 7 U.P.), 427 of 80 (or 20 U.P.), 346 of 117 (or 17 O.P.), and 1111 of 105 (or 5 O.P.), all at 67°, together; what will be the per-centage of the compound?

Solution.

Firstly,

The tabular specific gravity of 111 at 67° (by Prob. III) is	= 902·44, which	× 556 is	-	= 501·76
That of 93 is	= 925·04, which	× 942 is	-	= 871·39
That of 80 is	= 939·48, which	× 427 is	-	= 401·16
That of 117 is	= 894·33, which	× 346 is	-	= 309·44
That of 105 is	= 910·25, which	× 1111 is	-	= 1011·30
And the sum of these products is			-	= 3095·05

Secondly,

111 at 67°	is = 100 Sp. + 60·05 W. and	501·76	× 100	÷ 160·05	= 313·50
93 - - -	is = 100 Sp. + 95.83 W. and	871·39	× 100	÷ 195·83	= 444·97
80 - - -	is = 100 W. + 76.24 Sp. and	401·16	× 76·24	÷ 176·24	= 173·54
117 - - -	is = 100 Sp. + 50·49 W. and	309·44	× 100	÷ 150·49	= 205·62
105 - - -	is = 100 Sp. + 70·66 W. and	1011·30	× 100	÷ 170·66	= 592·58
				And the sum of these quotients is	= 1730·21

Thirdly, 1730·21 : 3095·05 : : 100 : 178·888.

The

The resulting compound will therefore be found to be equal in strength to one composed of 100 parts by weight of Mr. Gilpin's alcohol with 78·88 of water, and which is, by Problem II, = 100·765 (= about $\frac{3}{4}$ or 3 quarts O.P.) at 67°.

§ 37. Problem VII.—*To find the quantity by measure which will be produced by a mixture of given quantities of different strengths at any given temperature, as in the last problem.*

Practical Rule.

Divide the sum of the products found in the first step of the preceding process by the tabular specific gravity of the resulting compound, and the quotient will be the quantity by measure produced.

Example.

What quantity of the compound shall we have under the circumstances stated in the example to the last problem?

Solution.

The tabular specific gravity of the resulting compound of 100·765 (or $\frac{3}{4}$ O.P.) at 67° is ·91558; and $\frac{3095{\cdot}05}{{\cdot}91558}$ = 3380·43 gallons at that temperature.

Note. The sum of the quantities mixed in the present instance was 3382 gallons; so that the concentration by mixture in this case was about six quarts.

§ 38. Problem VIII.—*To find what proportions, by weight or measure, of any number of liquors of different strength, but at the same temperature, must be mixed together in order to produce a compound which shall be of any required strength between that of the strongest and the weakest of them at that temperature.*

Practical Rule.

Firstly, Find the specific gravity of each liquor, and also that of the required compound at the given temperature, by Problem III.

Secondly, Find the compound corresponding to each of the given liquors, and also to the required compound, in Column 1, and divide the weight of the spirit in each compound by the sum of the weights of its spirit and water.

Thirdly, Range the quotients belonging to these given liquors in any convenient order, and couple or pair them together by curves or circumflexes, so that every one which is greater

greater than that belonging to the required composition may be coupled or paired with some one which is less.

Fourthly, Against each of these place the difference between that with which it is so coupled or paired, and the quotient belonging to the required compound.

Fifthly, Then as the sum of all these differences is to the difference (or sum of the differences, if more than one,) standing against each quotient, so is the specific gravity of the required compound to the proportion of each by weight *which will produce it; which proportion, divided by the respective specific gravity of each before mixture, gives that of each by* measure.

EXAMPLE.

In order to make up 774 gallons of a compound which shall be 108 (or 8 O.P.), at 50°, how much must I take of each of five liquors, of which one is 127 (or 27 O.P.), another 116 (or 16 O.P.), another 102 (or 2 O.P.), another 87 (or 13 U.P.), and another 67 (or 33 U.P.)?

Solution.

Firstly, The specific gravity of 127 at 50° is = ·88948; that of 116 = ·90473; that of 102 = ·92239; that of 87 = ·93954; that of 67 = ·95827; and that of the required compound of 108 = ·91498, by Problem III.

Secondly, The compound answering to 127 at 50° is = 100 Sp. + 37·89 W.	and contains	·72522	by weight, of Mr. Gilpin's alcohol, of the specific gravity of 825 at 60°.
That answering to 116 is = 100 Sp. + 53·55 W.		·65125	
——— 102 is = 100 Sp. + 78·03 W.		·56170	
——— 87 is = 100 W. + 88·83 Sp.		·47042	
——— 67 is = 100 W. + 55·07 Sp.		·35513	
And the required spirit is = 100 Sp. + 66·77 W.		·60101	

Thirdly and fourthly, The proportion by weight of spirit in the required compound is = ·60101

	Alternate Differences.	
·72522	·24588	
·65125	·03931	= ·16990
	·13051	
·56170	·05024	
·47042	·05024	
·35513	·12421	

Sum of the differences = ·64047

Fifthly,

Fifthly,

$$\cdot 64047 : \left\{ \begin{matrix} \cdot 24588 \\ \cdot 16990 \\ \cdot 05024 \\ \cdot 12421 \end{matrix} \right\} :: \cdot 91498 : \left\{ \begin{array}{l} \cdot 35127 = \text{the proportion by weight of 127} \\ \cdot 24272 = \text{that of 116} \\ \cdot 07177 = \text{that of each of those of 102 and 87} \\ \cdot 17745 = \text{that of 67.} \end{array} \right.$$

And $\frac{\cdot 35127}{\cdot 88948} = \cdot 39491$, the proportion by measure of 127 (or 27 O.P.)

$\frac{\cdot 24272}{\cdot 90473} = \cdot 26828$, that of 116 (or 16 O.P.)

$\frac{\cdot 07177}{\cdot 92239} = \cdot 07781$, that of 102 (or 2 O.P.)

$\frac{\cdot 07177}{\cdot 93954} = \cdot 07639$, that of 87 (or 13 U.P.)

$\frac{\cdot 17745}{\cdot 95827} = \cdot 18517$, that of 67 (or 33 U.P.)

But these making 1·00256, the concentration by mixture is therefore ·00256 of the whole; and, multiplying each of these by the required quantity, 774 gallons, we get

305·66 gallons for the requisite quantity by measure of 127 (or 27 O.P.)
207·65 gallons for that of 116 (or 16 O.P.)
60·23 gallons for that of 102 (or 2 O.P.)
59·13 gallons for that of 87 (or 13 U.P.)
143·33 gallons for that of 67 (or 33 U.P.)

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776. gallons in the whole, composing after the mixture the 774 gallons required; the concentration in this case being exactly 2 gallons.

It will easily be perceived, that, when the proportions of more than two of these different kinds of spirit are undefined, as in the preceding question, the problem admits of many answers, and the quantities of each kind of liquor may accordingly be variously proportioned.

A variety of other problems may be proposed and solved by means of these tables, which the mathematician will suggest to himself without any difficulty. There is, in fact, no possible question respecting these matters, of which, with the proper application of arithmetic or algebra, we may not here find the solution. The authors of this essay

conceive

conceive themselves to be as patient and attentive in experiment as the majority of persons; but they are obliged to confess, that they so far prefer these experiments to their own, that they have long taken them as the groundwork of all their calculations for the graduation of their spirit-hydrometers.

§ 39. As every one into whose hands the present essay may fall may, perhaps, not be in possession of the tables of Mr. Gilpin, we shall in this chapter present the reader with two short but correct tables of our own, calculated from his experiments by the methods before given in the last; by the help of which the per-centage, according to the mode of estimating it, described and recommended in § 26, and the concentration per cent. on reducing any over-proof spirit to proof, or proof to an under-proof, may be accurately obtained, and that even with more facility than from those of Mr. Gilpin himself, in their present state of arrangement.

Table I.

For finding the Specific Gravity of any Spirituous Compound at 60°, when that which it possesses at any other Temperature is given.

Specific Gravity.	Correct for each Degree.	Specific Gravity.	Correct. for each Degree.	Specific Gravity.	Correct. for each Degree.
810 to 820	± ·475	880 to 890	± ·456	950 to 960	± ·340
20 to 30	± ·473	90 to 900	± ·450	60 to 70	± ·269
30 to 40	± ·472	900 to 910	± ·442	70 to 80	± ·165
40 to 50	± ·471	10 to 20	± ·434	80 to 90	± ·090
50 to 60	± ·471	20 to 30	± ·424	90 to 1000	± ·084
60 to 70	± ·466	30 to 40	± ·406		
70 to 80	± ·460	40 to 50	± ·381		

USE OF THE TABLE.

The above Table is to be entered with the existing specific gravity of the liquor, against which will be found the correction to be added to it for every degree which its temperature is higher, or subtracted for every degree which it is lower than 60°.

Example.

If a quantity of rum is of the specific gravity of 894 at 73°, what will be its specific gravity at 60°?

Ans.

Ans. Here, the specific gravity being between 890 and 900, we must add ·450 for each degree of difference. The specific gravity, therefore, at 60° would, of course, be 894 + ·450 × 13 = 899·85.

Table II.

For finding the Per-centage of any Spirituous Compound at 60°, when its Specific Gravity at that Temperature is given.

Specific Gravity.	Per-centage.	Corr. for each 1.	Concentration.	Corr. for each 1.	Specific Gravity.	Per-centage.	Corr. for each 1.	Concentration.	Corr. for each 1.
810	169·22		5·62		905	111·79		0· 56	
		·426		·080			·772		·037
15	167·09		5·22		10	107·93		0· 37	
		·460		·074			·778		·037
20	164·79		4·85		15	104·04		0· 19	
		·474		·068			·808		·037
25	162·42		4·51		20	100·00		0· 00	
		·506		·063			·834		·033
30	159·89		4·19		25	95·83		0· 17	
		·524		·052			·854		·030
35	157·27		3·93		30	91·56		0· 33	
		·542		·057			·889		·028
40	154·56		3·64		35	87·12		0· 47	
		·562		·055			·938		·024
45	151·75		3·37		40	82·43		0· 59	
		·584		·054			·988		·021
50	148·83		3·10		45	77·49		0· 69	
		·600		·054			1·050		·017
55	145·83		2·83		50	72·24		0· 77	
		·616		·047			1·124		·011
60	142·75		2·59		55	66·62		0· 83	
		·634		·051			1·252		·001
65	139·58		2·34		60	60·36		0· 82	
		·646		·048			1·412		·013
70	136·35		2·10		65	53·30		0· 76	
		·656		·048			1·590		·027
75	133·07		1·86		70	45·35		0· 62	
		·670		·018			1·712		·038
80	129·72		1·62		75	36·79		0· 44	
		·682		·043			1·732		·037
85	126·31		1·41		80	28·13		0· 25	
		·700		·044			1·620		·030
90	122·81		1·19		85	20·03		0· 10	
		·712		·045			1·482		·018
95	119·25		0·96		90	12·62		0· 01	
		·734		·040			1·322		·002
900	115·58		0·76		95	6·01		0·002	
		·758		·041			1·202		·001
5	111·79		0·56		1000	0·00			

USE OF THE PRECEDING TABLE.

This Table is to be entered with the specific gravity next below that of the spirit at 60°, against which there will be found, in the second column, the per-centage if that were really the specific gravity, and in the third the per-centage to be subtracted for every unit that its specific gravity exceeds the number in the first column. The fourth column, in like manner, contains the concentration per cent. of the liquor against whose specific gravity it stands; and the fifth, the correction to be applied to the concentration for every unit which the specific gravity differs from the nearest in the first column.

EXAMPLE.

What quantity of water must we add to 427 gallons of a liquor whose specific gravity is 883 at 48°, to reduce it to proof; and how much proof spirit will it make?

Ans. We find by Table I that the specific gravity of the liquor at 60° would be $883 - \cdot456 \times 12 = 877\frac{1}{2}$ very nearly.

We see also by Table II that if the specific gravity at 60° was 875, the per-centage would be 133·07; but that, as it is 887½, we must subtract $\cdot670 \times 2\frac{1}{2}$, or 1·67, from the per-centage standing against 875. The real per-centage of the liquor, therefore, at 60° is $133\cdot07 - 1\cdot67 = 131\cdot4$; and 100 : 131·4 :: 427 : 561·08; which latter, therefore, will be the quantity of proof spirit produced.

The only remaining question is as to the quantity of water necessary to produce these 561 gallons of proof. For this we must find the concentration by Table II. Now the concentration of spirit of 875 at 60° is 1·86 per cent., and that of spirit of $877\frac{1}{2} = 1\cdot86 - \cdot048 \times 2\frac{1}{2} = 1\cdot74$. Therefore $31\cdot4 + 1\cdot74$, or 33·14 gallons, is the quantity of water to be added to every 100 gallons of the given spirit to reduce it to proof, making 141½ gallons in the whole.

§ 40. The two preceding Tables, therefore, as will be seen by the foregoing example, are, in fact, capable of answering all the most necessary questions to be resolved by those of Mr. Gilpin, and the solution of which cannot, indeed, be obtained from them except by a process of some length. The calculation of the numbers in these tables, short as they are, was a work which occasioned the authors some trouble, but which was necessary for the graduation of those instruments with which they have, in a great measure, supplied Europe. They give the per-centage and concentration at 60° only, on the supposition that the given liquor

liquor is reduced to and measured at that heat; and the computation from them, though most strictly accurate in that case, will therefore be liable to some small error in the extremes of temperature; they will, however, be found to be sufficiently correct for all practical purposes. Should the legislature change the standard of proof, they will of course become in a great measure useless as well as the instruments which are graduated from them, and new ones must therefore be calculated.

LXIII. *Extract of a Memoir read in the French National Institute, on the Strength of the Flax of New Zealand, compared with that of the Filaments of the Aloe, of Hemp, Flax, and Silk.* By C. LABILLARDIERE.

THE flax of New Zealand, which, as is well known, is obtained from a plant of the family of the asphodela, called *Phormium tenax*, holds the first rank among the vegetable fibres, yet known, proper for the making of ropes. This fact was first made known by the celebrated Captain Cook and his illustrious fellow-navigator Sir Joseph Banks. It was afterwards confirmed by Dr. Forster, who gave a good description of the plant, which he found growing in full vigour during various excursions in New Zealand, at several parts of which he touched when he accompanied Captain Cook on his second voyage round the world. A good figure of the plant may be seen in the first volume of the account of that voyage, and also in Miller's *Icones Plantarum*. Dr. Forster has decribed all the parts of fructification, and illustrated them with figures, in his work on the new genera of plants discovered in the South Seas.

No person, however, has ever yet attempted to ascertain how far the fibres of the *Phormium tenax* are superior in strength to those of hemp. This is the object of the present memoir, in which I shall compare their strength with that of the filaments of the aloe, of flax, and of silk. It is of the more importance to examine the strength of the flax of New Zealand, as compared with that of hemp in particular, because it might be substituted for the latter with great advantage in the navy, whereas the other substances are too scarce and too dear, or much inferior in utility.

The flax of New Zealand, which I submitted to examination in order to ascertain its strength, was given to me in exchange for toys by some of the inhabitants of that extensive country, with whom we had an intercourse, towards its northern point, during the voyage undertaken in search of Perouse; Ventose 22d, 1st year of the republic. The plant which produces it is of great use to these savages; and when they approached us, the first articles they exhibited were large handfuls of its leaves prepared for various purposes. Even when at a considerable distance from us they waved them with a sort of enthusiasm, as if desirous to make known to us their value, and we soon found that we had properly understood this kind of language, for they set a very high price on them when they got on board our vessel.

For my experiments I preferred these filaments to those produced from the leaves of the same plant raised in green-houses, where the fibres certainly do not acquire so much strength as in the open air; besides, the season proper for collecting leaves capable of giving the strongest fibres can be known only by experience.

The apparatus I employed for ascertaining the strength of the different fibres which I subjected to trial consisted of two pieces of wood, ten inches in height, fixed on a plank in a vertical direction, at the distance of 6 centimeters, or 2·598 inches from each other; they were slightly rounded at the upper extremity, and on the exterior part of each was fixed a small iron cylinder, about a millimetre in diameter. To these two small cylinders I affixed the filaments the strength of which I intended to try. They rested on each side on the rounded extremities of the pieces of wood already mentioned. I took the precaution to employ fibres of the same diameter, that is $\frac{1}{10}$ of a millimetre or 0·0443 of a line, which I verified by means of a microscope and a good micrometer, taking care to twist equally the part of the filament which I examined, having chosen it as far as possible of the same dimensions throughout its whole length. I tried the strength of it from every 8 centimetres to 8 centimetres, or every 2 inches 11·464 lines, which was the distance between the pieces of wood, and I suspended from about the middle of it, by means of a wire hook well covered with hemp, a weight which I increased until the filament was broken.

I took care that it should not be twisted, in order that I might ascertain its whole strength, for without this precaution it would have broken, as is well known, much sooner. Besides, for many reasons which it would be superfluous to mention here, I should have obtained results much less certain; and it is needless to observe that, in such cases, a rigorous determination cannot be obtained, but merely an approximation.

After

After having tried the strength of twelve lengths of hemp, as above described, and having divided the sum by that number, to ascertain the mean strength of each, I found that it was equal to $16\frac{1}{3}$, while that of the fibres of the *Phormium tenax*, tried in the same state, was $23\frac{5}{11}$. The filaments of the aloe gave only 7, flax $11\frac{3}{4}$, and silk 34; or, in other words, the fibres of hemp broke only with a weight of 400·5917 grammes, that of the flax of New Zealand by 590·5034 grammes, flax by 295·8228 grammes, and silk by 855·9978 grammes.

The hemp and flax which I employed for these experiments were the first fibres of the best kind produced in the department of L'Orne. I extracted, by maceration and slight friction to detach the parenchyme, the fibres of the aloe from a leaf of the *Agave fœtida*, Linn. or the *Furcræa gigantea*, Vent. which was given to me by my colleague C. Thouin.

I must here observe, that at first I took the filaments of a diameter much smaller, $\frac{1}{20}$th of a millimetre, or 0·0221 of a line, and even less; but I soon observed that it was difficult to obtain them of that tenuity without a great many inequalities and other defects, which prevented the exactness of the results; besides, the more delicate they were, the more difficult it was to ascertain their diameter. I paid attention, therefore, to those only the diameter of which was $\frac{1}{10}$ of a millimetre.

It may, therefore, be readily conceived what advantage it would be to the navy to have ropes, the strength of which, were it confined merely to this proportion, would be almost one-half greater than that of hemp ropes. But I have no hesitation to assert that it will far exceed it; for the fibres of the flax of New Zealand, according to a series of comparative experiments which I made on purpose to determine the tension of which they are susceptible before they break, are more tensible by one-half than those of hemp; and the principal cause of the diminution of the strength of a rope, in proportion to its being more twisted, arises in particular from the fibres of which it is composed experiencing different degrees of tension, the strength and inequality of which are increased by torsion. But it is evident that the more the fibres which enter into a rope are susceptible of tension, the less is the difference in the distribution of their strength, whence it results that the most tensible fibres, *cæteris paribus*, will always make the best ropes.

It has been observed that certain kinds of hemp, with

 stiff,

stiff, but very strong fibres, are often capable of less resistance, when employed to make ropes, than other kinds, the fibres of which are weaker, but softer and more flexible. It is besides known, that stiff fibres break by a weak degree of torsion, which is resisted by those that have more flexibility.

To ascertain the tensibility of the fibres of the flax of New Zealand, I took six of $\frac{1}{10}$ millimetre, or 0·0443 line in diameter, and suspended to lengths of 14 centimetres, or 5 inches 2·062 lines, a weight which I gradually increased, examining by what quantity they were extended before they broke. The sum of these quantities, divided by the number of the filaments subjected to trial, gave for quotient the mean term of the tensibility of each. Having subjected to the same trial the filaments of the aloe, of hemp, of flax, and of silk, the results which I obtained were: for the flax 1·1279 millimetres; for the hemp 2·2558; for the flax of New Zealand 3·3837; for the aloe 5·6395; and for the silk 11·2790: so that the tensibility of flax being equal to half that of hemp will be expressed by 1; that of the *Phormium tenax* by $1\frac{1}{2}$; that of the filaments of the aloe by $2\frac{1}{2}$; and that of silk by 5. It is thence seen what prodigious power of resistance is exhibited by a few threads of silk, carefully spun, as their very great tensibility causes them all to make an effort nearly equal before they yield to the effort made to break them.

It may not be improper here to remark, that the Chinese, who make great use of silk strings for their musical instruments, have no doubt found that twisting them for that purpose hurts their strength, and also the justness of the sound, for they are manufactured without twisting; the threads of which they are composed being merely united by means of an elastic resin: on this account they are, on the first view, taken for catgut. I have no doubt that if our artists would attempt this new manufacture, their labours would be attended with success, especially as they employ with great dexterity various kinds of elastic resin; but that extracted from the *Vahe* of Madagascar (*Vahea elastica*), would be preferable to caoutchouc, which comes from Guyana, because the latter has a very dark tint, while the other inclines very much to a white colour. It readily dissolves, as is well known, in ether. Besides gum elastic extracted from several other vegetables might also be employed for the same purpose.

The *Phormium tenax* is far from being the only plant of the division of the monocotyledons, capable of furnishing filaments

filaments proper for the uses of rope-making; for besides some gramineous plants, most of the palms, and all the species of the Agave, &c. there are many others of this great division which have not yet been employed, and which might be turned to advantage, particularly several kinds of iris, the leaves of which possess very great strength.

I must here observe, that in most plants of the division of the monocotyledons, the leaves produce the filaments proper for the purposes of rope-making; and the disposition of their fibres, which is nearly parallel throughout the whole length of the leaves, will call to the remembrance of botanists the excellent memoir of our colleague Desfontaines, on the organization of the monocotyledon plants. On the other hand, in the division of the dicotyledons, the filaments employed for ropes is obtained from the bark; and it is well known, that among the great number of sections which these vegetables contain, they are found chiefly in those of the *Thymeli*, *Urticæ*, *Malvaceæ*, *Tiliæ*, and the *Amentaceæ*. The bark of a shrub of the first section (of a new kind of *Pimelea*) produces filaments which I have seen the inhabitants of Cape Van Diemen employ for the purpose of making ropes. These savages have so little industry, that they use them without the least preparation. They even take no advantage of a very excellent kind of flax which grows spontaneously on their coasts. The crude bark of the *Pimelea* abovementioned formed the handles of some baskets made of reeds, which the women at the hours of repast filled with shell-fish, diving in the sea to considerable depths, at the risk of being devoured by sharks, or of being detained at the bottom of the water by marine plants, some of which, and particularly the *Ficus pyriferus*, are several hundreds of feet in length.

They employed this bark also for fastening round their bodies the skin of the kangaroo, the only clothing worn by the best dressed of these savages; for several of them were entirely naked, though exposed to severe cold in the latitude of 44° South, and by a very strange kind of whim this vestment served only to cover the shoulders.

The *Phormium tenax* will succeed perfectly in France, for it is found in New Zealand from lat. 34° to lat. 47° South, and is exposed there to very severe frosts in the most southern part of that very large country. Moist places are better suited to it than dry, and the same may be said of most of the other *Lilacæi*. It would thrive well in many of the marshy districts, which at present are considered as useless

less; besides, it is a lively plant, and will require very little care. It may readily be conceived what advantages must result from the culture of this valuable plant, and particularly to the navy, as it will lighten in a very considerable degree the lading of our vessels, for the weight of the rigging in a 74-gun ship is estimated at 3714·005 myriagrammes, or 68000 pounds. The use of the flax of New Holland would lessen this weight more than one-half; and also that of the other ropes, which are above the line of flotation; and therefore the vessel would be capable of taking in a much greater quantity of provisions. Besides, it is well known that the less the diameter of the ropes above the line of flotation, the less will be the lee-way; and, therefore, these new ropes will contribute to accelerate the progress of ships of war, which will still be increased by the lightening they will experience when loaded with a less weight than usual. These ropes being smaller and lighter than those made with hemp, fewer hands will be required to manage them; so that, if introduced, ships will need fewer men than those rigged with hemp.

It is evident also that fibres so strong and so pliable will be proper for the fabrication of different kinds of cloth, and may be substituted with advantage in our manufactories for hemp and even flax. They will no doubt retain in the loom that superiority which they have in strength over hemp. Their whiteness and silky appearance give reason to hope that cloth made of them will exceed in beauty that manufactured from flax.

All the dresses which we purchased from the savages of New Zealand were made from the fibres of their flax. To cords of the same substance they had attached different ornaments, among which were pieces of human bones, and which were suspended on their breast as a kind of trophy. They seemed to attach great value to them, and were very unwilling to part with them.

Their fishing-lines were formed of two filaments twisted together; but their nets were made from the leaves of a plant separated into filaments, without any other preparation. As their nets are of prodigious extent, for the purpose of fishing at a great distance from the coast, these savages do not make them of ropes, because this labour would require much time, and they besides find that their flax employed in this manner is sufficient.

All the piroguas which approached us had on board men armed for the most part with stones, some of them of granite, and others of serpentine, which they had attached to

their

their wrists with cords of the *Phormium tenax*; but I must observe that these were only defensive weapons, for they did every thing in their power to engage our confidence, and soon consented to exchange these weapons for our hatchets, and for other instruments of iron, on which these warlike people set great value.

It follows from the experiments, the results of which I have here given, 1st, that the strength of the fibres of the aloe being equal to 7; that of flax is represented by $11\frac{3}{4}$; that of hemp by $16\frac{1}{3}$; that of the flax of New Zealand by $23\frac{5}{11}$, and that of silk by 34. But the quantity they stretch before they break is in another proportion; for that of the filaments of the aloe being equal to $2\frac{1}{2}$; that of flax is only $\frac{1}{2}$; that of hemp 1; that of the flax of New Zealand $1\frac{1}{2}$; and that of silk 5. 2d, That great advantages will result from the cultivation of the New Zealand flax in France, where it will thrive exceedingly well.

LXIV. *Sketch of a Geological Delineation of South America.* By F. A. Von Humboldt *.

Since I sent to Madrid the two first sketches of a geological delineation of South America, from the Caraccas and Nueva Valencia, I have travelled 1200 miles, and described a square between Caribe, Portocabello, Pimichin, and Esmeralda, a space comprehending above 59000 square miles, for I am not acquainted with the land between the mountain Parea and Portocabello, and between the northern coast and the valley of the Black river. In consequence of the great circumference of this district, I must content myself with delineating it in a general manner, and to avoid details, with describing the construction of the earth, the declivity of the land, the direction and inclination of the mountains, their relative ages, their similarity with the formation of those in Europe. These are the circumstances most necessary to be known in this science. We must proceed in mineralogy as in geography; we are acquainted with stones, but not with mountains; we know the materials, but we are ignorant of the whole of which they form component parts. I wish I may be able, amidst the variety

* This sketch is an extract from a paper transmitted by M. Von Humboldt from South America, together with a geological collection, to the directors of the cabinet of natural history at Madrid. It was sent also by M. Von Humboldt to Delametherie, and inserted by him in the *Journal de Physique*, vol. 53. p. 30.

of

of the objects which occupy my attention during my travels, to throw any light on the structure of the earth. The laborious journeys which, for eight years, I have made through Europe, had no other object; and if I have the good fortune to return to Europe, and to recover my geological manuscripts which I left behind me in France and Germany, I shall venture to give a sketch of the structure of the earth. What I have long said, that the direction and inclination, the rising and falling of the primitive strata, the angles which they form, with the meridian of the place, and with the axis of the earth, are independent of the direction and depression of the mountains; that they depend on laws, and that they observe a general parallelism which can be founded only in the motion and rotation of the earth. What Freiesleben, Von Buch and Gruner have proved better than I will be found confirmed, namely, that the succession of the alluvial strata, which was considered as a peculiarity of certain provinces, such as Thuringia and Derbyshire, takes place generally, and that there appears an identity in the order of the strata (see Plate IX.); from which there is reason to conclude that the same deposition has been effected at the same time over the whole surface of the earth. All these ideas are of the greatest importance, not only to the philosopher, who endeavours to elevate himself to general principles, but also to the miner, who must conceive in his mind what he has not before his eyes, and guide himself by analogy deduced from actual experience.

Before I describe the situation of the mountains which I have observed from the coast to the province of Venezuela, I shall give a general view of the form of this continent. Unfortunately there are no early observations to serve as a ground for this description. For half a century past many accidental observations respecting this land have been collected, but not a single idea relating to its geology has been made known. The great genius of Condamine, the zeal of Don George Juan de Ulloa, would certainly not have left us in the dark on this subject, had mineralogy been more cultivated at the time when they wrote. All that could then be done was to measure and to take levels. As they were employed on the high cordillera of the Andes, which extends north and south from Zitara, as far as Cape Pilar, and beheld with wonder the immense height of the mountains, they forgot that South America exhibits other cordilleras, which extend east and west parallel to the equator, and which, on account of their height, deserve as much

much the attention of naturalists as the Carpathians, Caucasus, the Alps of the Valais, and the Pyrenees. The whole immense tract on the west side of the Andes, which extends obliquely to the coast of Guiana and Brasil, is described as a low plain, exposed to the inundation of the rivers. As only a few Franciscan missionaries and a few soldiers have been able to penetrate over the cataracts to Rio Negro, the inhabitants of the coast of Caracas imagine that the immense plains (the Llanos de Calabozo, del Guarico, and de Apure) which they see to the south, beyond the valleys of Aragua, extend without interruption to the Pampas of Buenos-Ayres, and to the country of the Patagonians; but the extent of these plains is far from being so great; they are not uninterrupted plains, they are rather phenomena of the same kind as those presented by Canada and Yucatan, the Island of St. Domingo, the north of Sierra de St. Martha, the province of Barcelona, and the land between Monte-Video and Mendoza, New Holland, the eastern part of Hungary, and the country of Hanover. They are separated from each other by the cordilleras, and are as far from lying in the same plane as the desarts of Africa, and the steppes of Tartary, which rise by gradations, according to the distance from the sea coast.

When one considers the irruptions which the North Sea, the Mediterranean, &c. have made into the old world, the direction of its cordilleras appears not to be very different from that of those in the new world, as most naturalists have asserted. We are acquainted also with the traces of several high chains of mountains which extend from north to south, and run out from those which extend east and west. The garnet and micaceous schistus of Norway, Scotland, Wales, Brittany, the province of Gallicia, Alemtego, Cape Bogador, (I have found the same with granite on Teneriff,) the upper part of Guinea, Congo, and the Table Mountain, as also the original mountains of Orenburg, Caucasus, Lebanon, of Abyssinia and Madagascar, seem at first to have formed nothing else than two large cordilleras parallel to the meridian.

In the new world these cordilleras run parallel to the meridian from Cape Pilar to the north of California beyond Nootka and Prince William's sound towards the Aleganhey mountains, which were discovered in 1792 by Mr. Stewart on his journey to the sources of the Missoury, the northern part of the Andes, which is inhabited by Indians nearly as much civilized as the Peruvians were fifteen hundred years ago. From this cordillera proceed ramifications of the original

original mountains which extend from west to east. With those of North America I am not acquainted, but it appears that some exist in Canada under the latitude of 50° and 42° north latitude, as in the destroyed continent of the Gulph of Mexico under 19° and 22°, as is proved by the mountains of Cuba and Saint Domingo. In South America there are three chains of original mountains which run parallel to the equator: the chain of the coast under 9° and 10°; that chain which is in the great cataracts of Autures (in latitude 5° 39′) is between latitude 3° and 7°; and that in Maipure in 5° 12′ 50″, which I therefore call the chain of the cataracts or that of Parime, and the chain of Chequitos under 15° and 20° south latitude.

These chains in the old continent on this side of the western ocean can be traced, and it is seen how the original mountains of Fernambouc, Minas, La Bahia, and Janeiro, correspond, under the same latitude, to those of Congo, as the immense plains near the river Amazon lie opposite to the plains of Lower Guinea, the cordillera of the cataracts opposite to those of Upper Guinea, and the Llanos of the Mississippi, since the irruption of the Gulph of Mexico, a property of the sea, opposite to the Desart of Serah. This view will appear to be less hazarded when one reflects in what manner the old continent has been separated from the new one by the force of the water. The form of the coasts, and the salient and re-entering angles of America, Africa, and Europe, are a sufficient proof of this catastrophe. What we call the Atlantic ocean is nothing else than a valley scooped out by the sea. The pyramidal form of all the continents with their summits turned southwards, the great flattening of the earth at the south pole, and other phænomena, observed by Dr. Forster, seem to show that the influx of the water was from the south. On the coast of Brasil, from Rio Janiero to Fernambouc, it found resistance, and taking a direction from the latitude of 50° north towards the north-east, where it scooped out the Gulf of Guinea near Loango Benin and Mine, it was obliged by the mountains of Upper Guinea to direct itself north-west, and separated, to the latitude of 23° north, the coast of Guinea from Mexico and Florida. The force of the waters was still broken by the cordillera of the United States of America, and once more turned towards the north-east, and seems to have spared less the western coast of Europe than the northern of America. The least breadth of this channel is at the Brasils and Greenland; but, agreeably to the geographical history of plants and animals, it seems to have been

been formed at a time when the organic creation had not been properly expanded. It would be of great importance to geology if a sea voyage were undertaken, at the expense of some government, to examine the rising and depression and the relative situation of the mountains to the salient and re-entering angles of America and Africa. The same analogy would be found here as is observed in the English Channel, in the Sound, the Straits of Gibraltar, and the Hellespont; small creeks which are as new as the secondary formation of the chalk rocks of Jura, of Pappenheim, La Mancha, Marseilles, Derbyshire, and Suez, which have all been produced at the same time by precipitation.

Of the three cordilleras of primitive mountains which traverse South America from west to east, the most northern, that of Venezuela, is the highest, but the narrowest. The real chain of the Andes extends from the large plain of Quito, through Popayan and Choco, to the western side of the river Atrato (or Rio San Juan), between the valley of Tatabé, in the provinces of Zitara and Biruguete, towards the isthmus, where it forms a mountainous district of not more than two or three hundred toises in height on the bank of the Chagre. From these Andes arises the cordillera on the coast of Venezuela. Rows of mountains higher, but forming groups less regular, extend on the east side of the Rio Atrato under the name of the Sierra de Abibé and the Montes de Cauca, through the high savannahs of Jolu towards Magdalen river and the province of St. Martha. The cordillera of the coast contracts itself like that of the Gulph of Mexico, approaches nearer to Cape Vela, and then proceeds first from south-south-west to north-north-east, and then from west to east to the ridge of Paria, or rather to the Punta de la Galera in the Island of Trinidad. Its greatest height is found at that place where it has the name of Sierra de Nevada de St. Martha in latitude 10° 8′, and of Sierra Nevada de Merida in latitude 8° 30′; the former is about 5000 the latter 5400 Spanish ells (*varas*), or 2350 toises in height. The Paramo de la Rosa and de Macuchi, and also the mountain of Merida, are continually covered with snow: boiling water (with hydrogenated sulphur) issues from their sides, and they exceed in height the Peak of Teneriff, and are, perhaps, equal to Mont Blanc, which has been more accurately measured. These colossal masses and St. Martha stand almost insulated, being surrounded by few high ridges. To the west of Santa Fé, or as far as the Sierra of Zuindiu, no snow-clad peaks are seen, and the Sierra Nevada de Merida stands at the edge of the plain of Caracas, which is scarcely forty toises above the level of the sea. Mont Blanc, which terminates the high ridge of the Alps, exhibits the same phænomenon. The altitude of the highest mountains, however, is so very small in proportion to the magnitude of the earth that it would appear that very small local causes ought to have accumulated more matter in these points. That part of the cordillera of the coast which lies to the west of Maracaybo-Sees, and joins the Andes, has large vãlleys extending from north to south, such as that of Magdalena, of Cauca, of Saint George, of Sinu, and Atrato. They are very long and narrow, but covered with wood.

On the other hand, that part of the cordillera which extends from Merida to Trinidad incloses three valleys lying east and west, which show by certain signs, like Bohemia, or the Haslithal of Swisserland, that they have formerly been lakes the water of which has evaporated or run off by opening for itself a passage. These three valleys are inclosed by the two parallel rows of mountains into which the cordillera of the coast divides itself, from Cape Vela to Cape Codera; the northern row is a continuation of Saint Martha, the southern a prolongation of Sierra Nevada de Merida. The first extends through Burburuta, Rincon del Diablo; through the Sierras de Mariara, the mountain Aguasnegras, Monte de Arila, and the Silla de Caracas, to Cape Codera. The second from three to four miles more to the south extends through Guigui, La Palma, the high summits of Guairaima, Tiara, Guiripa, and the Savana de Ocumare, as far as the mouths of the Tuy. These two chains unite with two arms which run from north to south, like, as it were, dykes, by which these old lakes were confined within their boundaries. These dykes are, on the west the mountains of Carora, Tonto, Saint Maria, Saint Philips, and Aroa; they separate the Llanos de Monai from the valleys of Aragua: on the east they are the naked summits of Los Teques, Coquiza, Buena Vista, and the Altos de S. Pedro, by which the valley of Aragua or the sources of the Tuy (for there is only one valley between the bottom of Coquiza or the Hacienda de Brisenno to Valencia) from the valley of Caracas. On the east from Cape Codera the greater part of the cordillera of the coast of Venezuela was destroyed and laid under water by the great catastrophe which formed the Gulph of Mexico. The rest of it is distinguished in the high mountain peaks of the Island of Margaretha (Macanao and the Valle S. Juan) and in the cordillera of the Isthmus of Araya, which contains the micaceous schistous mountains of Maniguares, Chuparipari, Distilador, Cerro-Grande, the mountain of St. Joseph and of Paria: the remainder I have accurately examined, and found in them the same structure, the same direction, and the same inclination of the strata. The three hollows, or valleys of Caracas, Aragua, and Monai, are remarkable on this account, that the level of them is above the surface of the sea; they become lower by gradations, and the highest step is the eastern, which may serve as a proof that they were formed at an earlier period than the Llanos, whose declivity proceeds from east to west, like the whole continent of South America. By repeated barometric measurement I found the height of the valleys of Caracas to be 416 toises, of Aragua 212 toises, above the surface of the sea; the Llanos of Monai, the western bason, appears to have an elevation of no more than 80 or 100 toises. The valley of Caracas has once been a lake, which formed for itself an efflux through the Quebrada de Tipe, Catia, and Rio Mamon; the bason of Aragua appears, on the other hand, to have become dry by gradual evaporation; for the remains of the old water (loaded with muriate of lime) are still seen in the lake of Valencia, which becomes less every year, and discovers islands which are known under the name of Aparecidas. The height of the cordillera of the coast is commonly from 600 to 800 toises; the highest peaks, Sierra de Nevada de Merida and the Silla de Caracas, (to which we undertook a laborious journey with our instruments) are 2350 and 1316 toises in height. To the west they always become lower, and the height of Cape Codera is only 176 toises. The Macanao, on the island Margaretha, which I measured trigonometrically, is not more in height than 342 toises; but this speedy depression takes place only in the primitive mountains of the cordillera. On the eastern coast secondary accumulations of lime rise from Cape Unare to a more considerable height than the gneis and micaceous schistus; these calcareous rocks, which are covered with sandstone of a calcareous base, and which accompany the cordillera of the coast in its southern declivity, are very low on the side towards Cura, but rise in a mass towards the eastern extremity of the continent.

In Bergantin they are 702 toises high, in Coccollard 392, in Cucurucho du Tuminiquiri (the highest summits of the province of Cumana) 976 toises, and the pyramid of the Guacharo rises above 820 toises: from Cape Unare they form a separate ridge of mountains, in which the original ridge totally disappears; they are connected also with the

 micaceous

micaceous schistous cordillera of Maniquare and Paria only by the Cerro de Meapire, which, analogous to the branches of Torito and los Teques, which separate the basons of Monai, Aragua, and Caracas, extends north and south from Guacharo and Catouaro, to the mountain Paria, and separates the valley of Cariaco (the dried up bank of the Gulph of Cariaco) from the valley of St. Boniface, which formerly belonged to the Golfo Triste. It will be seen hereafter, that the accumulation of calcareous formation on the eastern part of the coast of this country seems to have been more exposed to earthquakes; and that the Cerro de Meapire, at the time of the irruption of the Gulph of Cariaco, and the Golfo Triste, prevented the water from converting the land of Araya and the ridge of Paria into an island.

The declivity of the cordillera of the coast of Venezuela is gentler towards the south than towards the north, which is particularly striking when one descends from the heights of Guigue, through St. Juan, Parapara, and Ortiz towards the Mera de Paja, which belongs to the great Llano de Calabozo. The northern declivity is every where very steep, and there is scarcely found, Mont Blanc excepted, above Courmayeur, a more frighful precipice than the perpendicular wall of Silla de Caracas, beyond Caravalledo, which rises to the height of 1300 toises. An accurate measurement of this wall of rock was of great importance to navigators, as they could find its distance from the coast only by taking the angle of its elevation: its longitude, therefore, of 60° 37′ 32″ west from Paris, will enable them to discover it.

The phenomenon of a more gentle declivity towards the south seems to contradict the observations made in other cordilleras of the earth, as it is asserted that they all decline more abruptly towards the south and west. This contradiction, however, is only apparent as the northern part of the cordillera, during the great catastrophe which produced the Gulph of Mexico, was torn away by the force of the water; and therefore the northern declivity might at that time be gentler than the southern.

If the form of the coast be considered, it appears to be pretty regularly indented. The headlands of Tres Puntas, Codera, S. Roman, and Chichibacoa, on the west, from Cabo de la Vela, form a row of promontories, the western of which runs more to the north than the eastern. To the windward of each of these capes a creek has been formed; and one cannot help seeing, in this singular formation, the

action

action of the tropical currents, which may be called the currents of the earth's rotation; an action which shows itself also in the direction of the coast from Cuba, St. Domingo, Porto Rico, Yucatan, and Honduras, as in the series of the windward islands Grenada, Orchila, Rocca, Aves, Buenos-Ayres, Curaçoa, and Aruba, the ruins of the cordillera from Cape Chichibacoa, which are all parallel to the equator. It was this headland of Chichibacoa, notwithstanding its inconsiderable height, which by its resistance to the influx, preserved the kingdom of New Grenada from losing so much land as the general government of Caracas.

The second original cordillera of South America, which I have called the cordillera of the Cataracts of Orinoco, is yet very little known. During the journey which we made on the Black River, to the borders of the Great Bara, we travelled more than 200 leagues, first from north to south, from Cerro de Uruana to Atabapo and Tuamini; then from west to east, from the mouths of the Ventuari to Vulcan de Duida, which I have found to be in latitude 3° 13′ 26″, and longitude 60° 34′ 7″ west from Paris. Since the journey of Messrs. Ituriaga and Solano, a passage over these cordilleras, which may be called also Parima or Dorado (golden), a name which has occasioned so much misfortune in America, and so much ridicule in Europe, has been possible; but as all the European settlements on the Alto Orinoco, and the Rio Negro (Black River), contain at this time no more than 400 Indian families, and as the way from Esmeralde to Erevato and Caura has been totally lost, our researches in a land so little civilized, presented more difficulties than Condamine experienced during his tedious navigation on the river Amazon, the banks of which for many years have been inhabited.

The cordillera of the Cataracts or of Parima separates itself from the Andes of Quito and Popayan, in the longitude of from 3° to 6°. It extends from west to east from Paramo de Tuquillo and St. Martin, or the sources of the Guaviare, the theatre of the gallant deeds of Philip de Urre, and the old residence of the Omeguas, through Morocote, Piramena, and Macuco, stretching through the country of the Indians of Guajibos, Sagi, Dagueres, and Poigraves, according to the direction of the great rivers Meta, Vichada, Zama, Guaviare, and Ymerida, in the longitude of 70° west from Paris, between the high summits of Uniama and Cunavami. They form the Raudals of Atures and Maypuré, tremendous waterfalls, which afford the only passage by

 which

which one can penetrate into the interior of the land in the valley of the River Amazons.

These cordilleras of the Cataracts rise from the longitude of 70°, and spread out in such a manner that they comprehend the whole immense tract of country between the rivers Caura, Erevato, Cavony, Paraguamusi, Ventuari, Jao, Padamo, and Manariche, and then ascend south towards the sources of the Pasimona, Cachevayneris, and Cababury, towards the forests, where the Portugueze, penetrating into the Spanish district, collect the best sarsaparilla known (*Smilax Sarsuparilla*, LINN.). In this district the cordilleras of the Cataracts are above 120 miles in breadth. Their continuation more towards the east, between the longitude of 68° and 60° west from Paris is little known. I proceeded with astronomical instruments only, as far as Rio Guapo, which discharges itself into the Orinoco, opposite the Cerro de la Cauchilla, in longitude 68° 33′ west from Paris. The Indians of Catarapeni and Maquiritares, who reside in the small mission of Esmeralde came fifteen miles further east over the mountains Guanaja and Yamariquin to the Canno Chiguire; but neither the Europeans, nor Indians with whom Europeans have had any intercourse, are acquainted with this source of the Orinoco, which is here called Canno Paragua, and is scarcely 150 or 200 toises in breadth, whereas at Boca de Apuré, in latitude 7° 32′ 20″, it is 1632 toises, as I myself found. The wildness of the Indians of Guaicas, who are only four feet in height, but who are a very white and warlike people, and particularly the savage state of the Guajaribos, greater men-eaters than any of the other nations which we visited, prevent any one from penetrating over the small cataracts (Raudal de Guajaribos) east from Chiguire, unless a military expedition were undertaken on purpose. But by the wonderful journey undertaken by D. Antonio Santos, who married Onotho, and who dressed sometimes as a Carib, and sometimes as a Macacy, whose languages he spoke, from Orinoco (the mouth of the Rio Caronis) to the small lake Parima and the river Amazon, we have obtained information respecting the continuation of the cordillera of the Cataracts. Under the latitude of from 4° to 5° and longitude 63°, it becomes so narrow that it is scarcely 60 miles in breadth. It assumes here the name of Cerrania de Quimiropaca and Pacaraimo, and forms a chain of not very high ridges, by which the waters were divided. The water of the northern declivity, the Nocapray, Paraguamuci, Benamo, and Mazurini, flow towards the Orinoco and Rio Esquibo; the waters

waters of the southern, the Rio Cururicana, Parime, Madari, and Mao, pour themselves into the River Amazon. Some degrees further towards the east, the cordillera again extends in breadth as it ascends southwards towards the Canmo Parara along the Mao. It is here that the Dutch give to the Cerro d'Ucuamo, the magnificent name of the Gold-Mountain, or Dorado, because it consists of a very shining micaceous schistus, a fossil which has brought into celebrity the small island of Ypamucena in the lake of Parima.

On the east from Rio Esquibo, or on the other side of the land of the Aturajo Indians the cordillera turns south-east as it unites with the garnet mountains of the Dutch and French Guiana, which are inhabited by a mixture of Negroes and Caribs, and give an origin to the rivers Berbice, Surinam, Marony, Aprouague, and Oyapock. The last mentioned ridge of mountains extends very much: its gneis appears at Baxo Orinoco, in latitude 8° 20′, between the mouths of the Upata and Acquire, and in latitude 2° 14′ on the north side of the river Amazon, in the mountains of Fripoupon and Maya.

Such is the form of the great cordilleras of the Cataracts, which are inhabited by a great number of uncivilized savages, little known to the Europeans. I must here observe, that in this description I have followed my own observations only, and the notices we obtained from the Indians, as also the observations of D. Antonio Santos, and the companions of his journey, who dictated to their friends. The maps of this part of the continent are entirely false, and the map added to the history of the Evircoco by P. Caulin, a work in other respects meritorious, is by our last observations some degrees more wrong in longitude and latitude than the map published thirty years before by d'Anville. All the Indian names in it also are mutilated, and mountains and rivers are delineated where none exist; a defect the more pardonable as the author was never beyond the waterfalls of Orinoco, nor at the Rio Negro.

[To be continued.]

LXV. *Description of Mr.* RICHARD KNIGHT's *Apparatus for preparing Fluoric Acid, and for Etching on Glass.*

THE fluoric acid, as every chemist knows, has the property of dissolving and volatilizing silex; therefore vessels made of glass, which consists chiefly of silex, cannot be conveniently employed to prepare or retain this acid. The common method of preparing it is by employing a leaden retort into which is put a quantity of fluor spar in powder, and an equal or a greater quantity of sulphuric acid: a gentle heat is then applied, and a gas comes over, which may be received in the usual manner into jars standing over mercury. This gas is the fluoric acid. Or the gas may be made to pass into a receiver containing water; in which case the acid is obtained dissolved in the water.

Mr. Knight's apparatus consists of a leaden body A, fig. 1. (Plate VIII.) furnished with a wide groove, *a a*, round its mouth. The body A is fitted into the mouth of another vessel B, into which is put water, the medium through which the heat is applied to the contents of A. To the body A is fitted a cover C, which rests on the outer edge of the groove *a a*, and also enters into the groove, which is filled with water when the apparatus is to be used.

If fluor spar in powder be put into A, sulphuric acid be poured over it, and heat be applied to the vessel B, the water therein will transmit heat to the materials and the gas will ascend into the head C, where it will be absorbed by the water in the groove *a a*, and form liquid fluoric acid. If a piece of glass, covered with wax, or any proper etching-ground on which a design has been traced with a sharp point, be exposed in the head C to the action of the acid gas, the parts of the glass that have been laid bare will be corroded in the same way as copper is by aquafortis when etched. In this case the fluoric acid always leaves the surface it has acted upon dull and opake. When liquid fluoric acid is employed instead of the gas, the bottoms of the lines are transparent.

For etching on glass, however, with the gas, the following modification of Mr. Knight's apparatus seems preferable to the former:—The materials are to be put into the leaden vessel A, fig. 2, which has a cover fitted into a groove (filled with water when made use of), and a pipe in the cover by which it is connected with another leaden vessel D (furnished with a cover), into which the glass intended to be acted upon by the acid is put resting on a strip of lead bent into any form that may not interfere with the design on the glass. In this case, as in the former apparatus, the vessel A is to be heated by water in an exterior vessel.

Instead of drawing with a sharp point through an etching ground when the gas is to be employed, another process may be followed:—With a hair pencil apply a proper varnish to those parts of the glass which are wished to be defended from the action of the acid: in a few moments

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the exposed surface will become comparatively dull; and on removing the varnish from the other parts they will appear to have undergone some process by which they have received a higher polish than glass usually exhibits: for the parts acted upon, though really dulled a little, will still appear transparent if the process has not been carried too far.

LXVI. *Description of the Vulture of Pondicherry.* By F. M. Daudin *.

It is not only easy to separate the vultures from other birds of prey because they have the head or neck bare of feathers, but they may be subdivided also into several sections, as some of them have caruncles while others are unprovided with them.

The most remarkable species are met with among those of the first section, but the one which hitherto seems most worthy of the attention of ornithologists is the *Oricou vulture*, discovered by Levaillant in Africa; for the aperture of its ears is surrounded by a membranous caruncle, four lines in height, nearly similar to an external ear, and which descends downwards on each side of the neck. The head and neck of this bird, very well preserved, may be seen in Levaillant's collection.

Sonnerat also discovered at Pondicherry another vulture so similar to the oricou in size, dimensions, and principal characters, that several naturalists have been of opinion that this vulture of Bengal might be the female of the oricou, for on each side of the neck and a little below the ear it has a membranous caruncle turned downwards; but as these two vultures exhibit other differences more striking I have thought it proper to consider these birds as two kindred species †.

The vulture of Pondicherry differs from the oricou described by Levailliant, 1st, By its caruncles, which are placed below the ear: 2d, By its face, furnished with stiff hairs, which surround the tympanum, cover the cheeks, and are proportionably longer than on the neck: 3d, By its breast, covered with ash-coloured silvery down, short and compact; 4th, by the white downy cravat placed on each side

* From *Annales du Museum National d'Histoire Naturelle*, No. 4.

† Levaillant, Histoire Naturelle des Oiseaux d'Afrique, pl. 9 Daudin, Traité d'Ornithologie, vol. ii. pl. 10. Vautour Oricou (*Vultur auricularis*), p. 11. Vautour de Pondicherry (*Vultur ponticerianus*).

of the lower part of the neck: 5th, By the plumes of the whole lower part of the body, which are very short, and not long and unravelled as in the oricou.

The rest of the plumage is of a very dark colour; the bill and feet are yellow.

The individual from which the annexed engraving was taken (Plate X.) is now in the National Museum at Paris, and was found in India by Massé, the naturalist. The description published by Sonnerat is completely applicable to the individual found by Massé; but the figure is so incorrect that Mauduyt did not venture to mention the caruncles of the neck in his *Dictionnaire Ornithologique*.

LXVII. *Twelfth Communication from Dr.* THORNTON, *on Pneumatic Medicine.*

To Mr. Tilloch.

SIR, No. 1, Hinde-street, Manchester-square.

I AM happy to inform the philosophic world that the *pneumatic practice* is at this time advancing. I am credibly informed that Dr. Baillie and Dr. Reynolds, physicians equally distinguished for science and humanity, have each ordered the administration of the *vital air*. Several other practicioners are following the same liberal course; and it is probable that this century will see the completion of my ardent wishes; namely, the establishment of the virtues of the *aërial* remedies.

The First Case of the Application of Vital Air.

To Dr. Thornton.

DEAR SIR, Conduit-Street, Jan. 12, 1804.

In compliance with your request, I sit down to state to you the case of Mrs. L——, the lady of —— L——, Esq. living near Guildford. This lady laboured under a decline, at a time when her husband was attending a course of Dr. Priestley's discoveries, nearly thirty years ago, at my lecture-rooms, then in George-Street, Hanover-Square, soon after those discoveries were made. The atrophy kept on increasing for some time after, till her state made an eminent physician of Guildford desire Mr. L—— "to prepare for the worst." This alarm induced him to ask his physician, "if some of those newly discovered airs might not be usefully employed in her case." His answer was: "Any thing might be tried, but he feared all would be to no no manner of purpose." Mr. L—— immediately set out for London, and requested I would fit up an apparatus for Mrs. L——, to try the effects of the dephlogisticated air, as it was then called. I immediately accompanied him to the country. Here I ought to blush, and apologize to the faculty, for having dared to employ a *new medicine* without possessing any pathological knowledge: but the case was desperate. An agonizing husband, determined to try every expedient to save a beloved wife, could not fail to rouse the utmost efforts of humanity; and the *vital air* appeared to me not unlikely to produce relief, (if not a cure,) as I had often myself breathed it mixed with common air, and found it *very reviving*. I therefore put a table-spoonful of minium (red lead) into a saucer, and poured upon it as much vitriolic acid as would moisten it, and placed it about a yard distant from the patient, that as the gas rose it might be much diluted with the common air, so as not to irritate the lungs. Finding no ill effects to arise, I repeated the same dose for a quarter of an hour on that day, but placed nearer the nostrils, and she found herself better. So encouraged, I pursued this practice for several days, till I judged that she might draw the gas from a vessel contrived for this purpose, and still less mixed with common air. Her cough was in consequence considerably abated, her breathing became very easy, she felt herself after each inhalation *revived*, and was *evidently* so much mended that I took my leave of the lady, after having put the family into the way of continuing on the process. This practice I understand was persisted in for some time, till Mrs. L—— was established in her health. I then lost sight of the family for several years, (Mr. and Mrs. L—— having gone abroad*,) when I was at last agreeably surprised by a call from Mr. L——, who said, "he was returned to England, and was come to thank me for a wife and two children." Only three years ago this lady with her husband attended my lectures, and had continued since in perfect health. I have the honour to remain, dear Sir,

With much respect and esteem, yours, &c.

A. Walker.

Observations on this Case by Dr. Thornton.

1. As the attending physician is dead, I am unable exactly to ascertain all the symptoms of the disorder here mentioned;

* Upon putting the question, neither of the Mr. Walkers have any idea that this expedition was undertaken for the purposes of health.

mentioned; but the debility must have been great, and the danger alarming.

2. "After each inhalation of the superoxygenated air, the patient was *revived*." Mr. Walker also mentions a like effect, from inhaling an atmosphere of a higher standard. Dr. Priestley likewise experienced the same good effect, and ventures to prophecy "that in time the inhaling of oxygen air would become a fashionable article of *luxury*. Hitherto," says this philosopher, "only two mice and myself have had the pleasure of breathing it." In my *first* communications, published by Dr. Beddoes, December 1793, I have stated the same circumstance, and add, by way of P. S. to my second letter, "I cannot at this time forbear mentioning the instance of a clergyman, the Rev. Mr. T—r—r, who laboured under dyspepsia, and great depression of spirit. He had exhausted the whole catalogue of tonics, without experiencing much benefit. As nothing conduces more towards good spirits and quick digestion than a clear pure air, I accordingly ordered him to inhale vital air, blended with a proportion of atmospheric. The load on his chest, as he termed it, was removed; his appetite was quickened; his spirits were raised to the pitch I would term *gaiety*; and, as he informs me, he felt the same night so strong a desire to go to the play, to which he had not been, not feeling the least inclination towards such an excursion, for a long time, that he went that night; and declares, that he is fully convinced that no inducement could have got him thither, had he not previously inhaled a more exalted atmosphere." About the same time Dr. Biggs was a patient of Dr. Beddoes, and being a physician, the more credit will be allowed to his assertion. He says, "after breathing the superoxygenated air, I found my difficulty of breathing much relieved in three days, and before the expiration of eight days it entirely ceased. Before this time I had been subject to coldness of the extremities, which now went off. I could even sleep with fewer bedclothes. I had also *a greater flow of spirits*." Dr. Maxwell, and Dr. Goodwyn, infused 4 pints of vital air into the cellular texture of several dogs, by making an insertion under the skin. After the first effects of the operation was over, the animals appeared "*exceedingly lively*" (*maxima alacritas*.) (Vide Dr. Maxwell's Thesis, published in 1787, Edinburgh.) The celebrated Dr. Beddoes, in his history of that remarkable case, where a person subject to epilepsy was thrown into an unusual fit, says, "I was not prepared to expect any thing like intoxication from an overdose of

diluted oxygen air, especially as in the instances where I have known more inspired in the same time, nothing beyond a *sensation* similar to the *alertness* of *healthy children* was *felt*. (Vide Letters of Dr. Withering, &c. to Dr. Beddoes, p. 33.) Thus it is a common remark, after coming out of vitiated air in a crowded room, how *grateful* how *reviving* is the air! The western breeze in spring, replete with oxygen air is even a theme for the poet's song. There are many who do not feel refreshed unless they use exercise in the open air. Besides the nerves,

3. That the inhalation of oxygen air acts on the circulation, appears to be proved from the following particulars. From experiments with animals we learn the following very curious facts:—"I observed," says Dr. Beddoes, "signs of much stronger irritability in the right auricle and ventricle, in the diaphragm and intercostal muscles of the *oxygenated* rabbit; and, considering the *force* and *frequency* of the *contractions*, the quantity of action would have been greater in the oxygenated had the irritability continued five times as long in the other. The speedier *coagulation* of the oxygenated venous blood is, I think, also remarkable; and, as it happened in three following experiments, was not accidental. There was an alteration made also in the *muscular fibre*. Several persons, of whom all did not know the one rabbit from the other, found the boiled flesh of the oxygenated, in both cases, more stringy and harder. The difference was most sensible in the young pair. The greater stringiness was apparent in both these occasions to the eye."

"In a society for philosophical experiments and conversations, Mr. Taylor's pulse was first felt by Dr. Higgins, and by many other members present with myself. It was only 64 previous to his inhaling 19 pints of pure oxygen air, although he was healthy, and only 22 years of age. In the minutes of our society, which are published (see p. 146), it is noted, "that during the respiration his pulse was quickened to 90 beats in a minute, and considerably increased in strength and fullness; but he felt *no inconvenience* whatever. The vessel being charged again with nineteen pints of oxygen air, he respired these also, and his pulse was now increased to 120 beats in a minute, and vigorous withal: he felt *no inconvenience*, but had a sense of *unusual warmth* in his lungs. In one hour after the experiment, his pulse was returned to 64 beats, as before the experiment."—That evening Mr. Taylor appeared to me, and others to be rather in fuller spirits.

[The subject of the *pneumatic practice* will be resumed in the next.]

LXVIII. *Notices*

LXVIII. *Notices respecting New Publications and the Fine Arts.*

A Practical Essay on the Analysis of Minerals, exemplifying the best Methods of analysing Ores, Earths, Stones, inflammable Fossils, and Mineral Substances in general. By FREDERIC ACCUM. 12mo.

MR. ACCUM, to whom the public are under obligations for a useful work of which we lately took some notice, namely, *A System of Theoretical and Practical Chemistry*, has brought forward the present essay, as he informs us in his preface, by the express desire of a number of gentlemen to whom he delivered a private course of lectures on practical chemistry. We have no doubt but it will meet with a favourable reception, as it presents much useful information on the subjects which it embraces. The following extract will convey some idea of the nature of the work:

General Analysis of Earths and Stones.

In the preceding pages we have considered earths and stones solely with a view to discover their principal prevalent component parts, in order to determine therefrom the genus to which the mineral belongs: we shall now enlarge upon this subject more fully, by pointing out some general observations, which may serve as a guide for separating all the different earths that may exist in a mineral submitted to our examination. In the analysis of earthy substances, or stones, we must first attend to their solubility or insolubility in acids; and with that view we divide them into two classes, namely, earths and stones, which effervesce with, and are either totally or nearly soluble in, nitric acid, diluted with five or six times its weight of water; and such as are not soluble in that acid. Suppose, therefore, that the stone to be examined consisted of silex, alumine, magnesia, lime, strontia, and barytes.

The method of separating these different earths will become obvious from the following considerations:

Process I. Reduce a quantity of the mineral to powder, and try whether it effervesces with nitric or muriatic acid diluted in the above proportions; if so, let a determinate quantity be put into a tubulated retort of as little capacity as possible, immerse the neck of it under a cylinder filled with water, and placed in the pneumatic apparatus.

II. Let a quantity of muriatic acid be put at once through

 the

the tubulure, or opening, at the top of the retort, and immediately stop it so as to be air-tight.

III. When no more gas is liberated by the addition of a fresh portion of acid, assist the action by heat, and transfer the cylinder containing the gas into lime water: the carbonic acid will now be absorbed; the loss of the whole bulk, after deducting the air which was contained in the retort, indicates the quantity of carbonic acid contained in the stone.

IV. The substance from which the carbonic acid has been expelled must be diluted with double its weight of water, and filtered; the insoluble part, if any, put aside for further examination. The solution may contain lime, magnesia, alumine, barytes, and strontia.

V. In order to ascertain if barytes or strontia be present, dilute a small portion of the solution with 24 times its bulk of water, and drop into it a solution of sulphate of soda. If barytes or strontia (or both) be present, a cloudiness will take place, and a white precipitate will gradually be deposited.

VI. Having thus investigated the presence or absence of these earths, our next object is to separate them. Suppose they should both be contained in the fluid? For that purpose, add a solution of sulphate of soda till it produces no further cloudiness; when the precipitate has subsided, collect it on a filter, wash and dry it.

VII. Boil this precipitate, with four times its weight of carbonate of potash, in a sufficient quantity of water for at least one hour, supplying this fluid as it evaporates, then suffer the insoluble part to subside, and wash it.

VIII. Transfer the insoluble part of the last process into nitric acid of the specific gravity 1·4, diluted with an equal weight of water. The carbonate of strontia which it contained will be dissolved, but the barytes will not be acted upon: the weight of the latter, deducted from the weight of the whole, gives the quantity of each; or the two may be separated by adding to the nitric solution barytic water till no further precipitate ensues: the barytes in this case will seize the acid, and the strontia will be thrown down; but in this case it is essential that the nitric solution of the earth is perfectly neutral, or has no excess of acid.

IX. The strontia and barytes being thus separated, heat the fluid and drop into it a boiling solution of carbonate of soda: the precipitate which falls down may consist of all the remaining earths which were contained in the solution

solution, namely, lime, magnesia, and alumine. In order to separate them, proceed as follows:

X. Boil the precipitate in a solution of caustic potash for at least half an hour, dilute the fluid with water, and separate the insoluble part by the filter, the alumine will now be dissolved by the potash, and the other earths remain untouched.

XI. To separate the alumine, neutralize the alkaline solution by muriatic acid; a precipitate falls down; wash it, and expose it to a red heat. It is the alumine which was contained in the mineral.

XII. To separate the other earths, dissolve the residue of Process X in nitric or muriatic acid, evaporate the solution to dryness, weigh the dry mass, and pour on it at least double its weight of sulphuric acid, and heat the mixture till no more white fumes rise. Digest the mass in twice its weight of cold water, filter it, and dry the insoluble part in a low red heat.

XIII. The insoluble portion of the last process contains the lime combined with sulphuric acid. To ascertain its quantity deduct from its weight 59 per cent.; the remainder is the quantity of lime.

XIV. To obtain the magnesia, concentrate the fluid obtained in the XIIth Process to one-third of its original bulk; make it boiling hot and decompose it by a solution of carbonate of potash; collect the precipitate, expose it to a red heat till it does not effervesce by the addition of an acid. It will then be the pure magnesia contained in the mineral.

Stones insoluble in Diluted Nitric and Muriatic Acids.

Process I. Take a determinate quantity of the stone reduced to an impalpable powder, mix it with at least three times its weight of potash, and fuse the mass thoroughly in a silver or platina crucible. From the phænomena which take place during this process, we may already form some conjecture concerning the nature of the stone submitted to examination. If the mass fuses completely, siliceous earth predominates; but if the fusion remains imperfect, and the mass cannot be rendered liquid, the other earths are most abundant. If it remains in a powdery form, and can partly be rendered liquid, and if the bulk of the mass has been considerably increased, then alumine may be expected to be the most prevalent part. If the mass in the crucible be of a brownish red colour, it contains oxide of iron: a bright green colour announces the presence of manganese, especially

cially if a small quantity of the mass, when dissolved in water, communicates to that fluid the same colour. If the mass is of a yellowish green, the oxide of chrome may be present.

II. When the mass has been thoroughly fused or kept in a red heat for at least two hours, remove the crucible out of the fire, and when nearly cold pour water into it gradually, in order to detach the mass from the crucible; transfer the whole into a flask, pour four times its quantity, or more, of water over it; boil the mixture for about half an hour, and then suffer it to subside.

III. Having done this, pour gradually muriatic acid into the before-obtained solution without previously separating the insoluble part, if any. The first portion of acid which is added occasions a flocculent precipitate, then an effervescence takes place, and a copious precipitate immediately follows; which, however, is no sooner formed than it is redissolved. On adding more acid, the portion of the mass which resisted the action of water, and which was not dissolved in Process II., will become dissolved. If it consists of alumine it will be taken up silently by the acid; if it be lime, barytes, or strontia, it will be dissolved with effervescence.

Remark.—From the phænomena attending the process of the solution of this mass in muriatic acid, some indications may be derived. If the solution be colourless the stone contains no metallic substance, or only a minute quantity. If its colour be purpleish red, it contains manganese; orange red is a sign of oxide of iron; gold yellow shows chrome.

IV. To separate the different earths, &c. contained in the solution, evaporate it to dryness; when the evaporation is approaching towards its completion it assumes a gelatinous appearance, it must then be diligently stirred with a glass rod till it is almost dry.

V. Transfer the mass into a large quantity of water, boil the mixture for a few minutes and then filter it, wash the insoluble residue left on the filter repeatedly, dry it and expose it to a red heat; its weight shows the quantity of silex contained in the stone. If it is pure silex it will be perfectly white, entirely insoluble in sulphuric, nitric, and muriatic acids: if it be coloured it is contaminated with some metallic oxide, and shows that the evaporation to dryness has been performed with too much heat. From the metallic oxide it may be purified by digestion in muriatic acid, and then washed and dried as before. The acid expended

pended in washing may be added to the fluid which passed through the filter in obtaining this earth.

VI. The fluid from which the silex has thus been obtained, is then to be concentrated by evaporation and mingled with a heated solution of carbonate of potash till no more precipitate ensues. The precipitate must be separated by the filter, washed and dried. It may contain alumine, lime, magnesia, glucine, and yttria, beside metallic oxides.

VII. Transfer the precipitate obtained in the last process into a solution of potash, and boil it for half an hour. If alumine and glucine were present, they will both be dissolved in the potash, while the other substances remain untouched in the form of a powder.

VIII. To separate the alumine, decompose the solution by the addition of an acid, taking care to add the acid employed in excess, so that the precipitate which first appeared becomes redissolved. Having done this, drop into it a solution of carbonate of ammonia in such quantity that the liquid tastes of it. By this addition the whole of the alumine will be precipitated in white flakes, and the glucine will remain dissolved provided the quantity of carbonate of ammonia used be not too small. The liquid must now be filtered, and the alumine washed, dried, and ignited; its weight may then be ascertained.

IX. The fluid from which the alumine has been separated may be boiled for some time; the glucine, if it contains any, will be precipitated, which may be dried and weighed.

X. The insoluble part left in Process VII may now contain lime, magnesia, and some metallic oxide: let it be dissolved in diluted sulphuric acid, and the solution evaporated to dryness; on the dry mass pour a small quantity of water, and digest it for a few minutes; the water will dissolve the sulphate of magnesia and the metallic sulphates; but the lime combined with the sulphuric acid will remain undissolved: let it be heated red-hot in a crucible, and the quantity of lime determined, as directed before, page 143.

Remark.—If yttria be suspected, let the residuum of Process VII. be treated with carbonate of ammonia, which will dissolve the yttria and leave the other bodies; then proceed as above.

XI. The solution from which the lime has been separated must next be copiously diluted with water; add a small excess of acid, and then drop into it a solution of carbonate of potash as long as a precipitate ensues. This will separate

rate the oxides of iron, chrome, and nickel; but the oxide of manganese, and the magnesia, if any be present, will remain dissolved.

XII. To separate the oxide of manganese from magnesia, pour into the fluid obtained in the last process hydrosulphuret of potash: the manganese will be precipitated, but the magnesia will remain dissolved. The precipitated manganese must be heated to redness, and weighed.

XIII. To the fluid of the last process, from which the manganese has been separated, add a solution of potash; the precipitate which now falls down is magnesia; let it be washed, dried, and heated to redness.

XIV. In order to obtain the metallic oxides, boil the insoluble residue, left in Process XI, repeatedly in nitric acid to dryness.

XV. Transfer the dry mass into a concentrated solution of potash. The oxide of chrome, acidified in the last process, will thus unite to the potash, but the other oxides will remain untouched: decant the fluid from the insoluble residue.

XVI. To separate the oxide of chrome, add to the solution muriatic acid in excess; and evaporate the fluid till it assumes a green colour: then, on adding a solution of potash, the oxide of chrome falls down, because the quantity of oxygen required for its acidification has been separated by the muriatic acid: let the precipitate be dried and weighed.

XVII. Let the insoluble residue of Process XIV be next dissolved in muriatic acid, and to the solution add liquid ammonia in considerable excess: the oxide of iron will be precipitated; let it be washed, dried, and weighed.

XVIII. The oxide of nickel which remained in solution on account of the excess of ammonia will now fall down: on evaporating the fluid to dryness, its weight may be ascertained in the same manner with the other ingredients, and the analysis of the stone is now completed.

Elements of Galvanism in Theory and Practice; with a comprehensive View of its History, from the first Experiments of Galvani to the present Time: containing also Practical Directions for constructing Galvanic Apparatus, and plain Systematic Instructions for performing all the various Experiments. Illustrated with Plates. By C. H. Wilkinson. 2 Vols. 8vo.

The title of this work sufficiently explains its object. The author, in his preface, mentions the sources whence he has chiefly derived his information, namely, the productions of Sue, Reinhold, and Humboldt, and the Medical Journal, Mr. Nicholson's Journal, and the Philosophical Magazine; and

and it is but justice to the author to say he has been very industrious, having allowed nothing to escape him which ought to appear in a work of the kind he had undertaken. He divides the historical part of his work into two epochs; the first consisting of the various discoveries from the period of Galvani to that of the Voltaic pile; when the second commences, which comes down to the present time. This is followed by what the author calls his particular theory, in which, however, several opinions are mentioned as new which we have seen elsewhere, and some of which appear to us to have been mentioned in the historical part as being entertained by others.

The language of the author is neat and correct, and the work will afford a considerable portion of amusement to readers in general, as well as to those whose pursuits render it necessary for them to make themselves acquainted with this new and interesting subject.

The Soldier's Friend: containing Familiar Instructions to the Loyal Volunteers, Yeomanry Corps, and Military Men in general, on the Preservation and Recovery of their Health. By WILLIAM BLAIR, *A.M. &c. &c.* A New Edition. 12mo.

Mr. Blair's exertions at the present crisis have been highly meritorious. His gratuitous lectures to the volunteers will be long remembered with gratitude by his countrymen, and the present little volume will be well received by the public, especially by those for whose service it is chiefly intended. No military gentleman or volunteer ought to be without it.

The Conversion of Saul: engraved by HELLYER *from a Picture by* DAYES.

The composition, breadth of light and shadow, and other points of excellence which are conspicuous in this print, rank it among the finest productions of the British school. It possesses a force of expression that must recommend it to all the lovers of true art, at the same time that the choice of the subject, and its truly classical mode of treatment, seem well calculated to ensure to it a general reception. The style of the engraving, which does great credit to Mr. Hellyer, has not been excelled by any thing of the kind we have seen, the judicious mixture of the line with the dot forming a most happy foil to each other.

We cannot help observing that this print is doubly welcome to us, as it shows that the arts have only been apparently on the decline since the publication, from the pictures of Mr. West, of those fine subjects—Mark Anthony, Regulus, Stratonice, and the son of Antigonus, &c. &c. What

a cona contrast between such subjects as these and the insignificant trifles chosen by some artists from the different occupations of children!

Historical painting, when properly executed, serves to rouse the mind to acts of heroism or virtue, or to instil some great moral truth. Like music, it misses its aim if it touch not our feelings. To be feelingly alive to whatever is great and noble ought to be the study of every artist, whose wish is not only himself to excel but to improve the public taste, as the best and only certain means of insuring to the arts that patronage which will otherwise be expected in vain.

LXIX. *Proceedings of Learned and Economical Societies.*

FRENCH NATIONAL INSTITUTE.

The following letter from C. Mechain, charged with continuing the meridian of France to the Balearian islands, was read in the sitting of the Institute, Monday, November 10, 1803:

"You know how many obstacles and how much delay I have experienced on the continent; as I could do nothing else, nor better, I undertook to form the chain of triangles on the coast of Catalonia, from the eminence of Matas on Mount Allegre, as far as Mount Sia beyond Tortosa, which I reached by six triangles; the last of which only is very large, and by a small acute triangle, that is to say, of 23 degrees. I had reverberators which I used for measuring the angles, and with success. I did not neglect the day signals when I was able to observe them without prolonging my stay too much at the different stations. I am now at that of Montserrat, which I hope soon to terminate; nothing will then remain but that of Matas. My cooperators can tell you what we had at first to suffer from the scorching heat of the climate; how much I have been impeded by fogs, continual rains, and torrents, the most violent tempests and dreadful hurricanes, which assailed us almost incessantly, and in every place, till our arrival at Montserrat. Such a stormy state of the weather would scarcely be credible in the most intemperate climates of the earth. However, this chain of triangles will be terminated after three months' labour. The distance between Matas and Mount Sia is about 110 miles. The Pui de la Morclia and Mola Cima, the highest of the peaks of Mount Sia, will be the two summits of the large triangles for the islands. Their distance is 85 miles; these two points are very visible

visible from each other when the weather is favourable. The height of the Morella is 1700 feet above the level of the sea; that of Mola Cima 1400; that of Silla Torellas, in the island of Majorca, is about 4600.

"We are now employed on this great triangle and that for Ivica, which will be as great.

"The court of Spain has given the most positive orders to the captain of the brig who is to convey us to the Balearian islands, and to different points of the coast of Catalonia, as often as may be necessary. To defend the reverberators and lodge the observer with his instruments on mountains so elevated, and during an inclement season, it will be necessary to erect four huts of wood, or of stones, as tents would not be sufficient.

"In regard to the success of the triangles, it is very certain, at least in regard to that which will join Majorca to the coast of Spain. That which is to join Ivica to the coast of Majorca will not be certain, unless we can find in Ivica a mountain 2400 feet in height: without this Ivica cannot be observed. I have been assured that it may be seen from Mola Cima; but during the three weeks which I spent on that wretched peak, the weather was so dismal that I could not ascertain the truth of this circumstance, which was told to me eleven years ago. I was favoured only by one night to observe the reverberators of the mountain of Leberia and the chapel of St. John. There were two at Leberia, and three at the chapel of St. John. They were more than sufficient, though the distance exceeds 58 miles, and though the visual ray passed over the sea. I, however, employed only a circle of 18 inches with its old sights. I can place twelve reverberators, and even more, on one of the summits, the most distant of those to be observed, at the same time. It was proved about eleven years ago, that one reverberator lighted on the Silla de Torellas, was observed from Mount Jouy for two hours, at the height of 525 feet above the level of the sea. This, indeed, was the case by using a large achromatic telescope of 18 inches' focus; but the telescopes which I applied to the circle of two feet are as powerful as that of three feet, and I shall have twice as much light, and even more. There will also be a great advantage in regard to the height of the Morella and of Mount Sia, which is almost triple that of Mount Jouy. Nothing then can retard us in regard to this first triangle, but waiting for a favourable moment to make our observations. As for the rest, I do not know whether it will be possible till I traverse the mountains of Ivica. But even if I find it impossible, the operation,

tion, that is to say, the prolongation of the meridian to the 39th degree of latitude will not be rendered ineffectual. 1st, It will not be difficult to connect the small island of Cabrera to Silla de Torellas and another point of the island of Majorca, provided we can make in that island a few subsidiary triangles, and measure a base. We shall find means at Palma to make iron rules, and I shall carry them back to Paris in good preservation, that I may compare them with the platina rules used at Melun and Perpignan. 2d, It is certain that Ivica may be connected with Majorca, and some other points of the coast of the kingdom of Valencia, by the mountains of Cape Marten and that in the environs of Oropesa; and to unite these points to Mola Cima and Leberia four triangles will be sufficient. I shall be better able to form an opinion on this subject when I have visited the mountains of Ivica, where I shall commence my operations.

THE BOARD OF AGRICULTURE

Has offered the following Premiums:

[Continued from p. 286.]

III. *Cottages.*—To the person who shall build on his estate the most cottages for labouring families, and assign to each a proper portion of land, for the support of not less than a cow and a hog, and for a sufficient garden,—the gold medal. Accounts of the expenses of building, land assigned, culture,—if any, live stock, and state of the families, with the rent paid—verified by certificates, to be produced to the board on or before the third Tuesday in April, 1804. The same premium for 1805.

IV. *Cows for Cottagers.*—Doubts having been expressed by some persons concerning the expediency of cottagers keeping cows, except on rich soils, the board will give to the person who shall produce the most satisfactory account, verified by experiments, of the best means of supporting cows on poor land, in a method applicable to cottagers,—the gold medal.—Accounts to be produced of the soil, articles cultivated, produce, stock kept, and every material circumstance—verified by certificates, on or before the first Tuesday in May 1804. The same premium for 1805.

V. *Land for Cottagers.*—The board being informed that the labouring poor on the estates of several persons in Rutland and Lincolnshire, having land for one or two cows, and a sufficiency of potatoes, did not apply in the late scarcity for any parochial relief; and it appearing to be a great national object to spread so beneficial a system, the board will give to the person who shall explain, in the most satisfactory

 manner,

manner, the best means of rendering this practice as general through the kingdom as circumstances will admit,—the gold medal. To be sent to the board on or before the first Tuesday in November 1804.

[To be continued.]

LXX. *Intelligence and Miscellaneous Articles.*

GEOLOGY.

Mr. Esmark of Kongsberg, on his travels through Norway, has lately made some very interesting researches to determine the snow-line and line of vegetation. Of all the mountains which he ascended the Sneehutten on Dovrefield is the highest, its altitude above the level of the sea being more than 8000 Rhinlandic feet. It is continually covered with snow, and in some places, where the snow had tumbled down, it appeared to consist of twenty-five strata, each covered with a perceptible incrustation of ice. The uppermost stratum, which has an undulated form, was in the hollows between the waves of snow weak and of an amethyst colour, as has been observed in the Alps. In places where the rays of the sun fall in an oblique direction, which is the case towards the north and north-east, the snow-line is placed at the height of 3000 feet above the level of the sea; but towards the south and west, where the sun is more powerful, the snow melts at the height of 7000 feet above the sea. The highest points which Mr. Esmark ascended consist of micaceous schistus, except the mountain of Tronfieldet between Tonstel and Foldalen, the summit of which consists of a kind of stone hitherto unknown, which is a mixture of green feldspar and schiller spar, about 4500 feet above the level of the sea. This stone is so magnetic that it changes the direction of the magnetic needle at the distance of four feet. It is susceptible of a fine polish; and in regard to colour has a great similarity to the Labrador stone. The height of the line of vegetation in Norway is different, as well as the kinds of trees and plants, which are more or less capable of enduring the cold. At the height of 1000 feet several species of fruit-trees thrive and produce abundant crops. The silver fir can bear in Norway a greater degree of cold than the spruce fir. The latter grows only at the height of 2000 feet; on the other hand, the former is found at the height of 3000 feet. The birch thrives very well to the height of 3000 feet; at a greater altitude nothing is found but the *Betula nona*, together with some willows and the juniper, which, however,

1 does

does not thrive at a greater height than that of 3200 feet above the level of the sea. Barley and oats, however, grow at the height of from 1500 to 1800 feet, but only in valleys. At the height of from 1200 to 1300 feet the night frosts are very prejudicial to the seed.

Mr. Wolf has found near Turneau in Bohemia a peculiar mass of glass produced from a blackish basaltes, which is met with in abundance at Buchberg in Bohemia. When this stone is placed in a glass furnace, it fuses in eight hours so that boxes and other articles can be made of it, and of any form, at pleasure. It is more fusible than glass, and therefore cannot be blown like glass, but can be drawn out into coarse threads and rods. When cold it is harder than glass, and is more difficult to be ground and to be cut. When cast it adheres strongly to iron moulds; and on this account moulds of brass must be employed. It corrodes the crucible also much less than glass; but this stone may be used instead of manganese, as an addition to glass, which it purifies in a similar manner.

SIR, AGRICULTURE.

In your 66th number of the Philosophical Magazine there is an extract of Mr. Close's communication to the Board of Agriculture, in which he says, "the eighth part of an acre of good turnips steamed, and with the liquor mixed with oat straw cut, will keep a full grown beast in good order six months. An acre of turnips with the first crop of hay, will fatten two bullocks in the same time, &c., &c."

I understand by this that one acre of steamed turnips will, with oat straw mixed in the liquor, keep eight full grown beasts in good order six months.

I wish to know what quantity will make the same number of full grown beasts *fat?*

There appears to me some ambiguity in the above, as also in what follows, namely, that four acres, with the addition of one-fourth of an acre of turnips, will keep *only three* beasts, and fatten *two* bullocks. It appears to me that by the first part, if steam was used, a great many more ought to be kept.

I also could wish to have the proper method of steaming detailed, with the quantity of turnips so given each animal each day; also the quantity of oat straw; also the expense of the steaming.

Your entering into this minutely would render an important service to the country in general, and I for one would thank you particularly.

To Mr. Tilloch. X. Y.

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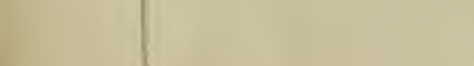
Books.

END OF THE SEVENTEENTH VOLUME.

ERRATA.

In some copies the plates given in No. 67 are marked V. and VI.; but they ought to be VI. and VII.

Taylor, Printer, Black-Horse-Court, Fleet-Street.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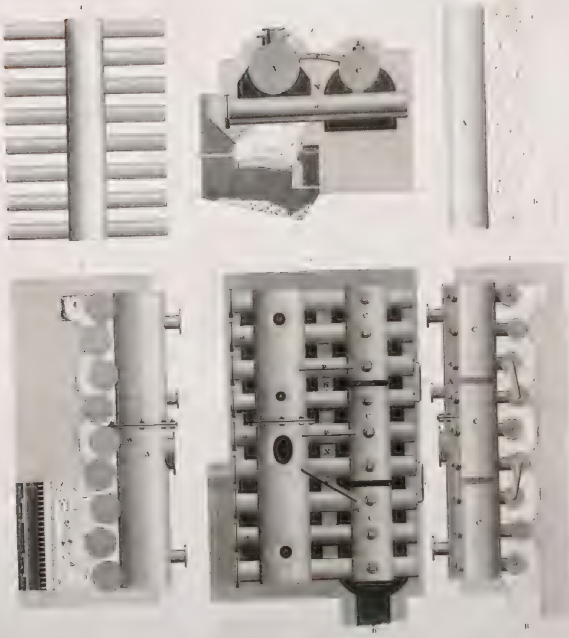

$\frac{1}{4}$ Inch to a foot

Lowry sculp.

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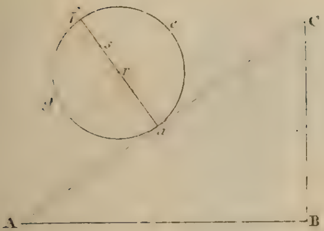

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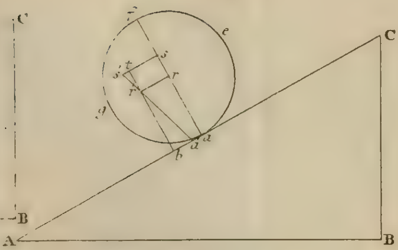

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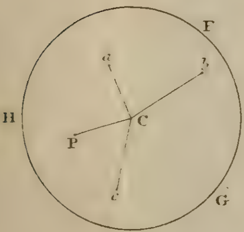

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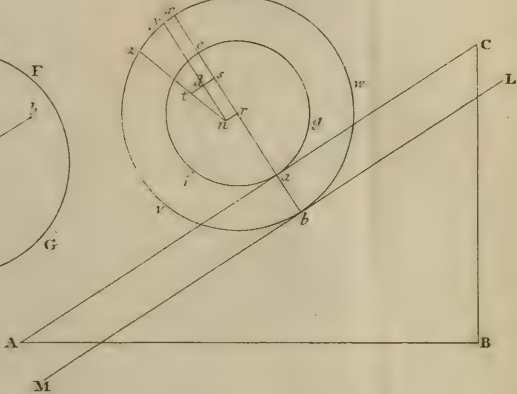

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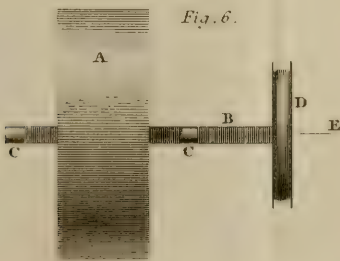

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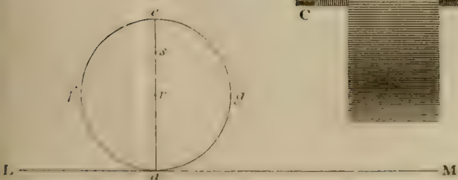

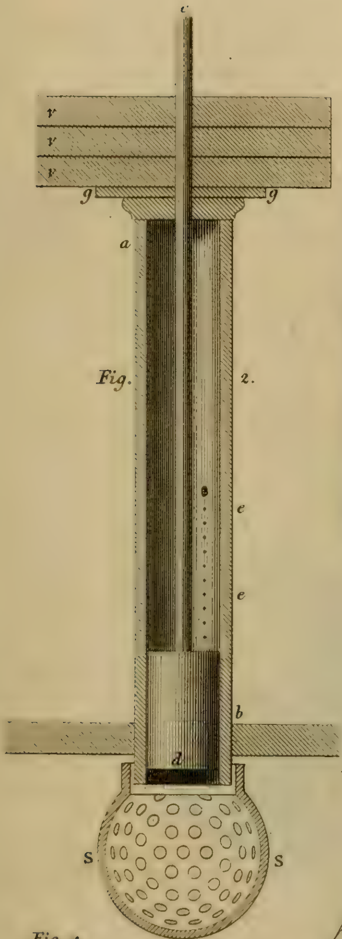

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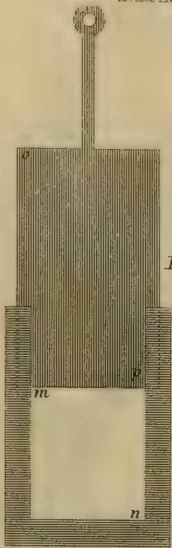

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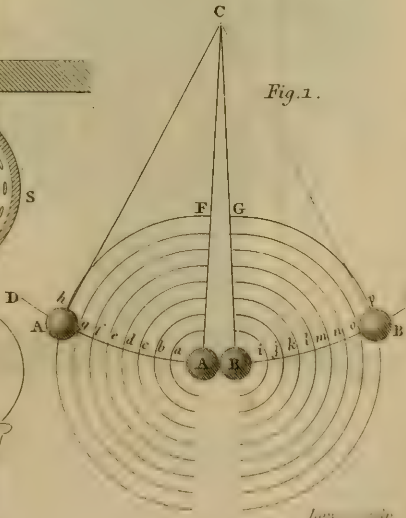

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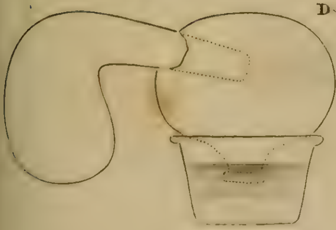

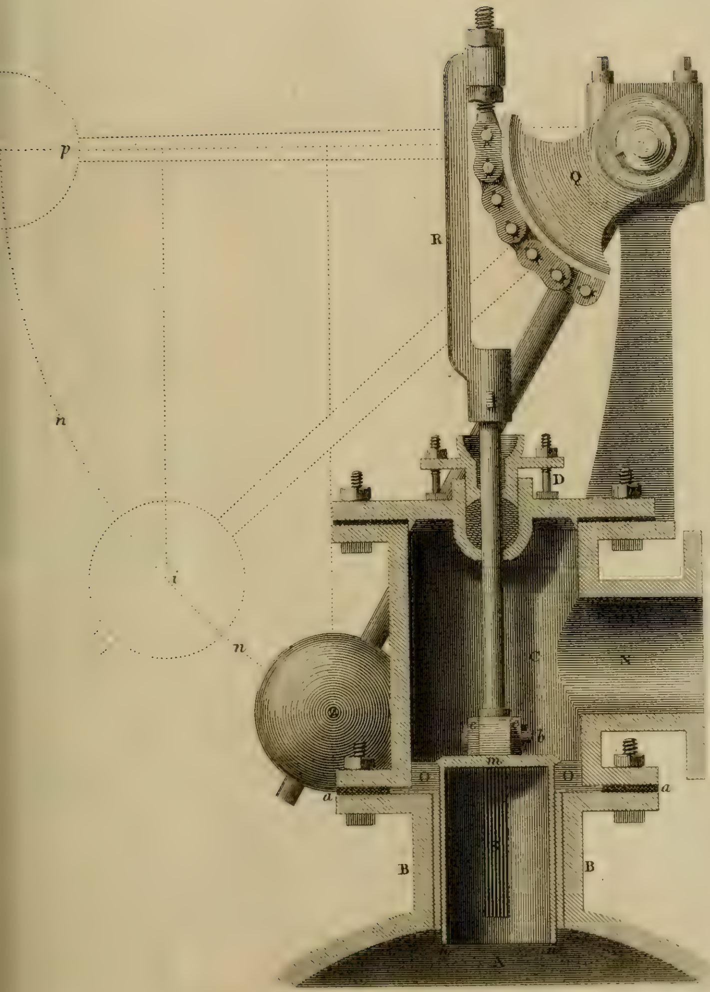

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Lowry sculp.

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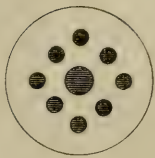

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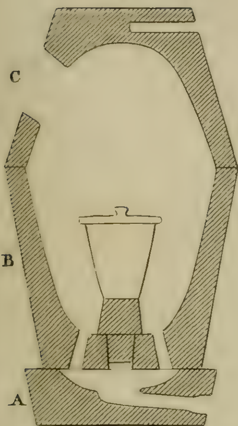

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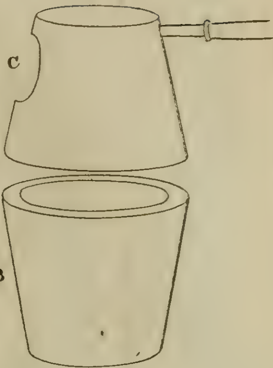

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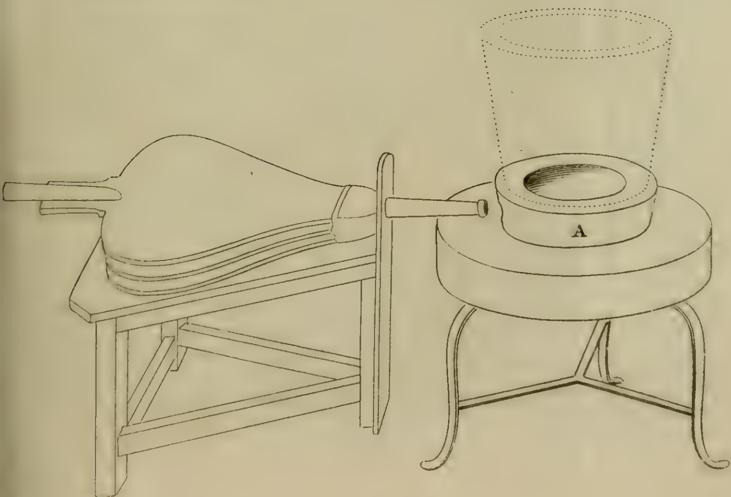

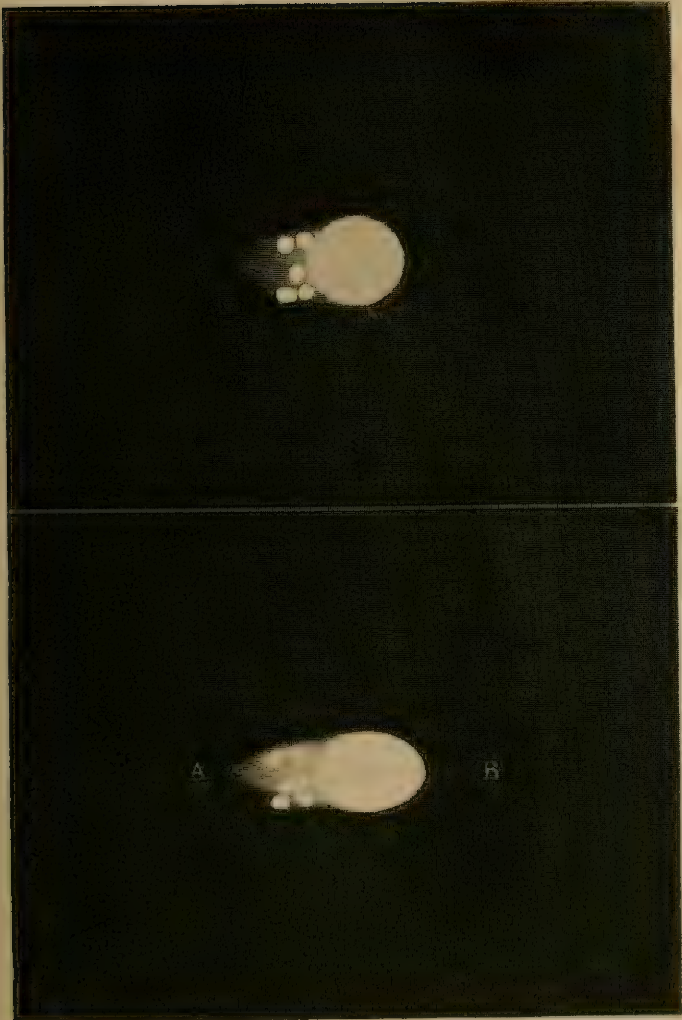

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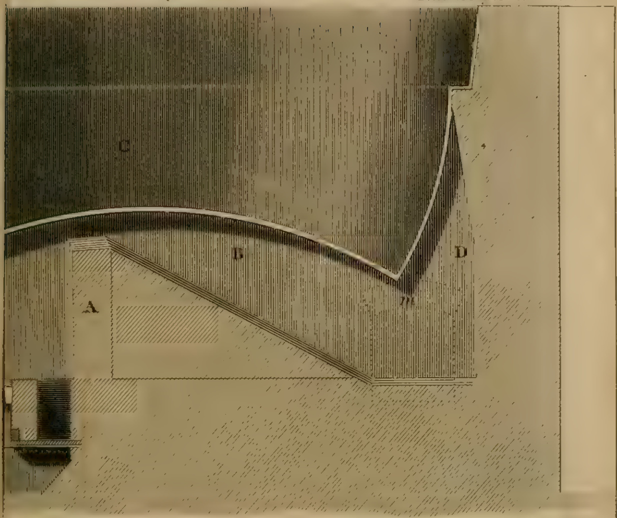

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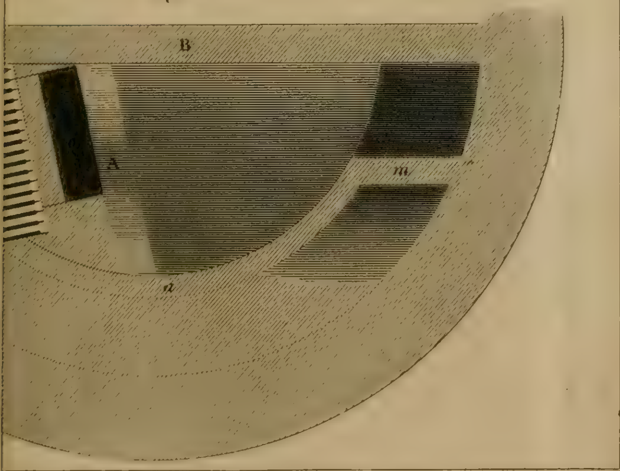

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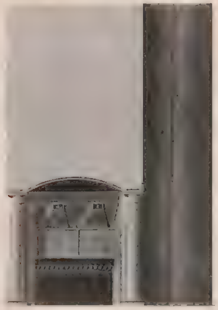


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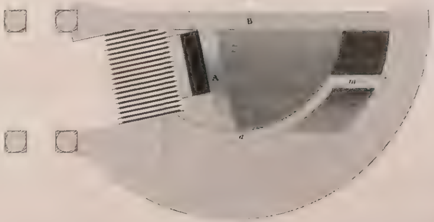
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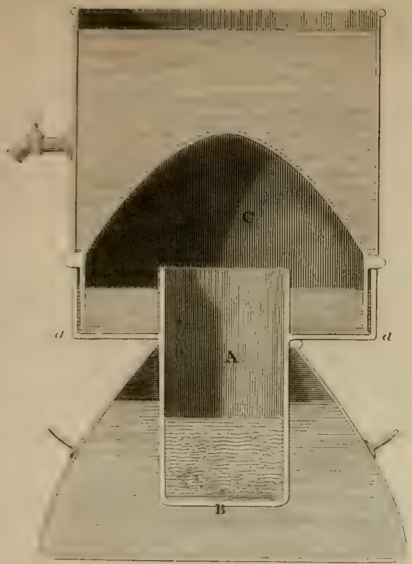

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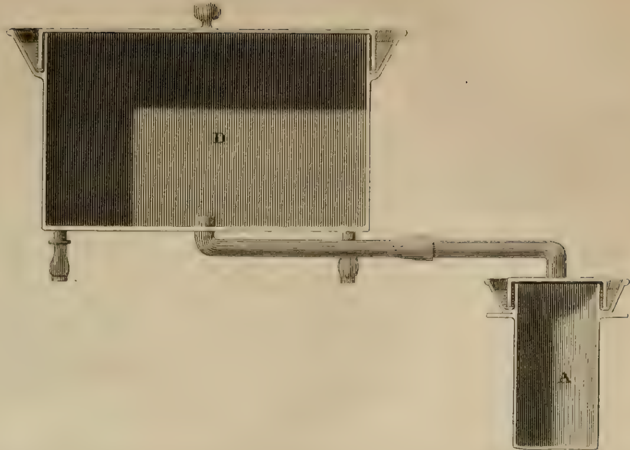

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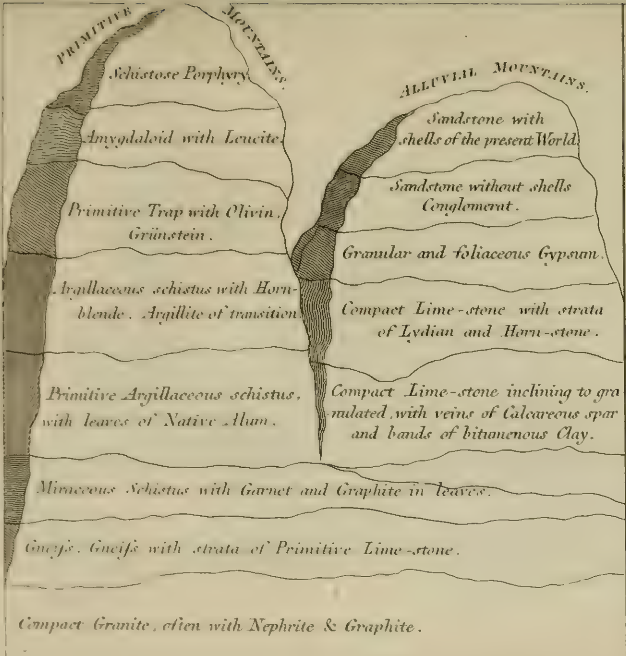

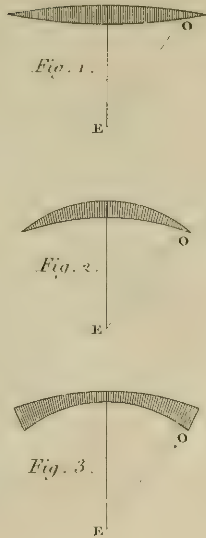

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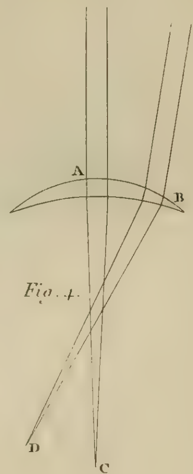

Fig. 4.

Lowry sculp.

VULTURE OF PONDICHERRY.