THE REPERTORY OF ARTS AND MANUFACTURES:

CONSISTING OF

ORIGINAL COMMUNICATIONS,

SPECIFICATIONS OF PATENT INVENTIONS,

AND

SELECTIONS OF USEFUL PRACTICAL PAPERS

FROM THE

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETIES

OF ALL NATIONS, &c. &c.

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1797.

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SIXTH VOLUME.

REPERTORY OF ARTS AND MANUFACTURES.

NUMBER XXXI.

Printed by John Nichols, Red-Lion-Paſſage, Fleet-Street, London.

I. *Specification of the Patent granted to Mr.* John Braithwaite, *of the New Road, in the Pariſh of St. Pancras, Middleſex, Engine-maker; for his Invention of certain new Improvements in the Conſtruction of Smoke-Jacks.*

WITH THREE PLATES.

Dated Sept. 18, 1795.

TO all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid John Braithwaite do hereby declare, that my ſaid invention is deſcribed in the drawings and deſcription thereof hereunto annexed. In witneſs whereof, &c.

The principal novelty of this invention confifts in the flyer or wheel moving round vertically in the chimney, with the axis placed in a horizontal direction; whereas, in common fmoke-jacks, the flyer or wheel moves round horizontally, with the axis or fpindle vertical; and the other improvements are dependent on and derived from this.

For explanation, Plate I. reprefents a perfpective view of a vertical flyer of a fmoke or air jack, fuppofed to be fixed in a chimney, the axis of which fhould be placed parallel to the horizon; and, although it will do if the axis is not exactly parallel with the horizon, yet the nearer it is horizontal the better. The axis of the flyer may pafs through the breaft of the chimney, on the extremity of which (being left fquare) a chain fufpended will turn a fpit, with fufficient power to roaft a moderate-fized joint of meat; but, as greater force will fometimes be required, it will be expedient to fix on the axis a pinion or worm, to which may be applied a cog or tooth wheel, of any convenient fize, which will be turned by the pinion or worm, when the

flyer

flyer is put into motion by the preſſure of the air or ſmoke on the fans or floats, ariſing from the draught occaſioned by the fire. On the cog or tooth wheel, or a metal or wooden wheel on the ſame axis, a chain or chains ſuſpended will turn a ſpit or ſpits for roaſting. If the chain be ſuſpended from the axis of the flyer, two collars ought to be fixed upon the axis, to confine the chain to its proper place.

B repreſents a plate of iron, or other metal, which ſhould be fixed to one ſide of the chimney, either above or below the flyer or wheel, but it will have the greater effect when fixed below; its uſe is as a conductor of the air or ſmoke to the fans or floats of the flyer in a particular direction, as may be ſeen in the drawing; and it ſhould be ſo placed as to guard and cover about three fifths of the flyer, ſo as to conduct the air or ſmoke beyond the centre of the flyer or wheel, that it may act with all its force on the fans or floats of the flyer not guarded by the plate B. Without this plate, the air or ſmoke would act on both ſides of the flyer with nearly an equal power, and conſequently would prevent the flyer from moving at all. The effect of the plate may be produced by erecting an abutment of brick, ſtone, or other materials; in which caſe, however, a cavity ought to be made in the breaſt of the chimney, covered by a movable plate, ſufficiently large to admit the flyer, which will require to be taken down when the chimney is ſwept.

The ſize of the flyer or wheel muſt be increaſed or diminiſhed, according to the ſize of the chimney it is to be fixed in; and the number of fans or floats muſt be more or leſs, according as the diameter is increaſed or diminiſhed

Plate II. is a ſectional view of one ſide of a flyer, drawn to a ſcale ſuppoſed to be two feet ſix inches in diameter, which will be found large enough for common uſe; it has twelve floats or fans, marked from No. 1 to 12, but the number may be more or leſs, as ſhall be found moſt convenient. They may be ſupported from the centre by twelve arms, or by an arm at each end of the flyers, or by rings, or in a water-wheel, or by any other mode which the maker

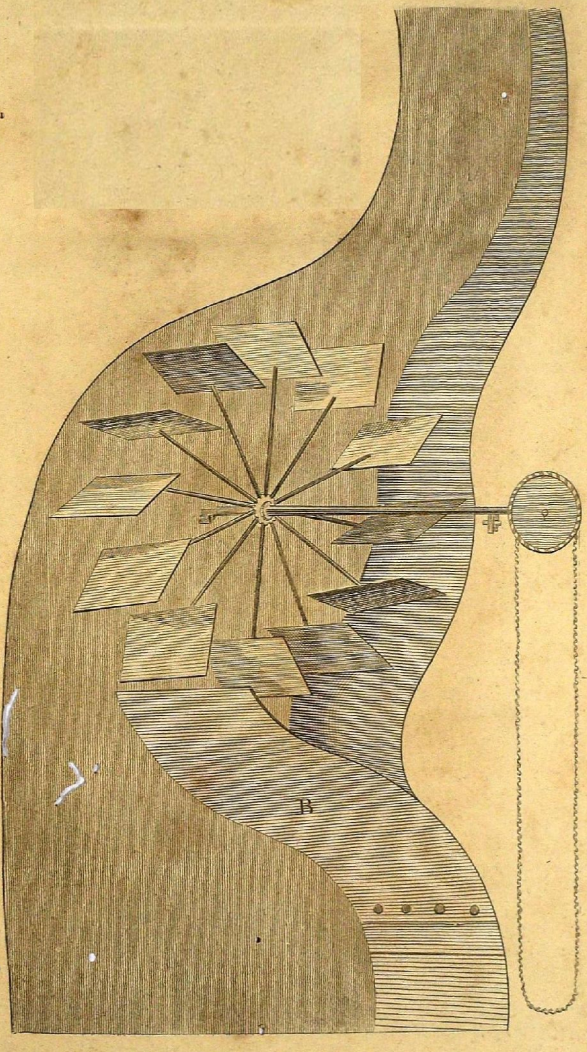
may

may prefer. The angle which the fans or floats are ſet to, from a ſtraight line drawn through the axis of the flyer, in this drawing, (namely, about fifty degrees,) is I think the beſt; though they might be fixed in a right line from the centre, and the flyer or wheel move, but not with ſo much power as when ſet in the manner of the drawing. B B repreſents the conducting-plate, which ſhould be fixed to one ſide of the chimney, and cloſed to the back and breaſt, ſo as to prevent the air from paſſing through any other channel except over the end of the plate.

Plate III. repreſents the ſection of the flyer or wheel, ſhewing two fans or floats. A and B are plates of iron, copper, or other proper materials; the length of the fans or floats here repreſented is fourteen inches, and the breadth about ſix inches; the extreme diameter of the fans or floats, from out to out, two feet ſix inches. C C are arms which the fans or floats are made faſt to, which may be fixed in a collar of iron, or other metal, turned with a hole for the axis D; which axis is alſo turned to fit the hole; and,

when

when the flyer is put in its proper place in the chimney, the ſcrew E, being turned, faſtens the flyer or wheel on the axis; and, by looſening the ſcrew, and removing the axis, the flyer may be taken down when the chimney requires ſweeping. Or the arms may be fixed into the axis; and alſo the axis may be ſupported in many other ways, according to the direction of the workman; particularly by fixing the arms at the extremity of the axis, and ſupporting the axis within the breaſt of the chimney, ſo as to obviate the neceſſity of carrying it to the back of the chimney. No oil in this caſe will be requiſite withinſide the chimney, which has hitherto been found an inconvenience attending the common ſmoke-jack.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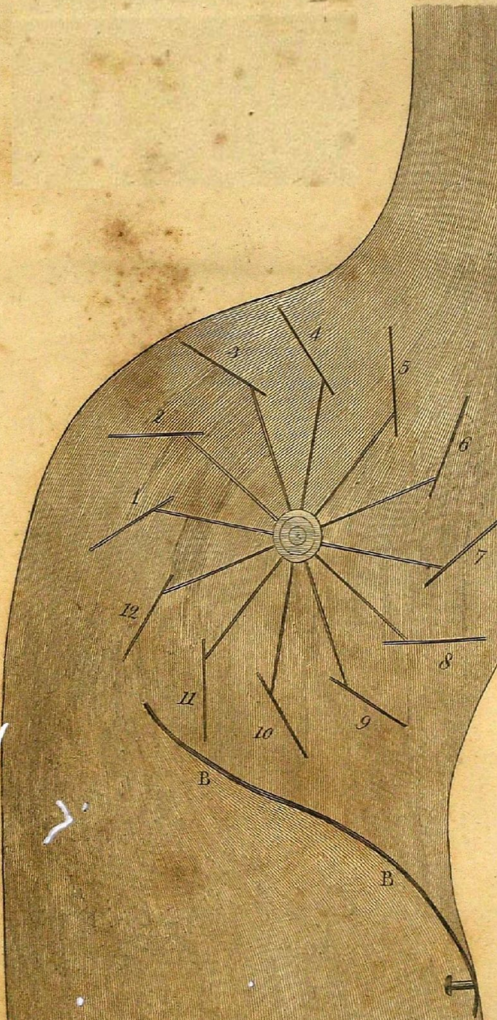
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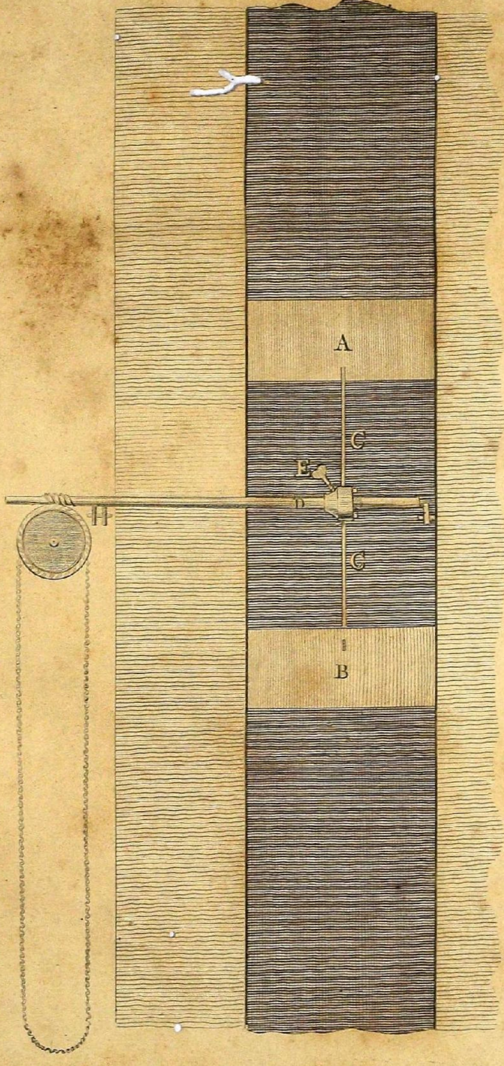
A
C
E
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C
B
H

II. *Specification of the Patent granted to Mr.* WILLIAM DESMOND, *of Shepherd-ſtreet, Hanover Square; for a Method or Proceſs, communicated to him by a certain learned Foreigner, of tanning all Sorts of Hides and Skins, and of rendering more ſolid and incorruptible, in Water, ſeveral vegetable and animal Subſtances, ſuch as Flax, Hemp, Spartery, Cotton, Silk, Hair, Wool, &c. as well as the Materials made thereof.*

Dated Jan. 15, 1796.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid William Deſmond do hereby declare, that the ſaid invention is deſcribed in manner following; that is to ſay, as that part of the preparation of hides and ſkins, properly called tanning, conſiſts in impregnating and ſaturating them with a principle obtained from tan, by which they acquire ſtrength and firmneſs, preſerve

ſerve a ſufficient flexibility, and become indiſ-ſoluble and incorruptible in water, either hot or cold, ſo the nature of this proceſs is, firſt, to aſ-certain, by a ſimple and certain criterion, ſuch ſubſtances as contain the ſaid principle; ſecondly, to extract it from them, to ſeparate it from every other principle by which its effect might be im-peded or counteracted, and to give it the degree of ſtrength neceſſary for the intended purpoſe; thirdly, to diſpoſe the hides and ſkins for the in-troduction of this principle; fourthly, to impreg-nate and ſaturate them completely with the ſame, in leſs than a tenth part of the time uſually em-ployed in tanning; all which operations are per-formed in the following manner. Provide five veſſels, called *digeſters*, of any convenient materials and dimenſions, with an aperture at the bottom of each; let them be placed near each other, and elevated upon ſtillages, or otherwiſe, ſo that a pail or other ſmaller veſſel may be placed under them. Fill the digeſters with tan; that is to ſay, with the bark of certain trees, of oak for inſtance, cut ſmall, or ground to a coarſe powder. Pour water on the tan in the firſt digeſter, where it may ſtand

ſome

ſome time, or be drawn off immediately. This liquor is to be poured on the tan in the ſecond digeſter, and drawn off as before; then on the tan in the third digeſter; and ſo on, until it comes through the tan in the fifth and laſt. The liquor is then highly coloured, and marks from ſix to eight degrees on the hydrometer for ſalts. This liquor is to be uſed for tanning the thickeſt hides, and may, for want of a more characteriſtic name, be called the *tanning lixivium.* It has this peculiar property, that if you take a ſmall quantity of it in a glaſs, and pour on it a few drops of a ſolution of animal glue, the liquor, which before was clear, becomes turbid, and a whitiſh ſubſtance falls to the bottom of the glaſs. The precipitate thus obtained, by means of the ſolution of glue, is a ſure indication that the liquor contains the tanning principle; for this reaſon, that glue being of the ſame nature with the ſkins or hides of which it is made, whatever ſubſtance unites indiſſolubly with the former will do ſo likewiſe with the latter. This ſolution is made by diſſolving a little common glue in water, over a moderate fire; by means of it, not only oak-bark, but alſo the bark of ſe-

 veral

veral other trees, ſuch as the plane-tree, cheſnut-tree, the American hemlock-tree, poplar, elm, willow, &c. as well as divers ſhrubs and plants, ſuch as myrtle, ſumack, &c. all which I call *tan*, are found to contain the tanning principle; and, by employing the ſolution as above, it will, in all caſes, be eaſy to aſcertain whether any given ſubſtance contains this principle or not. In the courſe of theſe lixiviations two things will be obſerved; firſt, the liquor running from the firſt digeſter at length loſes its colour; if in this ſtate you take a little of it in a glaſs, and repeat the former experiment, the liquor no longer becomes turbid, but remains clear, which ſhews that it contains no more of the tanning principle; but, if you pour into the ſame glaſs a few drops of ſulphat of iron, the liquor becomes thick and black. This liquor is not to be poured on the tan in the ſecond digeſter, but is to be laid by, and uſed for the depilation, or taking off the hair or wool, as will be more particularly deſcribed hereafter. It is diſtinguiſhed by the name of *gallic lixivium*, becauſe it appears to contain the ſame principles as galls. The ſulphat of iron is obtained by diſ-

ſolving

ſolving a ſmall quantity of iron in oil of vitriol diluted with water, or by diſſolving green copperas in water. This ſolution ſerves to aſcertain ſuch ſubſtances as contain the *gallic* principle; lime-water will alſo produce this effect. When the liquor ceaſes to grow black by the mixture of the ſulphat of iron, it will be uſeleſs to pour any more water on the tan in the firſt digeſter; this tan, being exhauſted both of the *tanning* and *gallic* principles, muſt be removed, and new tan put in its place. You will obſerve, ſecondly, that the liquor, after running through all the digeſters, at laſt grows weak: add to your ſtock of *tanning lixivium* all the liquor that marks from ſix to eight degrees on the hydrometer; what proceeds afterwards from the laſt digeſter is to be poured on the new tan in the firſt; then the freſh water is to be conveyed on the tan in the ſecond digeſter, and the liquor of the firſt to be laid by, while it marks ſix or eight degrees on the hydrometer, and added to the *tanning lixivium*, which muſt always be carefully ſeparated from the *gallic*. In this manner the tan in all the digeſters may be renewed, and the lixiviations continued. The number of thefe lixiviations, as well as the mode of making them, may be varied at pleafure; the effential point is, to repeat them fo as to give the liquor a fufficient degree of concentration, which may be determined by the hydrometer, and proportioned to the quicknefs required in the operation, and to the thicknefs of the hides and fkins to be tanned; all which experience will foon teach. As all kinds of tan are not equally good, it will fometimes happen that fix or more filtrations will be neceffary to obtain a lixivium of fix or eight degrees; in this cafe, the number of digefters may be increafed, and the fame method purfued as above, and, when a weaker lixivium is wanted, three or four filtrations will be fufficient. The perfon who directs thefe lixiviations fhould be provided with the folutions of glue and fulphat of iron already defcribed, in order to afcertain the qualities of the different lixivia, as well as with an hydrometer or areometer, properly graduated, to determine the degree of concentration or fpecific gravity.

Cow-hides, ox-hides, &c. Firft, *wafhing and flefhing*: they fhould be wafhed in running water,

well

well cleaned, and fleſhed in the uſual way. Secondly, *depilation*, or *taking off the hair*: immerſe the hides, for two or three days, in a vat filled with *gallic lixivium* and a mixture of ſulphuric or vitriolic acid or oil, marking ſixty-ſix degrees on the hydrometer for acids, and in the proportion of one to a thouſand, that is, one part of oil of vitriol to a thouſand parts of *gallic lixivium*, or one pint to 125 gallons. During this immerſion the hair is detatched from the hides, in ſuch a manner that you may eaſily know when they are to be taken out of the vat, that is, when the hair is quite looſe; it is then to be ſcraped off, with the round knife, on the horſe. Thirdly, *raiſing*: when *raiſing* is neceſſary, which is ſeldom if ever the caſe, immerſe the hides for ten or twelve hours in another vat, filled with water and a five hundredth part of its volume of mineral acid, of the ſame quality as the former, and the operation of *raiſing* or *ſwelling* is done. Waſh the hides repeatedly, and uſe the round knife, then they are fully prepared for tanning. Fourthly, *tanning*: the remaining part of the proceſs conſiſts in tanning, properly ſo called; for which purpoſe, ſteep the

hides

hides for ſome hours in a weak tanning lixivium, of only one or two degrees, to obtain which you make take that which runs from the ſecond digeſter, or ſome that has been already uſed for tanning. They are then to be put into a ſtronger lixivium, where, in a few days, they will be brought to the ſame degree of ſaturation with the liquor in which they are immerſed. The ſtrength of the liquor being then conſiderably diminiſhed, it muſt be renewed; and, when the hides are completely ſaturated, that is, fully tanned, which is known by cutting off a bit of the edge, remove the leather, and let it dry ſlowly in a ſhady place.

Calf-ſkins, goat-ſkins, &c. Firſt, fleſh them with the knife, and work them in running water, like the others. Secondly, ſteep them in lime-water, in which there ſhould be more lime than the water can diſſolve at once; what is not diſſolved will ſubſide to the bottom, but muſt be mixed with the water, by ſtirring it ſeveral times a day. Thirdly, after two or three days, remove the ſkins; when the hair is found quite looſe, ſcrape it off on the horſe; waſh and preſs the ſkins well, until the water running from them is perfectly clear,

clear, and the lime totally exhausted. Fourthly, steep them first in a weak lixivium, then tan them as above; but observe that the tanning lixivium must not be near so strong as for the hides. Lime is used for these soft skins, instead of the mixture of *gallic lixivium* and vitriolic acid, for this reason, that acid always swells the leather more or less, which would injure the skins; and also because the lime may be more easily extracted from them, by washing and compressing them, than from thick hides, which, when limed, are harsh and apt to crack, if the lime is not totally extracted before they are tanned. Amongst the different modes of immersion which may be practised in the course of these operations, the best appears to be that of suspending the hides vertically in the lixivia, by means of transversal rods or bars, and at such a distance asunder as not to touch each other in any one point. If they are laid out one over the other, according to the common practice, they will require frequent handling, in order that all the parts may be equally saturated, and to prevent the folds or

plaits

plaits that otherwife would be formed in them; all this would occafion a confiderable lofs of time and labour. In fome cafes, it will be found expedient to mix frefh tan, from time to time, with the lixivium; this and other modifications, fuch as the various ftrength of the lixivium, the raifing or not raifing the hides, the ufe of the gallic lixivium, &c. which may be found neceffary, will depend on the ftate and quality of the hides and fkins to be tanned, as well as on the purpofes for which they are intended; all thefe confiderations muft be left to the judgement of the manufacturer, but do not in any way alter or change the principle on which this mode of tanning is founded. Befides the very great faving in point of time and labour, the leather tanned according to the above method, being more completely faturated, will be found to weigh heavier, to wear better, and to be lefs fufceptible of moifture, than the leather tanned in the ufual way. The other animal and vegetable fubftances already mentioned, by being fteeped, for a certain time, in a weaker or ftronger lixivium, according to the difference of their contexture, will acquire ſtrength and incorruptibility. Cords, ropes, and cables, made of hemp, or ſpartery, impregnated with this principle, will ſupport much greater weights without breaking, will be leſs liable to be worn out by friction, will run more ſmoothly on pulleys, &c. This liquor, in ſhort, will be found ſo advantageous, particularly in the rigging of veſſels, as to render the uſe of tar, in many caſes, unneceſſary; even meat may be preſerved by it, without ſalt. In witneſs whereof, &c.

III. *Specification of the Patent granted to* PATRICK MILLER, *of Dalſwinton, in North Britain, Eſq; for his Invention of a Veſſel on a new Conſtruction, which draws leſs Water than any other Veſſel of the ſame Dimenſions, which cannot founder at Sea, and which is put in Motion, in Calms and light Winds, by a method never before practiſed.*

Dated May 3, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that in compliance with the ſaid proviſo, I the ſaid Patrick Miller do hereby declare, that my ſaid invention and diſcovery is deſcribed in manner following; that is to ſay, the ſaid veſſel is kept afloat without the aid of its ſides, ſolely by the buoyancy of its bottom, which is flat; the bottom never being ſo deeply immerſed as to bring the upper ſurface thereof on a level with the water; ſuch veſſels not being conſtructed for

for the purpoſe of carrying cargoes, but for that of carrying paſſengers, with the neceſſary ſtores and proviſions; and, as theſe veſſels are not kept afloat by the aid of their ſides, but by the buoyancy of their bottom, as above deſcribed, they cannot ſink, and therefore pumps are not required, nor are they in any reſpect neceſſary for the preſervation of ſuch veſſels. The ſaid veſſel is put in motion, during calms, and againſt light winds, by means of wheels. Theſe wheels project beyond the ſides of the veſſels, and are wrought by means of capſtans: the number and the dimenſions of the wheels depend upon the length of the veſſel. Theſe wheels are built with eight arms, which conſiſt entirely of plank. Sliders are uſed to work and to keep the veſſel to windward, when under ſail. Theſe ſliders are placed in the centre of the veſſel, from ſtem to ſtern; they are made of plank, and the number and dimenſions muſt depend on the length of the veſſel, and they are raiſed and let down, either by the hand, or by means of a purchaſe, according to the ſize of the veſſel. Veſſels of this conſtruction draw water in proportion to their dimenſions, as follows: a veſſel of forty feet in length, and from thirteen to nineteen feet in breadth, will draw from thirteen to ſixteen inches of water. One of fifty feet in length, and from ſeventeen to twenty-four feet in breadth, will draw from fifteen to eighteen inches of water. One ſixty-feet long, and from twenty to twenty-eight feet broad, will draw from eighteen to twenty-one inches of water. One ſeventy-feet long, and from twenty-three to thirty-two feet broad, will draw from twenty-one to twenty-four inches of water. One eighty feet long, and from twenty-ſeven to thirty-ſeven feet broad, will draw from twenty-four to twenty-ſeven inches of water. One ninety feet long, and from thirty to forty-two feet broad, will draw from twenty-ſeven to thirty inches of water. One of one hundred feet in length, and from thirty-three to forty-ſeven feet in breadth, will draw from thirty to thirty-three inches of water.

As, from the principle upon which this veſſel is conſtructed, ſhe cannot ſink, the invention muſt prove a means of ſaving many lives; and, as it will give more room and height between the decks than any veſſel of the ſame dimenſions, of another conſtruction, it muſt add greatly to the comfort and accommodation of perſons at ſea of all deſcriptions. It is expected that, from theſe advantages, a more general and friendly intercourſe amongſt nations will take place, which will have the effect to diffuſe knowledge, and to remove national prejudices, thereby promoting the general welfare of mankind. At preſent it would be altogether improper to give any deſcription of ſhips of greater dimenſions, leſt it ſhould be converted to a purpoſe very different from that intended by the inventor. In witneſs whereof, &c.

IV. *Specification of the Patent granted to Mr.* John Richmond, *of Titchfield-ſtreet, in the Pariſh of St. Mary le Bone; for his Diſcovery of the Application of a Principle in Hydraulics, ſuitable to an Hydraulic Machine which he invented for raiſing Water, from all Depths, out of Mines, Pits, or Wells, and for other Purpoſes.*

Dated Jan. 2, 1782.—Term expired.

TO all to wnom theſe preſents ſhall come, &c. Now KNOW YE, that I the ſaid John Richmond, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my ſaid invention, and declare the conſtruction of a machine or engine, formed according to the principles of the ſaid invention, to be as follows; that is to ſay, the machine or engine is to conſiſt of three working pumps, tubes, or barrels, of any ſize and diameter that may be found moſt convenient for

for uſe, and ſuitable to the purpoſe and ſituation of the place where they may be wanted. Theſe are to be joined together as pumps uſually are, or in any manner found moſt convenient to keep them firm and tight in an upright poſition. But the upper and lower pumps, tubes, or barrels, are to be of equal bores, and the middle one is to be of a diameter that ſhall contain a larger quantity of water, in any given length of pipe, than what either of the other two can contain, even to double the quantity, or more, and is to be open at top, ſo as to admit of a free paſſage for air, notwithſtanding its junction with the upper pump, tube, or barrel, by means of a hollow trumpet-tube hereinafter mentioned; but it is to be cloſe at the bottom, where it joins the lower pump, tube, or barrel, excepting a hole to be left for the pump-rod to paſs through. By this means, the hydroſtatic paradox is introduced to act upon the bottom part of a hollow tube, which is to be worked within the upper and middle pump, tube, or barrel, and to be of a length ſufficient to make the full ſtroke of the engine, of whatſoever length it may be; with its lower end of a diameter ſufficient to fill the bore of the middle pump, tube, or barrel, and its upper end to fill the bore of the upper pump, tube, or barrel, in the form of a trumpet, or any ſuch like form, in order to admit the motion up and down to the full extent of the engine's ſtroke, and to receive the preſſure of the water underneath on its expanded bottom; which may be opened and ſhut with a valve, or not, as may be found moſt beneficial. From the middle pump, or tube, to the lower one, a communication is to be made by a hole, as before mentioned, through which the pump-rod is to paſs, connected with the aforeſaid movable tube, and to be fixed to a movable bucket and valve, which is to be worked in the lower pump, tube, or barrel; the lower end of which pump, tube, or barrel, is to be immerſed in the water, and to have a fixed box, and a valve, in the like manner as other pumps have, for the purpoſe of lifting water. The pump-rod, which is to be carried through the upper pump, tube, or barrel, to the top of the pit or well, or to the ends of the pumps, tubes, or barrels, for the purpoſe of working the machine, either by fire, water, wind,

horſe,

horſe, man's labour, or other motive force, is to be, connected with the movable tube before mentioned, ſo as to lift it up and down, to make a ſtroke of the machine. To the three pumps, tubes, or barrels, before mentioned, is to be added a lateral pump, tube, or barrel, of the ſame bore as the upper and lower pumps, tubes, or barrels, and to communicate with them by a junction at each end. One end is to open into the lower pump, tube, or barrel, juſt above the ſtroke of the bucket which draws the water from below, and the other end is to open into the upper pump, tube, or barrel, juſt above the ſtroke of the movable tube before mentioned; by which means the water drawn at every ſtroke of the machine, from the lower pump, tube, or barrel, through the lateral pump, tube, or barrel, is carried into the pumps, tubes, or barrels, that may be added above, to diſcharge the water to any height. But, in order to procure the counterbalance of water which is the object of this invention, or of weights equal thereto, to act with the advantage of the hydroſtatic paradox, or by any means to aſſiſt the lift of the pump by a counterbalance of the water contained therein, in, there muſt be a horizontal tube of communication between the ſaid middle pump, tube, or barrel, and another upright pump, tube, or barrel, of the ſame dimenſions and bore as the middle pump, tube, or barrel, before mentioned; and ſuch upright pump, tube, or barrel, is alſo to be connected with other pipes, &c. in like manner as before deſcribed, when the machinery is to be worked by double pumps, which in deep mines may be the moſt effectual manner of working; but, if by ſingle pumps, weights muſt be added on the ſurface of the water in the upright pump, tube, or barrel, joined as before mentioned, till they ſhall balance the whole column of the water, in like manner as if pumps, tubes, or barrels, were carried to a level of the other pumps, tubes, or barrels, to form the machinery of working with double pumps. In conſtructing the double pumps, there may be a horizontal tube of communication between the two upper pumps, tubes, or barrels, a little above the higheſt aſcent of the movable middle tube in each pump. In witneſs whereof, &c.

V. *Account of a Machine to be uſed in making Hay. By Mr.* John Middleton, *of Paradiſe-Row, Lambeth.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

HAVING obſerved, in the courſe of my reading, that, ſomewhere in the north of England, it is not altogether uncommon to ſee ſome of the inhabitants dragging their hay together, without the aſſiſtance of either cart, waggon, or ſledge; and having myſelf experienced that much time, and, in general, the beſt workmen, are employed in loading the carts in a hay-field, particularly at a time when the price of labour is high, and hands not always to be procured; I was induced, from theſe conſiderations, to turn my thoughts to the

 ſubject;

ſubject; and, in conſequence, ſketched the lines for a carpenter to make me the following machine, for the above purpoſe; and it performed the work ſo well, that I uſed it all laſt hay-time with great advantage.

It is drawn by four horſes, in pairs, with a boy to manage and drive each pair. On ſmooth ground theſe alone were ſufficient; but, where the machine was to be drawn acroſs ridges and furrows, it was found neceſſary to have a man to attend with a fork in his hand; which he ſhould uſe, as often as the machine ſhews a tendency to ſlide over the ſtill row of hay, by thruſting the prongs into it to the greateſt depth that can be done, without ſuffering the points to touch the ground, and nearly cloſe to the hay then in motion by the machine; the moving hay advances to the fork, and drives forward the hay ſo held by its prongs, and with it all that part of the row; and, it being once put in motion, the machine keeps it ſo. The man ſhould keep walking briſkly forwards before the machine, and put the fork into the ſtill hay, until the machine gets hold of it, as often as may be neceſſary; which

will

will be particularly ſo in paſſing every furrow, but, in level fields, this will ſeldom happen; though I found that, even where the ridges were a little unfavourable, as in the caſe of being too round, the machine was prevented from being ſtopped or impeded, by breaking the row of hay at every twenty or forty yards diſtance.

I ſhall endeavour to make the whole more clearly underſtood, by the following ſketches and explanations, to which I beg leave to refer, and ſhall now proceed to obſerve on what I conceive to be its particular merits.

In caſes where the hay can, without inconvenience, be ſtacked in the field, this machine will entirely ſuperſede the uſe of every ſort of carriage, as it may be made to draw all the hay in the field to the ſtack; and it may, with equal facility, be made to draw the hay produced on any number of fields to one place, provided the gateways are made ſufficiently wide to admit the machine's paſſing through, namely, about fifteen feet; and conſequently all the hay of any farm might thus be drawn to the ſtack-yard. But it appears to be adviſable, as a matter of prudence, to confine its uſe to a graſs ſurface; as, in paſſing over gravel roads, gateways, &c. it would probably pick up ſome dirt, and other extraneous matter, which might be injurious to the hay.

It will be found uſeful in very ſcorching hot weather, eſpecially when hands are ſcarce, in dragging the hay together the moment it is ſufficiently made, and thereby preventing (what frequently happens) its being too much dried. In catching or ſhowery weather, it will be of ſtill more ſervice; as, in the caſe of a field of hay, more or leſs, not being quite fit to carry to the ſtack, and ſymptoms of approaching rain appearing, the whole may generally be ſwept into heaps, containing as much as the horſes can draw at twice, by fetching the ends of each row to the middle, or by drawing two or more rows into one heap, and employing every hand in making it into large cocks or pikes, containing a ton or two in each, proportioning the ſize to the dryneſs of the hay; thus the whole may frequently be ſecured before the rain falls, and, if properly made, they will turn all the rain that may fall. Even if the weather ſhould prove wet for a week or more, the

cocks

cocks will be found to have ſuſtained no very material damage, except that the outſides will be a little ſtained or diſcoloured by the rain, and the bottoms by damps ariſing from the ground; the latter will always happen when the cocks are ſuffered to ſtand a fortnight or more in the field, but the former will only happen in caſe of uncommonly heavy or long-continued rains.

In caſes where the hay is ſufficiently made to bear ſtacking, and there is an appearance of rain, it may be ſpeedily dragged to one place near the middle of the field, and all hands employed in making the ſtack, which may immediately be ſecured by putting a cloth over the top; and, even where a cloth is not at hand, only let it be made ſufficiently high in the middle, hard trod, and well raked down on the outſide, and it will be almoſt equally ſecure.

I experienced the uſe of the machine in all theſe caſes laſt ſummer, and am of opinion, that when the boys are agile, and the horſes tractable, and uſed to the work, ten acres of hay may be thus ſecured in little more than an hour.

Description of the Machine, and Manner of using it.

(See Plate IV.)

It will firſt be neceſſary that the hay ſhould be put into rows, as is univerſally done before the loading of carts, waggons, or ſledges; then, in order to ſweep the hay together with greater facility, order a man with a fork to go and turn the end of a row up, two or three yards, ſo as to form a ſort of heap, and then walk on, ten, twenty, or forty paces, and break the row, by turning the hay forward into another ſimilar heap; let him go on and repeat this operation to the end of the row, which he ſhould do as faſt as he can walk; then order the boy, who has the management of that pair of horſes to which the empty machine is attached, to draw it acroſs the end of the row; and, the moment the centre of the machine is at the middle of the row, let him turn his horſes ſhort round, to within a yard or two of the hay, ſo as to be in a proper poſition

poſition to ſet off; the other boy muſt inſtantly place his horſes on the oppoſite ſide of the row, and hook the chain of his ſplinter-bar to the machine, pulling the gate or ſide of the machine round, ſo as it were to claſp the hay, as appears in the plate. The boys being mounted, and all now ready to ſtart, let them draw ſlowly on for the firſt twenty or forty yards; they may then, if the buſineſs requires diſpatch, increaſe their pace, urging the horſes into their faſteſt walk, and from that into a ſlow trot, until as much hay is collected as the horſes can draw; then, unhooking one end, let the horſes at the other end turn from the hay, and draw out the machine from behind it; then trot away to the end of the next row, and repeat the proceſs, taking care to keep the horſes on each ſide of the hay, at equal diſtances from the row, and oppoſite to each other. When the machine is loaded, and the intention is to draw the load to a diſtant place, the four horſes cannot be kept too near together.

The elevation of the machine, as it appears when drawn by one end, and empty, is ſhewn in

 the

the lower part of the plate, where the ſcantlings of the ſeveral parts of the machine are marked.

The plan of the machine, when in the action of drawing the hay, is alſo ſhewn in the lower part of the plate, and is lettered as follows.

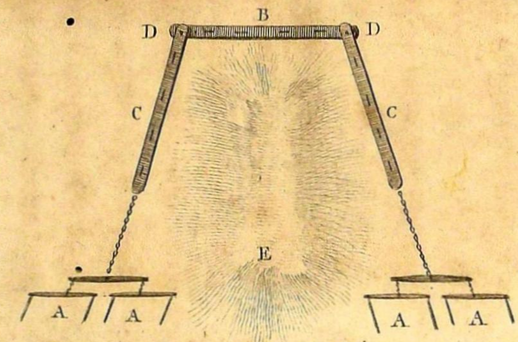
A A A A. The places occupied by the horſes, when drawing, though in many caſes one horſe on each ſide would be ſufficient.

B. The back, or principal part of the machine.

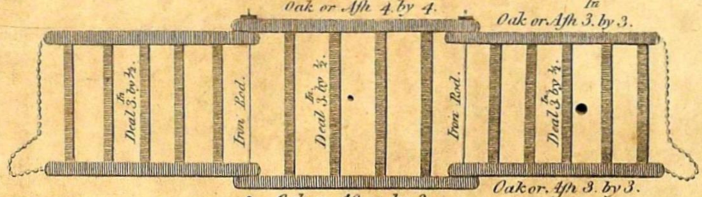
C C. The ſides, or gates of the machine, which ſwing on the iron rods fixed in the back at D D.

E. The row of hay.

The back of the machine, and the ſides or gates, are, each of them, about ſeven feet in length.



Plan of the Machine



Elevation of the Machine

VI. *A new Method of assaying Copper Ores.* By GEORGE FORDYCE, *M. D. F. R S.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

Process. TAKE 100 grains of the ore, powder it finely, put it into a small matrass or a glass phial, pour upon it half an ounce of nitrous acid, of the strength commonly sold by the name of *aqua fortis*, (that is, the pure acid diluted with about four times its weight of water,) and half an ounce of muriatic acid, sold by the name of spirit of salt. Place the vessel in a sand-heat; or, if you have none, an iron pot or fire-shovel, with sand, may be put over a common fire, and the matrass or phial set in it. Raise a moderate heat, an effervescence will take place, for the most part; when this ceases, increase the heat until it is renewed, and so proceed until the liquor boils, which is alſo to be done if no efferveſcence take place; boil them together for a quarter of an hour.

Remove the veſſel from the fire, and let it cool, then pour into it two ounces of water, ſhake them together, and let them ſtand till the liquor is clear; pour the clear liquor into a baſon where it may be preſerved.

Add to the *reſiduum* a freſh half ounce of each of the acids, and proceed again in the ſame manner, mixing the clear liquor with that procured by the firſt proceſs.

The ſame operation is to be repeated, until the freſh acids acquire no tinge of blue or green.

Diſſolve half a pound of mild fixed vegetable alkali, commonly ſold by the name of ſalt of tartar, in a quart of water. Purify the ſolution, either by filtration, or by letting the impurities ſubſide and decanting the liquor clear into a glaſs veſſel. Pour the ſolution of the alkali ſlowly into the baſon containing the fluid procured by the former proceſſes, until the whole matter be precipitated from the acids.

Add,

Add, by a little at a time, as much vitriolic acid, commonly sold by the name of oil of vitriol, as will redissolve the whole, or only leave a white powder; if there should be any such powder, which is seldom the case, it must be separated by filtration.

Having the liquor in the bason now clear, put into it a piece of iron, bright and free from rust, and at least an ounce in weight, and leave them together for twenty-four hours; the copper will be found precipitated, principally on the surface of the iron, and sometimes in a powder at the bottom of the bason.

Decant the fluid from the copper and iron, with great care, into another bason, so that as little as possible, or none, of the copper be carried along with it.

Wash the metals in a pint of water; let them subside perfectly, and pour this water into the second bason, with the same care.

Repeat the washing three times: if any copper be found in the second bason, let the washings stand in it for half an hour, so that the metal shall subside; decant the fluid carefully off, and

return

return the copper into the firſt baſon. Pour upon the copper and iron one ounce of vitriolic acid, and two ounces of water; let them ſtand together for a quarter of an hour, or until the copper ſhall be eaſily ſeparable from the iron. Separate the copper from the iron, taking great care that none be loſt; the remaining iron may be laid aſide. Pour the acid from the copper, after it has ſubſided, into the ſecond baſon; waſh the copper with a pint of water, and repeat the waſhing three times as before directed.

Great care is to be taken, in decanting both the acid and waſhings into the ſecond baſon, that none of the copper goes along with them; leſt any ſhould, they ought to ſtand for half an hour in the ſecond baſon, and be decanted from it alſo with care; and, if any copper is found at the bottom, it is to be waſhed, and added to the reſt.

The copper is now to be dried and weighed, and gives the proportion contained in the ore.

Obſer-

Observations on the above Process.

It is about twenty years ago that I contrived some methods of assaying ores, which might avoid tedious and troublesome roastings and fusions in great degrees of heat, which require a dexterity that is only to be acquired by great practice, and which, after all, form a process that is often various in the result, and seldom shews the substances contained in the ore, excepting the metal. The principles on which these processes depend, as far as regards copper ores, are,

First. Metals are attracted more strongly by acids than by sulphur, with which they are often combined in their ores. In consequence, if a metal be combined with sulphur in an ore, it may be separated by applying an acid, which will unite with the metal, and separate the sulphur.

The metal may generally be separated from the acid, in its metallic form, by means of another metal which attracts the acid more strongly.

Secondly. Arsenic unites with vitriolic, nitrous, and muriatic acids, forming a corrosion or compound

pound not ſoluble in water; whereas, moſt other metals may be united with one of theſe acids, or a mixture of them, ſo as to form a compound ſoluble in water: therefore, if there be arſenic combined with a metal in an ore, if it be diſſolved in ſuch acid diluted with water, the arſenic will fall to the bottom in a white powder, or in cryſtals, and the ſolution, being poured off, will contain the metal, which may be ſeparated from the acid by another metal, as before.

Thirdly. The calces of metals may be diſſolved in acids, whether they be pure (of which there are few inſtances in ores) or combined with gas, reſpirable air, or other vapours: therefore, if the metal in an ore be in the form of a calx, we may find an acid which will diſſolve it, and we may afterwards precipitate it in its metallic form, as before.

Fourthly. When an ore is to be aſſayed, it ſhould be ſeparated from the quartz, ſpars, and other earthy matters, with which it is often mixed, as perfectly as poſſible; however, after all our care, there will often be a part of them ſo intimately mixed with the ore, that it cannot be

entirely

entirely cleared. Many of these earthy matters do not dissolve readily in acids: therefore, if the metal of an ore be dissolved in an acid, so as to form a compound soluble in water, the solution of the metal may be poured off, leaving such earthy matters behind.

Fifthly. If the earthy matter should dissolve in the acid, it is seldom to be precipitated by a metal: therefore, if both earth and metal be dissolved, on the application of another metal, which attracts the acid more strongly, that which was combined with the acid will be precipitated, and the earth left in the solution.

Sixthly. Acids attract the metals with different powers: therefore, if two metals be combined with an acid, if we apply to the solution a mass of that which attracts the acid strongest, the other will be precipitated. The mass being weighed before and after the precipitation, the difference will be the quantity of additional metal dissolved: if, therefore, we pour off the liquor from the precipitate, and apply another metal, which attracts the acid still more strongly, the second metal will be precipitated; which, being weighed, and the weight loſt from the maſs deducted, gives the weight of the ſecond metal. As this principle is of great uſe in inveſtigating the elements of mixed metals, we ſhall give an example. Suppoſe copper and ſilver mixed: diſſolve the whole in pure nitrous acid, properly diluted with water; apply to the ſolution a maſs of copper, the ſilver will be precipitated. Pour off the ſolution, and waſh the ſilver and undiſſolved copper with water; pour the waſhings into the ſolution, weigh the maſs of copper left, and mark what it has loſt; apply to the ſolution a maſs of iron, the whole copper will be precipitated. Pour off the fluid, and waſh the precipitate carefully, dry it and weigh it; deduct the weight loſt from the maſs of copper, what remains is the weight of the copper in the mixture; if this weight, together with that of the ſilver, be the weight originally expoſed to examination, there is no reaſon to ſuſpect any mixture of another metal.

If the metals mixed are unknown, if we can find an acid which will diſſolve them, we may try to make a precipitation with the metal which is loweſt but one in the order of elective at-

tractions,

tractions, and so proceed to the next above it, until we come to the highest; and, by this means, we shall obtain all the metals in the mass.

There are other principles on which I have founded various processes for assaying, but these are sufficient for copper ores; all the different known species of which I have actually assayed, and therefore have ventured to offer the consideration of this process to the society; first, as only requiring an apparatus which can be bought at any apothecary's or chemist's, and capable of being performed by a person totally unacquainted with chemistry, so that any proprietor of an estate, or his servant, may determine if an ore be of copper, and its value; secondly, as affording an assay-master a more perfect manner of determining the value of a copper ore; and lastly, as a process by which the naturalist may investigate, not only the copper in an ore, but its various other contents.

There is but one known species of copper ore in which the copper is not capable of being combined with *aqua regia*, that is, blue vitriol, which is sometimes found solid, but more frequently in mineral waters; from this the copper may be precipitated by iron immediately.

We have lately had many opinions publiſhed, of metals being found in mineral waters combined with various ſubſtances. I never examined any mineral water in which I found the metals combined with any ſubſtance but vitriolic acid; and am certain many authors have been miſled, by not knowing this property of metallic ſalts, *viz* that if we diſſolve them in a ſmall proportion of water, or if there be ſuperfluous acid, the ſolution will remain perfect when expoſed to the air; but, if the acid be perfectly ſaturated with the metal, and the proportion of water to the metallic ſalt be very great, on expoſure to the air it is decompoſed, the metal precipitating in the form of a calx, and the acid being loſt. This may eaſily be tried, by taking common green or blue vitriol, diſſolving an ounce in three ounces of water, by boiling, letting them ſtand to cool, and filtering the ſolution. If this ſolution be expoſed to the air it will remain perfect; but, if we drop a drop or two of it into a wine-glaſs full of water, in a few minutes the tranſparency of the

water

water will begin to be disturbed, and the metal in a short time will fall down, in a red powder if it be iron, in a blue powder if it be copper.

An hundred grains of the ore is sufficient to give the copper contained, to one hundredth part; if greater accuracy be required, 1000 grains may be used.

The mixture of nitrous and muriatic acid is the most proper acid *menstruum* for copper ores; muriatic acid dissolving most readily the calces of metals, and nitrous acid when they are in their metallic form; a metal in its metallic form being a compound of a pure calx and a substance which has been called inflammable air, but which is an oil, found out by Stahl to exist in metals, and which we would call the oil of metals. The nitrous acid decomposes this oil, at the same time that it acts on the calx itself, and leaves it also to be acted upon by the muriatic acid.

When copper is combined with sulphur in an ore, it is in its metallic form; in dissolving in an acid, its oil rises in vapour; or vapours produced by the decomposition of this oil occasion an effervescence.

All the calces of copper I have tried are combined with gas, refpirable air, or other vapours, excepting one, which is of a light green colour, brittle, and which breaks fmooth like glafs; a fpecimen of it is contained in Dr. Hunter's mufeum: this diffolves without effervefcence, the others all effervefce. A boiling-heat is neceffary to render the folution complete, of which great care is to be taken.

If there be any fulphur in the ore, it appears quite clear, in lumps; a fmall portion of it, however, is deftroyed by the nitrous acid. Earthy matters infoluble in acids, if any, and arfenic, appear in a powder at the bottom. If there be any filver, it is mixed with this powder, and is to be extracted by melting it with black flux and litharge, and cupelling in the common way. If there be any gold, it may be taken out of the folution by æther.

When the copper is combined with nitrous and muriatic acids, it might be thought fufficient to apply the iron immediately; but it is much more convenient to precipitate it from them, and combine it with vitriolic acid, on account of the

convenience

convenience of washing the precipitate, which is in a more compacted mass.

If there be any calcareous earth dissolved, the vitriolic acid will combine with it, and form a white powder, which will be left after the copper is redissolved, and must be separated carefully from the solution.

After the precipitation of the copper, it is necessary to get rid of the salts perfectly, before we apply the vitriolic acid; otherwise part of the copper would be redissolved.

Vitriolic acid will not dissolve copper in its metallic form, and may be applied to dissolve any iron that may be mixed with the precipitate, as well as to loosen copper, which sometimes adheres to the iron.

The solution of the iron must be carefully washed off from the copper.

There is a criterion by which we may judge certainly if any of the copper be lost. Let all the washings, and every thing, except the copper, be put into a vessel together; pour in solution of fixed alkali, until no farther precipitation takes place; let the precipitate ſubſide, and pour off the liquor; apply to the precipitate ſolution of volatile alkali, ſold by the name of ſpirit of *ſal ammoniac*; ſhake them together, and let them ſtand for an hour: if the ſolution of the alkali acquires a purpliſh blue colour, the proceſs is imperfect, if it does not, it is perfect.

If the proceſs be imperfect, which is always for want of care in the decantations, pour in as much vitriolic acid as will diſſolve the whole precipitate, apply iron to the ſolution, the remaining copper will be procured.

VII. *On the Means of procuring Saltpetre from the Earths which contain it, and of purifying it; alſo on making Gunpowder. By M. de* BULLION.

From the MEMOIRS of the ROYAL SOCIETY of AGRICULTURE of PARIS.

SALTPETRE, like many other ſubſtances, is a production of nature, and is formed in greater quantities in the habitations of men than any where elſe. In great cities, ſuch as Paris, ſaltpetre is obtained by lixiviating the rubbiſh of old buildings; in the country it is obtained by lixiviating the earth of cellars, of ſtables, and of other places inhabitated by animals.

Saltpetre is not only uſeful for making gunpowder, but is alſo abſolutely neceſſary in many arts; we ought therefore to encreaſe the quantity of it as much as poſſible, and endeavour, by that means, to diminiſh the price of it. The object of this memoir is, to inftruct the inhabitants of the country how to procure the faltpetre which is formed in their habitations, and how to encourage its formation.

Saltpetre is formed of the nitrous acid, and a calcareous and alkaline bafis. The nitrous acid is generated in the atmofphere, by the help of the azote or vitiated air, which is difengaged from animal or vegetable fubftances, when in a ftate of putrefaction. If therefore, inftead of throwing fand on the ground in ftables, &c. and building and plaftering their walls with fat earth, or clay, the ground were to be covered with marl, or calcareous ftone, and the walls, within and without, plaftered with the fame, beat and tempered with water, in the form of mortar, in five or fix months time the ground, and alfo the plafter of the walls, would be found fufficiently charged with faltpetre to be lixiviated with advantage.

In order to perform the lixiviation, the plafter of the walls muft be fcraped off, and the ground of the ftable, or cellar, muft be dug up; but only to the depth of fix or eight inches, for faltpetre is very feldom found at a greater depth. It may be difdiscovered whether the ground is sufficiently impregnated with saltpetre, by plunging a red hot iron into it, which sets fire to the saltpetre. The ground, &c. being found in a proper state, casks are to be filled with it, and water is to be poured into them, which, when it has dissolved the saltpetre, is suffered to run out through a small hole, made about an inch above the bottom of the cask. Fresh water is then to be poured upon the materials, till it appears not to dissolve any more saltpetre. Boiling water would be preferable to cold water for lixiviation, as it would dissolve more saltpetre, and consequently there would be a less quantity of water to evaporate.

This water, charged with saltpetre, is then to be carried to caldrons of copper or iron, in which it is to be evaporated, till it is found that a drop of it, let fall upon any cold substance, appears, when cold, to crystalize. The solution is then to be poured into copper pans, that the saltpetre may crystalize, which it does as fast as it grows cold. In about forty-eight hours all the saltpetre will be crystalized; then the liquor above it is to be decanted into another vessel, and the cryſtals are to be drained. The ſaltpetre thus obtained is called ſaltpetre of the *firſt boiling.* The liquor which was decanted ſtill contains a great quantity of ſaltpetre; it is to be poured again into the caldrons, to be once more evaporated and cryſtalized. The liquor which remains after this ſecond cryſtalization contains ſcarcely any ſaltpetre, and is only of uſe to ſprinkle thoſe earths from which ſaltpetre is meant to be procured. At the bottom of the caldrons in which the liquor was evaporated, is found a ſalt, which was formed during the boiling; this is common ſea-ſalt, which, when purified, may be uſed to ſeaſon food, or to pickle meat.

To purify the ſaltpetre which we have obtained from the two preceding cryſtalizations, it is to be put into a caldron, with a ſufficient quantity of water to diſſolve it entirely; then pot-aſh is to be thrown into the caldron, to decompoſe the calcareous nitre produced in the firſt cryſtalization. The pot-aſh, in this operation, unites with the nitrous acid of the calcareous nitre; the earth, being now ſet free, renders the liquor turbid, and is precipitated. The evaporation is to be continued

nued until a drop, thrown upon a cold ſubſtance, ſhews a diſpoſition to form cryſtals; then it is to be poured into caſks, that the calcareous earth may fall to the bottom, which always takes place before the liquor is grown cold: it may then be poured off into the pans, in which it is to cryſtalize.

Forty-eight hours after, the liquor is to be poured from the cryſtals, and put into the caldrons, that it may be again evaporated, and freſh cryſtals produced from it. The cryſtals produced by this and the preceding cryſtalization are called ſaltpetre of the *ſecond boiling*; it is now purified, to a certain degree, but not ſufficiently ſo to be employed in making gunpowder; for that purpoſe it muſt undergo a third purification, which is called the *third boiling*.

The liquor which has furniſhed the cryſtals of the ſecond boiling, like that which furniſhed thoſe of the firſt, is good for nothing but to ſprinkle thoſe earths which are deſtined for the generation of ſaltpetre. The leys made uſe of for linen ought to be kept for the ſame purpoſe, as they ſtill contain a great quantity of pot-aſh.

Even

Even ſoap-ſuds ought not to be thrown away; it ſerves to precipitate calcareous earth from ſea-ſalt, and to form ſea-ſalt with a baſis of ſoda. Nothing therefore, in rural or domeſtic œconomy, ſhould be neglected.

By following the courſe of nature, it is poſſible to eſtabliſh artificial nitre-beds; it is only neceſſary to build walls with calcareous ſtone, and, inſtead of mortar, to make uſe of calcareous marl, tempered with water; theſe walls ſhould be plaſtered over with the ſame kind of mortar, to the thickneſs of about two or three inches. If the walls are built in the neighbourhood of dunghills, or other heaps of filth, they will generate ſaltpetre ſo quickly, that they may be lixiviated twice a year.

To make ſaltpetre-beds upon a large ſcale, we muſt dig cavities, either round or long, or of any other form, and throw into them all the filth of cities, ſuch as the contents of neceſſary-houſes, the refuſe of ſlaughter-houſes, the ſweepings of the ſtreets, dead animals of all ſorts, &c. which might there undergo putrefaction. Around theſe cavities ſhould be built ſeveral rows of walls, com-

poſed

posed of calcareous stone, in the manner above described. These walls should be eight or ten feet in height, and have walks between them eight or ten feet wide, that the air may have a free circulation. On the outside of these walls, and also within them, should be planted several rows of forest trees; such trees decompose the water of rain and dew, from which a great quantity of vital air is disengaged; this air combines with the azote furnished by the substances in a state of putrefaction, thus forming nitrous acid; which, in its turn, combines with the calcareous earth of the walls, and forms saltpetre.

The sun-flower (*Helianthus annuus*) may be planted with advantage within the walls; this plant abounds with fixed alkali, and very readily generates saltpetre, which may be obtained from it by lixiviation; the ashes of the plant, which contain a great deal of alkali, may be used to precipitate the mother-water of saltpetre. The husks of grapes, when burnt, also furnish ashes which contain a large portion of alkali, which may be employed for the same use. Walls may also be built of calcareous marl and straw,

with-

without uſing any ſtone, in the way in which walls are built in Normandy of earth alone: theſe walls ſhould have but little thickneſs, that the ſaltpetre may penetrate them more eaſily. Houſes, ſtables, &c. may be built of wood, and, inſtead of the uſual coating, they may be plaſtered with calcareous marl, which will be more apt to generate ſaltpetre than thoſe kinds of coating which are compoſed of fat earth, or clay. The inhabitants of the country ſhould be informed that it is their intereſt to conſtruct their habitations in this manner, and that they will, by ſo doing, poſſeſs a new ſource of profit, in the generation of ſaltpetre. Experience will ſoon ſhew them how advantageous it may be to attend to this ſubject; particularly if the adminiſtration of each department, of each diſtrict, and of each municipality, would take this branch of commerce under its protection, and would encourage it by rewards, and by furniſhing the inhabitants with the inſtructions and utenſils neceſſary in the purſuit of it.

The melting of the church-bells will furniſh matter for a great quantity of caldrons. More ſaltpetre is conſumed in the arts than is uſed in

making

making gunpowder; and, the greater quantity there is made the more neceſſary it will become, as it will be employed for purpoſes in which it has not yet been uſed, on account of its dearneſs. This ſalt, by becoming more common, will be lowered in its price; there will be a greater number of manufactories of oil of vitriol eſtabliſhed; alum, vitriol of iron, and of copper, ſo uſeful in dying, &c. will alſo become more common, and of leſs price; marine acid, which is obtained from common ſalt by means of oil of vitriol, will be proportionably cheaper; this acid is become valuable ſince it has been employed in bleaching linen and cotton. Nitre gives out its acid, by means of oil of vitriol and earthy vitriols. Nitrous acid is employed in the arts, particularly in that of ſeparating the perfect metals. It may alſo be uſed, in various operations, to encreaſe the effect of fire; it accelerates the fuſion of glaſs, and renders it more pure.

Of Gunpowder.

After having deſcribed the proceſſes for extracting ſaltpetre from the earths which contain it, this memoir would be imperfect if I did not alſo give an account of the manner of making gunpowder.

Origin of Gunpowder.

There is reaſon to think that gunpowder was invented in the time of Alexander the Great, if we judge by what Philoſtratus ſays of a city near the river Hypheſis, in the Eaſt Indies; which city was reckoned impregnable, and its inhabitants were ſuppoſed to be gods, becauſe they darted thunder and lightning upon their enemies. This, it is imagined, could only be the effect of gunpowder; and this conjecture is confirmed by the accounts of travellers, who certify that it was made uſe of in the Indies, and particularly in the Philippine iſlands, about the year 85 of the Chriſtian æra, that is to ſay, 1265 years before it was known in Europe; where it was ſuppoſed to be known about the year 1350; in France about the year 1366. Father Le Compte, a jeſuit, ſays that the Chineſe have always had gunpowder, and there is reaſon to think that it paſſed from them to the Indies, and thence into Europe; this, if true, deprives Berthold Schwartz, a German monk, of the glory of having invented it.

The

The manner of extracting nitre from the earths, and of purifying it, having been defcribed, I fhall now proceed to fpeak of the other fubftances which enter into the compofition of gunpowder, namely, fulphur, and charcoal.

Of Sulphur.

Sulphur is a combuftible matter, common in moft parts of the world; it is often found pure, in a femi-tranfparent criftaline form, of a lemon colour; very commonly it is mixed with earth and metals. Pyrites are nothing more than a combination of iron and fulphur, which latter may be obtained from them by fublimation; but, there being a fufficient quantity of fulphur to be procured by other means, at a low price, it is not worth while to extract it from pyrites. Sulphur, to be of a fit quality for making gunpowder, muft be pure, and of a fine lemon colour; it fhould crackle and break when grafped in the hand. If it is not pure, the beft way to purify it is to fublime it; it is then called flowers of fulphur, and is very fit for the purpofe of making gunpowder.

TO BE CONCLUDED IN OUR NEXT.

VIII. *Obſervations on the Nature of Honey, particularly on its ſaccharine Part, when obtained in a ſolid Form.* By Mr. Lowitz.

From Crell's Chemical Annals.

I. A SUBSTANCE ſo remarkable and ſo uſeful as honey ought to have been long ſince accurately analyzed by the chemiſts. Its ſaccharine taſte has always led them to ſuppoſe that it contained a large quantity of ſugar; but the great queſtion was, how to ſeparate the ſaccharine part from the mucilaginous, and other heterogeneous parts. This ſeparation was the principal object of my enquiry, in the experiments of which I am now going to give ſome account.

II. The property poſſeſſed by charcoal, of decompoſing and abſorbing the mucilaginous and phlogiſtic parts of various ſubſtances, (a diſcovery which I formerly made, and of which I then gave an account,) induced me to hope that I could, by

its

its means, obtain the object I had in view. I did indeed ſucceed in depriving honey, which had previouſly been diſſolved in a ſufficient quantity of water, of that ſmell which is peculiar to it, and alſo of its taſte and colour; but, when I evaporated the ſolution, by a very gentle fire, it ſoon acquired its former brown colour, and did not ſhew any diſpoſition to produce regular cryſtals. I therefore thought it reaſonable to conclude, that this property, of recovering its original colour, either was natural to the whole ſubſtance of honey, or belonged excluſively to one of thoſe conſtituent parts of it upon which charcoal had no power; for, when a ſolution of common ſugar is thickened by boiling, even though it is made to boil violently, it does not contract any colour until all the aqueous parts are evaporated.

III. The honey which had been treated with charcoal, and thickened by evaporation, in the manner already deſcribed, was obſerved, two months after, to have a great number of ſmall white lumps in it, which had the appearance of cryſtals; and, ſoon after, the whole maſs ſeemed

to

to be full of them. To diſtinguiſh accurately the nature of theſe ſmall lumps, it was neceſſary to ſeparate them from the reſt of the maſs, which was entirely coagulated, very thick, and glutinous. This operation I performed tolerably well, by waſhing the maſs with alkalized ſpirit of wine, without heat. I ſoon perceived that the ſpirit diſſolved the glutinous part completely, merely by ſhaking the mixture; but that fluid did not ſeem to have any effect upon the white granulated part; ſo that I ſucceeded in obtaining this laſt quite pure. After having ſeparated this ſaccharine granulated part from the liquor, by means of a filter, I dried it by a gentle heat, and reduced it into powder: this powder did not attract moiſture, and had a very agreeable ſweet taſte.

IV. As the granulated conſiſtence of white honey ſeems to ariſe from the coagulation of its ſaccharine part, I endeavoured to ſeparate that part by means of the pureſt ſpirit of wine, and which contained the ſmalleſt poſſible quantity of water. From twelve ounces of this ſort of honey, I procured three ounces of ſaccharine matter. This matter ſtill contained ſome heterogeneous ſub-

ſtances,

ſtances, which appeared not to be ſoluble in ſpirit of wine. To diſſolve the ſaccharine part, I again had recourſe to the pureſt ſpirit of wine I could procure; which I made uſe of by putting the mixture into a glaſs matraſs, and boiling it therein for ſome time. By theſe means the ſaccharine part was entirely diſſolved; while the inſoluble part remained behind upon the filter, having the appearance of a greyiſh dirty ſlime. I had filtered the mixture while it was hot; after which I had poured the clear liquor into another matraſs, in which I let it ſtand quiet for ſome days. After that time, the ſugar of the honey began to fix itſelf to the bottom of the veſſel, in the form of little ſpherical knobs, ranged in lines by the ſide of each other; theſe, increaſing in number every day, formed at laſt a ſolid cruſt, which was as white as ſnow, rather rough at the top, and which, after being ſeparated from the liquor above it, was ſo firm as to bear cutting with a knife into very thin ſlices. The remaining liquor, having been left quiet for ſome days, let fall, in that interval, a freſh portion of this ſac-

charine

charine matter, which was exactly ſimilar to that already ſpoken of.

V. Having thus provided myſelf with a certain quantity of this kind of ſugar, I tried various methods to make it take a regular cryſtalized form; but, in that reſpect, all my trials were in vain. Whether I uſed the pureſt ſpirit of wine, or water, to diſſolve this ſubſtance, the reſult was the ſame. I remarked, indeed, that the ſolution of it in water, which had been thickened to the conſiſtence of ſirup, depoſited, after ſome time, ſome ſmall knobs on the ſides of the veſſel, which had the form of cauliflowers; the whole ſolution afterwards coagulated, and appeared like a ſolid, dry, white maſs, full of ſmall cavities, which, when examined with a microſcope, ſeemed to be compoſed of very ſmall long cryſtals, extremely thin, and hardly viſible to the naked eye.

VI. Though this manner of cryſtalizing ſufficiently diſtinguiſhes the ſaccharine part of honey from common ſugar, I ſuſpected, at firſt, that this difference proceeded only from the preſence of ſome heterogeneous parts, from which the honey was not ſufficiently cleared; but the following-ing experiments evidently ſhew, that theſe two ſubſtances differ from each other by properties which are very ſtrongly marked.

1. If a certain quantity of lime-water is added to a watery ſolution of the ſugar of honey, it inſtantly acquires a brown colour, though it was before quite limped and colourleſs.

2. Quick lime, which I added to the watery ſolution of ſugar of honey, while it was upon the fire, produced a very ſtrong efferveſcence, and the mixture immediately became of a dark brown colour, almoſt black. By continuing to add quick lime until the efferveſcence ceaſed, the ſugar of honey was entirely decompoſed; the mixture turned quite black, and emitted a ſmell which was very diſagreeable, and even nauſeous.

3. The dark-coloured ſolution contains a large quantity of lime, which cannot be precipitated by means of, aërated alkali, nor by an alkali rendered perfectly cauſtic.

4. If vitriolic acid is made uſe of to precipitate this lime, it then appears in the form of

gypsum; but the remainder of the liquor still contains a very empyreumatic acid, which seems to have a strong analogy with the malic acid of Scheele.

5. If the acid of sugar of honey is treated with nitrous acid, it is converted into acid of sugar.

6. A much more pure acid may be obtained by making use of a double affinity. For this purpose, it is only necessary to boil together equal parts of honey and quick lime, in a great quantity of water, adding to this solution, which is of a brownish colour, as much charcoal-powder as may be requisite to take away the colour entirely. The solution must then be filtered, and to the clear liquor must be added a very saturated solution of lead in distilled vinegar, until all precipitation has ceased. The precipitate obtained by these means must be washed in such a quantity of water as will edulcorate it thoroughly; after which, as much diluted vitriolic acid must be added as may be sufficient to separate the acid of the honey from the lead: this acid may then be concentrated by evaporation.

7. If

7. If the ſolution of honey and quick lime is thickened by evaporation, after its brown colour is taken away by charcoal, a tranſparent maſs, of a light yellow colour, is produced, which reſembles gum arabic; it has a bitter taſte, and does not grow moiſt by being expoſed to the air.

8. The clear maſs which is produced from a mixture of the acid of honey and lime is perfectly inſoluble in ſpirit of wine; and it may be precipitated from its ſolution in water by this ſpirit.

9. Cauſtic fixed alkalies produce upon honey, and upon the ſugar which is procured from it, the ſame effect as lime. Honey, as well as its ſugar, is entirely decompoſed by them; and always with a very violent efferveſcence. The dark-coloured extractive maſs which is obtained by theſe means is completely inſoluble in ſpirit of wine; and, when the quantities of the two ſubſtances are exactly proportioned, very little taſte can be perceived in the maſs; that little is by no means alkaline, and can hardly be called ſaline. This proves that alkalies,

as well as quick lime, may be perfectly ſaturated by the acid contained in honey.

10. Volatile alkali alſo decompoſes honey in the ſame manner, and with the ſame circumſtances, as other alkalies; but this decompoſition takes place much more ſlowly, and only when heat is at the ſame time made uſe of.

VII. That conſtituent part of honey which is got from it by treating it with ſpirit of wine (III.) may be diſtinguiſhed from the ſugar of honey, by the following property, *viz.* that it cannot be reduced into a dry or ſolid form. It is owing to this part that the ſolution of honey ſo readily contracts a brown colour; for, a ſolution of ſugar of honey, deprived of this glutinous part, may be thickened upon the fire without ſuffering any alteration of colour. In other reſpects, the yellow glutinous part of honey, here ſpoken of, ſhews nearly the ſame properties as the ſugar of honey; and, when treated with cauſtic alkalies, or with quick lime, its taſte is alſo the ſame.

VIII. The properties which I have above deſcribed are thoſe by which the ſugar of honey

differs

differs eſſentially from common ſugar. If this laſt is treated like honey, it exhibits the following reſults.

1. Neither quick lime nor fixed alkalies produce any decompoſition in ſugar; no efferveſcence is obſerved, nor does the ſolution ſhew any change of colour.

2. Whatever quantity of ſugar is added to fixed alkalies, they always preſerve their cauſticity; and, even if they are boiled with ſugar for a conſiderable time, they never appear to be united with its acid.

As quick lime, when combined with ſugar, is attended with ſome phænomena which appear not to have been taken notice of by any perſon, I ſhall here mention them.

By boiling together equal parts of ſugar and quick lime, in a ſufficient quantity of water, a ſolution is obtained, which, by the ſurpriſing quantity of lime it contains, may be conſidered as a highly-ſaturated lime-water, in which the taſte of the ſugar is not to be perceived.

By evaporating this ſolution to dryneſs, a white tenacious maſs is obtained, which has ſuch an acrid and burning taſte as to affect the tongue like cauſtic alkalies.

3. By expoſing a ſolution of lime and ſugar to the air, after having been filtered into an open veſſel, the ſurface becomes gradually covered with a great number of ſmall cryſtals; theſe are ſucceeded by others whenever, by ſhaking the liquor, the firſt-formed ones are made to fall to the bottom of the veſſel. This formation of cryſtals at the ſurface continues till the liquor contains no more lime; then the ſugar again acquires its proper taſte.

4. The ſmall cryſtals, of which I have juſt ſpoken, very readily loſe their water of cryſtalization, by being expoſed to the open air; according to my experiments, I ſhould conſider them only as an aërated calcareous earth cryſtalized.

5. One of the moſt remarkable properties of the filtered ſolution of lime and ſugar is, that, by being made to boil, it ſoon grows turbid and thick; the lime then falls to the bottom of the veſſel, and this precipitate is of a milk-white colour;

lour; but, as ſoon as the ſolution grows cold, the lime again diſſolves in it ſpontaneouſly, and the ſolution becomes once more as limpid and tranſparent as it was at firſt. This phænomenon (which it is rather difficult to explain) was obſerved by M. de Laſſone, when, in the ſame manner, he combined the neutral ſalt of tartar with quick lime. (See Memoirs of the Academy of Paris, 1773, page 191.)

6. Alcohol, or very highly-rectified ſpirit of wine, precipitates the lime from the forementioned ſolution.

7. Mild alkalies, by the aërial acid they contain, produce the ſame effect.

8. Cauſtic alkalies do not cauſe the ſmalleſt alteration in the ſolution.

IX. From what I have ſaid it follows, that the union which exiſts between the ſaccharine part of honey and the oily part is much weaker than the union between the ſame parts in ſugar. This laſt cannot be decompoſed, in the humid way, except by treating it with nitrous acid; while honey, and the ſugar it contains, may be decom-

poſed,

poſed, not only by that acid, but alſo by mild alkalies, and by lime.

Upon the whole, there appears very little reaſon to hope that we ſhall ever be able to obtain honey in the form of ſugar; to bring it into that form, ſomething more than a mere ſeparation of its heterogeneous parts ſeems neceſſary. It is indeed ſaid, that, in ſome kinds of honey, eſpecially in that from Narbonne, cryſtals of ſugar, completely formed, have been obſerved; admitting the fact, I conſider it only as an accidental circumſtance.

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OF

ARTS AND MANUFACTURES.

NUMBER XXXII.

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IX. *Specification of the Patent granted to Mr.* ROBERT SALMON, *of Woburn, in the County of Bedford, Surveyor; for his Invention of an Improvement in the general Conſtruction of certain Machines, for the Purpoſe of weighing any Kind of Goods, Merchandiſe, Carriages, Waggons, &c. which Machines, ſo improved, he calls* Poidometers, *from their aſcertaining Weight by Meaſure.*

WITH A PLATE.

Dated March 8, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid

ſaid proviſo, I the ſaid Robert Salmon do hereby declare, that my ſaid invention, and the means of putting the ſame in uſe, are deſcribed in manner following; that is to ſay, the ſame is performed by means of a ſelf-adjuſting balance, by the action of which the ponderoſity or weight of any body or load applied thereto is accurately aſcertained, and deſcribed at inſpection; and farther, my invention or improvements in the conſtruction of other parts of weigh-bridges or engines, with their apparatus, for the purpoſe of weighing carriages, and to which ſaid engines the aforeſaid acting balance is particularly adapted and applicable; in purſuance of the ſaid letters patent to me granted, I do hereby aſcertain and deſcribe my ſaid invention, for which ſuch letters patent were granted to me, as aforeſaid; premiſing, and particularly meaning, that the ſize, dimenſions, and powers of my ſaid engines, may be ſo varied and applied to the various places and purpoſes to which they are applicable, as to prevent the ſpecifying any particular ſort or ſize. Their component parts may be made of wood, iron, or any other ſubſtance capable of being brought to the

ſhape

ſhape and uſes hereafter deſcribed; the advantage and effect meant to be produced by the aforeſaid engines, and for which theſe letters patent are taken out, is to render uſeleſs the application of more than one ſcale, and totally to exclude the uſe of weights; inſtead of which, by means of a circular dial, or upright index, as may beſt ſuit the place where fixed, to point out the weight of any burden put on a ſcale, or ſuſpended by ropes or ſlings; which operation is performed as follows. I procure of any of the aforeſaid materials, ſeparate or compound, a roller of certain diameter and length, according as the caſe may require; at each end of the ſaid roller is fixed a gudgeon or centre, truly turned and wrought; on one end of this roller I ſtrongly fix a wheel, of diameter as may be required; on the face of this wheel is a projecting part or grooved ledge, ſticking out therefrom as much as the caſe may require; one end of this ſaid ledge commences at the roller, and continues from thence, in a ſpiral manner, round on the face of the wheel in one or more revolutions, till it comes to the extremity of the ſaid wheel; the other part of the roller, on which the wheel does not go, is, from the aforeſaid gudgeons or centres, truly wrought, and turned circular. This done, the operation and effect is thus performed: the ſaid roller, together with the wheel and ſpiral ledge affixed thereon, is laid level, with its gudgeons or centres reſting on friction-wheels, &c. ſo as to make them turn as eaſy as poſſible. This done, a chain, webbing, ſtrap, or line, is applied on the ledge on the face of the wheel; one end of which chain, webbing, ſtrap, or line, is faſtened at the end next the roller; from thence it continues on the aforeſaid ledge round the ſpiral line, to the extremity thereof, near which it terminates, and to it is hung a certain purchaſe or counter weight, of ſize as the caſe may require. This done, near the other end of the roller, on the round part, is fixed another chain, webbing, ſtrap, or line, running the reverſe way to the one on the ledge, and hanging perpendicularly from the ſide of the roller towards the ground, to the lower end whereof is ſuſpended the weight required to be known; which ſaid weight is determined and aſcertained by means of the weight on the ſpiral ledge, which aſcends or deſcends, and

turns

turns ſo far, and to ſuch diſtance, and until the ſuſpended burden and the purchaſe-weight hang in equilibrium with each other; and as, by the burden's turning the roller, the purchaſe-weight will be raiſed or lowered, and go from, or approach near to, the centre of the roller, ſo conſequently the ſaid roller will always be turned more or leſs, in proportion to the burden applied; the weight whereof is then pointed out on a graduated circular dial, or other index, by a hand affixed to the end of one of the gudgeons, or by wheels, lines, or rods; which may be applied and connected with the aforeſaid apparatus in various other ways, taking their motion and effect from the ſpiral line aforeſaid. When this engine is to be applied to deſcribing the weight of waggons, carriages, &c. the before-deſcribed parts are to be placed—the roller directly perpendicularly over the extreme end of the main or long lever of the weighing-engine, and the end of the ſaid long lever, is then ſuſpended by the chain, webbing, ſtrap, or line, hanging down from the roller, and the weight is thereby aſcertained and deſcribed as before.

before. If immenſe weights are required to be taken in warehouſes, &c. then a large lever or ſteelyard may be fixed over my improved machine; the fulcrum of this lever is to be placed as much nearer one end than the other as the caſe may require; to the ſhorteſt end, by means of a chain or rope, is ſuſpended the burden required to be weighed, and the other or long end is, by means of a chain, webbing, ſtrap, or line, conducted to, and connected with, the aforeſaid roller, by means whereof the power on the roller is leſſened, but the effect nevertheleſs produced, and the weights pointed out. Farther, my invention is by applying the before-deſcribed parts of my engine at the top of ſtorehouſes, &c. where there are ſeveral floors, which may be ſo placed as to weigh and aſcertain the weight of goods on each floor, as well as if there were an engine on every one; and the weight of any thing ſuſpended on any particular floor will be pointed out in every one at the ſame time, whereby perſons on the bottom-floor may check and ſee the weight of goods ſuſpended and weighed on the top floor.

Befides the above-defcribed requifite parts and modes of ufing my faid engine, various other modes and changes may be made, according to the purpofes for which it may be wanted; and therefore, for the well underftanding of the intent of my faid patent, and to prevent encroachments thereon, I do particularly fpecify, that my invention particularly goes to the afcertaining and defcribing the weight of any matter or body, by means of a felf-adjufting machine, demonftrating the weight, however applied, and taking its effect by means of a fpiral line, as aforefaid; and, as the fame may be fhaped and applied in various and innumerable ways, I conceive it unneceffary to make any drawings of the fame. Farther alfo, my improvements in the conftruction of the bridges or platforms, with their apparatus, on which carriages are placed to be weighed, confifts in fixing all the centres, or points of bearing on the diagonal levers, in a direction at right angles from the faid levers; whereby the diftances of the points of bearing thereon are more accurately determined, and the operation thereby rendered more exact than on the levers now moſtly in uſe. I do alſo fix an open under-frame beneath the bridge or large ſcale, to which ſaid under-frame are fixed the iron ſtandards that reſt on the diagonal levers of the apparatus; by which improvements, the whole can be more readily fitted and fixed, and the mechanic part put to work and examined before the cumberſome ſcale or bridge comes on; which bridge may alſo by this means eaſily be taken off, repaired, or renewed, by any country carpenters, or others, without the removing or endangering the mechanic parts; and, from the frequent wear and decay of the bridges, more than any other part, this improvement will be found neceſſary and uſeful. And farther, in order for the more ready and eaſy application of theſe my aforeſaid machines, when uſed for heavy burdens, without the application of the bridge or platforms as in the caſe of weighing carriages, &c. I have found it requiſite to have ſome means of weighing up or raiſing immenſe weights to any height, ſufficient to enable the application of the ſlings or ſcale of my ſaid machine; which operation

tion I perform by means of a lever, ſo conſtructed that a ſingle man may raiſe immenſe burdens to the height required; when the burden is then ſlung, and ſuſpended to the chain, webbing, ſtrap, or line, as before deſcribed, which ſaid lever, being a requiſite inſtrument in the application of the before-deſcribed apparatus, I conſider as a part thereof. The conſtruction of it is according to the drawings and references hereunder deſcribed. In witneſs whereof, &c.

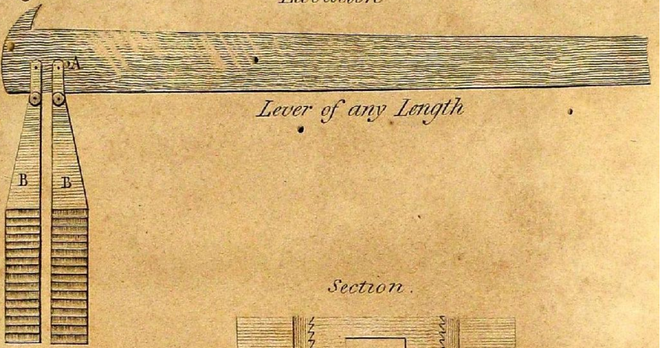
References to the Drawings of the Lever for weighing up and raiſing Weights, in order to apply them to the Weighing-Engines. (See Plate V.)

A. The lever, reſting on the fulcrums B B, which are connected together by the bearer C, and hung up to the lever by two pins, as ſhewn in the ſection.

D D are ſtrong iron racks, into which the lower parts of the fulcrums B B are forced by the ſpring F. Theſe iron racks are ſtrongly fixed to the upright poſts E E, which may be of any height, and muſt ſtand on proper ſills and bearers.

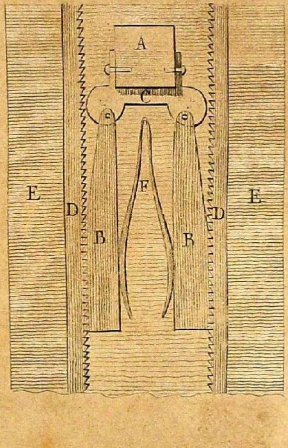
The burden to be raiſed is to be hung, by a ſtrong chain, to the hook G; and, in order to raiſe it, the end of the lever is to be worked up and down, in the manner that a pump is worked. By this operation, the fulcrums B B are alternately raiſed; and, by the ſpring forcing the teeth of the ſame into the racks D D, the ſaid lever, together with the fulcrums, is raiſed as high as may be required; and, by making the lever ſufficiently long, and adding weight thereto, any power may be acquired, with the ſtrength of one man only.

Elevation

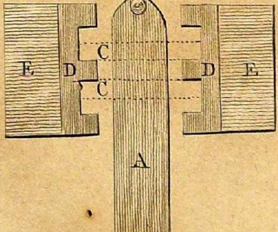


Lever of any Length

Section.



Plan



X. *Specification of the Patent granted to Mr.* James Keeling, *of Hanley, in the County of Stafford, Potter; for his Invention of a Substitute for Ceruse, commonly called White Lead, and Minium, commonly called Red Lead or Calcined Lead, or any other Preparation of Lead of the like Nature, in and about the glazing and enamelling all Manner of Cream-coloured earthen Wares, commonly called Queen's Wares, white earthen Wares, and what are commonly called China glazed Wares, and also Porcelain and China Wares of every Kind; and which is also a Substitute for the said Articles of Ceruse or White Lead, and Minium or Red Lead or calcined Lead, or any other Preparation of Lead of that Nature, in and about the making of Glass and Enamel of every Sort or Kind; and also for every Purpose for which the Article commonly called Glass of Lead was or may be used.*

Dated June 20, 1796.

TO all to whom these presents shall come, &c. Now know ye that, in compliance with the said

 proviso,

proviſo, I the ſaid James Keeling do hereby declare, that my ſaid invention is lead ore, which is to be uſed as herein after mentioned. The following is one method for making uſe of the ſame as a ſubſtitute for ceruſe or white lead, and minium or red lead or calcined lead, in making and preparing glazes; that is to ſay, take lead ore, and pulverize or grind it to a powder, or grind it with water or other liquid to a fine liquid ſtate, to which add ſuch quantities of the ſame ingredients as are uſually uſed and added to white and red lead in the preparation of glazes, and mix up the ſame in the common and uſual manner, and dip or plunge the wares or articles to be glazed in the ſaid mixture, according to the common method of dipping, to glaze the ſame. Before the wares are put into the crucible or firing-veſſel, or what is commonly called the *ſaggar*, to be fired, prepare a ſtrong waſh made of lime and water, and whitewaſh the inſide of the crucible, firing-veſſel, or ſaggar; then proceed in placing and firing the wares in the common way, only obſerving not to lute or ſtop the firing-veſſel containing the wares cloſe, as leaving ſome convenient aperture or apertures may often be found uſeful, to admit the evaporation thereout of any fumes or vapour that may ariſe from the ſaid ſubſtitute or lead ore, in the act of firing, or that may happen not to be abſorbed or taken up by the waſh. By obſerving the foregoing directions, the ſaid ſubſtitute will in general be found to anſwer the purpoſes of white and red lead, in the making of glazes for glazing the ſeveral goods and wares herein before mentioned; but the ſaid wares will be liable to be much injured and disfigured in the glaze, by the action thereon of the ſaid fumes and vapour, which will ariſe in the firing of the ſame, from the uſe of the ſaid ſubſtitute in the ſtate above mentioned; as it may frequently happen that the ſaid waſh will not abſorb the whole of the ſaid fumes and vapour, and the ſame may not have opportunity to evaporate as it ſhall ariſe from the ſaid wares, nor will the glazes prepared with the ſaid lead ore or ſubſtitute, in the ſtate above mentioned, be ſo entirely harmleſs to the workmen employed in uſing the ſame as ſuch like glazes prepared with the lead ore or ſubſtitute after it has undergone the proceſs herein after next mentioned; that is to ſay, in order to prepare the ſaid ore or ſubſtitute for uſe, inſtead of white or red lead, in making glazes for the goods and wares herein before mentioned, and alſo for enamels, glaſs, and glaſs of lead, take a quantity of lead ore, and put it into a reverberatory or other oven, kiln, or furnace, and roaſt or fire the ſame to what is uſually called a white heat, in which proceſs it will be obſerved to emit and ſend forth a conſiderable quantity of fume and vapour. Such firing muſt be kept up and continued, until ſuch fuming and vapour ceaſes and is gone; and, when the maſs has grown cool, it may be taken from the furnace or firing-place, and pulverized or ground, as herein before mentioned with reſpect to the crude lead ore; and will then be fit to be uſed, in the ſtead of white or red lead, in the making of glazes of every kind for the goods and wares herein before mentioned, and alſo for enamels of every kind; and, either with or without grinding, in the making of glaſs and glaſs of lead; and will be found to prevent the injuries and miſchiefs occaſioned to the workmen employed in the ſaid manufactures, by the uſe of white and red lead therein.

therein. And the ſaid ſubſtitute or preparation of lead ore laſt mentioned is to be added to, and uſed with, the materials heretofore made uſe of, or which may be uſed, for making glazes, enamel, glaſs, and glaſs of lead, in ſuch proportions, manner, and form, as white or red lead are or have been uſually uſed, or may be uſed therein; and the glazes and enamels ſo prepared, with the ſaid ſubſtitute, are to be made uſe of in like manner as glazes and enamels wherein white and red lead, or either of them, are or may be uſed in the common and ordinary way.

Although the ſaid ſubſtitute may be ſaid to be ſufficiently roaſted and prepared when all the fume and vapour has ſubſided, yet, as it is of importance that all the injurious qualities ſhould be thrown off in the ſaid proceſs, it would be adviſable to continue the roaſting or firing of the ſame for the ſpace of an hour or two after the vapour has viſibly ſubſided; as ſuch a continuance of the firing can be no ways injurious to the ſubſtitute or metal, and it may prevent a poſſibility of the ſaid article being ſhort-fired. In witneſs whereof, &c.

XI. *Specification of the Patent granted to Mr.* Francis Lowndes, *of St. Paul's Church-Yard, Medical Electrician; for a new-invented Machine for exercising the Joints and Muscles of the Human Body.*

WITH A PLATE.

Dated Sept. 9, 1796.

TO all to whom these presents shall come, &c. Now know ye, that I the said Francis Lowndes, in compliance with the said in-part-recited proviso, do hereby declare, that my said new invention is of the description, composed, constructed, and made, in manner and form following; that is to say, of metals simple or compounded, wood singly or conjunctly with metals, so constructed and arranged as to give and apply motion and exercise, voluntary or involuntary, to the limbs, joints, and muscles of the human body; and that their essential properties depend on the

use

uſe and application of cranks, movable or ſolid, wheels, or fly-wheels, treadles or treading-boards, and ſprings, ſo conſtructed and arranged as to produce the aforeſaid effect. And farther, that the ſhape, ſize, figure, arrangement, extenſion, abridgement, and component ſubſtance and parts of the ſaid cranks, wheels, fly-wheels, treadles or treading-boards, and ſprings, may be varied indeterminately, as occaſion may require, without in the leaſt departing from the principle or proceſs of action.

And I the ſaid Francis Lowndes do hereby farther declare, that the figure 1, in the drawing or plan hereunto annexed, (ſee Plate VI,) repreſents my ſaid invention, called the *Gymnaſticon*, or machine for muſcular exerciſe, with its cranks, wheels, fly-wheels, treadles or treading-boards, and ſprings, uncovered. The frame may be made of wood, or any other ſubſtance, and of any dimenſions or figure; its joints held together by tenons and ſcrews, or any other means moſt conducive to its ſtrength. AAAA are upright pillars or poſts, the upper and lower extremities of which are tenanted into the frames BBBB

 and

and CCCC. The frame BBBB may reſt on four or more feet, or on its own baſe. DD are two bars, which unite the front and back pillars or poſts AAAA, both with a view of giving ſtrength to the frame, and being otherwiſe uſeful in ſupporting the arms of the patient when occaſion requires. EE are treadles or treading-boards, for ſupporting the feet of the patient; their back extremities are kept in their places by hinges, or cocks and centered points, annexed to the back rail of the frame BBBB, or to the lower extremities of the back pillars or poſts AA. FF are metal cocks, inſerted into the front extremities of the treadles EE; each treadle has two, and the centered ſcrews which paſs through them embrace the croſs, or lower extremities of the treadle-lifters, GG, ſo as to admit of eaſy motion. The upper extremities or heads of the treadle-lifters GG are ſcrewed on the rods, and kept in their place by ſtop-nuts. The heads are divided into two parts, hollowed out, ſo as, when the upper parts or caps are ſcrewed down, they completely envelop the eccentric pivots of the lower cranks II, allowing free motion. II are the lower cranks, whoſe eccentricity is fixed

fixed at no particular diſtance, as they are made according to circumſtances; their extremities are pivots, fitted to run in ſockets or flanches fixed to the front poſts A A. K K are the upper cranks, which are made ſolid or movable, and whoſe eccentricity is fixed at no particular diſtances: their pivots likewiſe run in ſockets or flanches, which may be elevated or depreſſed, according to circumſtances, by ſlits or holes perforated through the ſupporting front poſts A A. L L are wooden handles, looſely put on, and are to ſupport the arms of the patient. M M are wheels, or fly-wheels, with grooves in their edges, to admit of a cord or band, to put them both in motion; they have metal ſockets or flanches in their centres, with ſquare holes, fitted to receive the ſquare ends of the upper and lower cranks, whoſe extreme terminations are tapped, and furniſhed with nuts, to keep faſt the wheels. N is a handle, to give motion to the machine, if neceſſary.

The figure 2 repreſents a ſection of a crank-rod or treadle-lifter, and treadle, detached from its ſituation. O is its divided head, with the upper diviſion or cap ſcrewed down. P is a ſpring or a ſpring-board, deſtined to give action to the joints and muſcles of the feet. The front or toe extremities of theſe ſpring-boards are held by ſprings, or cocks and centered points, fixed to each of the treadle-boards E E; their back or heel extremities are left looſe, to admit of elevation, when the ſprings are compreſſed (by the floor or any other means employed) by the deſcent of the treadles E E.

The figure 3 repreſents a ſection of an upper ſocket or flanch for ſupporting the upper cranks K K, and the manner of attaching them to the front poſts A A. In witneſs whereof, &c.

Fig. 1

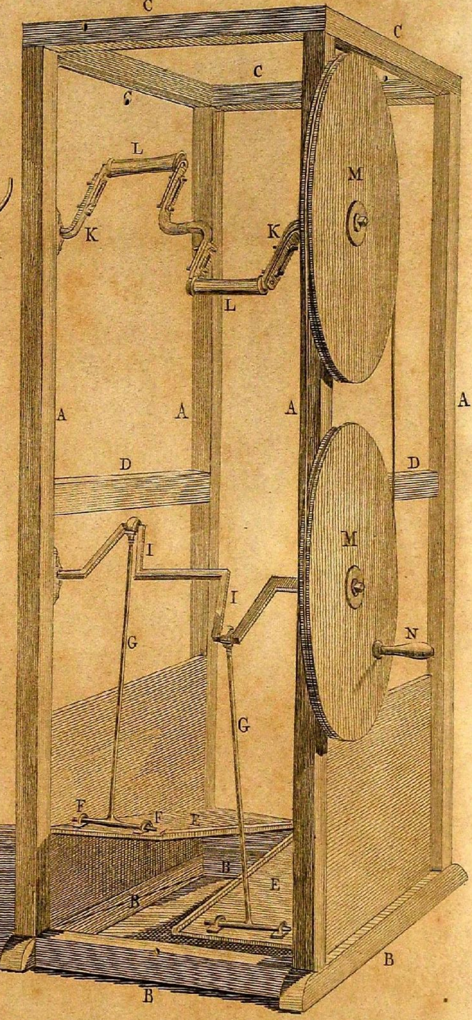


Fig. 2.

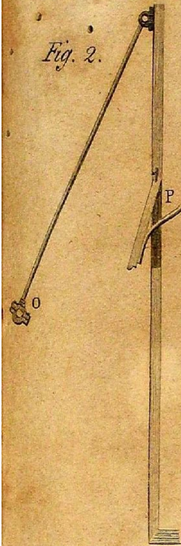
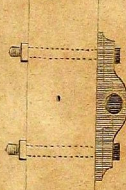


Fig. 3.



XII. *Specification of the Patent granted to Mr.* WALTER TAYLOR, *of Southampton, Block-maker; for his Invention of a great Improvement in the Conſtruction of Shivers or Pulleys for Ships' Blocks, which are better adapted for the Rigging of Ships, and other Purchaſes, than any now in uſe; part of which ſaid Invention will be of uſe for Boxes of Wheel-Carriages of all Kinds.*

Dated June 5, 1781.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Walter Taylor, in compliance with the ſaid proviſo, do hereby deſcribe and aſcertain the nature of my invention, and the manner in which the ſame is to be performed, in manner and form following; that is to ſay, Firſt, as to the planking ſhivers with lignum vitæ; *videlicet*, to buſh, box, coque, or plate all kind of ſhivers or pulleys, made of any kind of wood whatſoever, with lignum-vitæ plank, or

pieces

pieces of plank, let in on each ſide of the ſhivers, to croſs each other, ſo as it ſhall wear on the pin-head or endway of the grain, inſtead of any kind of metal; which kind of buſhes, boxes, or coques, not only ſtrengthen the ſhivers or pulleys, but wear much better and longer than when the ſhivers run on the pin-flat or ſideway of the grain, as is now practiſed; and, by various experiments, it has been found that they wear better than coques now in uſe, and with leſs noiſe, and leſs friction.

Secondly, as to planking ſhivers with other wood; *videlicet*, ſhivers or other pulleys for common uſe, where leſs purchaſe is required, and made of any kind of wood, as above mentioned, may be buſhed, boxed, coqued, or plated with pieces of plank of yew-tree, box, holly, and ſeveral other kinds of wood, ſo as it is fixed with the ſhivers or pulleys to wear on the pin-head or endway of the grain, as before mentioned.

Thirdly, to make old ſhivers ſerve again, which was never before practiſed; *videlicet*, when lignum-vitæ or other ſhivers are worn out at the centre, they may be made ſerviceable again, the

ſame

ſame as new, by new buſhing, boxing, coquing, or plating them, in the manner before mentioned.

Fourthly, with reſpect to all the above improvements; *videlicet*, all the buſhing, boxing, coquing, or plating made of lignum vitæ, or other wood, is faſtened in the ſhivers with ſcrews, or rivets.

Fifthly, as to boiling Engliſh wood ſhivers in oil, or ſalt water; *videlicet*, ſhivers or pulleys made of Engliſh wood, being liable to be affected by the weather, may be rendered more ſerviceable by being boiled or ſoaked in oil, or ſalt water.

Sixthly, as to the rim or groove in metal ſhivers; *videlicet*, the new invention to make ſhivers or pulleys of caſt iron, braſs, or any other kind of metal, as follows; the rim or groove part of the ſhivers is to be made of caſt iron, braſs, or any other metal, and the ſhivers are to have ſpokes of lignum vitæ, or any other kind of wood, croſſed at the centre, and faſtened to the ſaid rims or grooves with ſcrews, or rivets; which ſpokes may either be coqued with metal or iron at the centre, or fixed ſo as the lignum-vitæ or other wood

ſpokes

ſpokes ſhall wear or run head or endway of the grain. The ſhivers or pulleys with rims or grooves of caſt iron or metal may have new ſpokes fixed to them, when the old ones are worn out, and will do again the ſame as new ones, which has never before been practiſed.

Seventhly, as to plates of metal in wood ſhivers; *videlicet*, ſhivers buſhed, boxed, coqued, or plated with wood, as before deſcribed, and ſhivers or pulleys of caſt iron, braſs, or other metal, made as before deſcribed, intended to have great ſtrains or heavy purchaſes, may have plates of iron, braſs, or other metal, fixed on each ſide at the centre, to be ſcrewed or riveted in ſuch a manner as to jam the wood between the ſaid plates, and thereby render the ſhivers more ſecure.

Eighthly, as to the improvements in boxes of wheels for carriages of all kinds; the boxes for wheel carriages are to be made of lignum vitæ, or other wood, to wear or run on the axle-tree head or endway of the grain. In witneſs whereof, &c.

XIII.

XIII. *Additional Obſervations on the Management of Orchards* *. *By* THOMAS SKIP DYOT BUCKNALL, *Eſq. M. P. of Hampton Court.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

IT is generally imagined that, when the trees are planted, the troubleſome part of forming an orchard is over; but the fact is far otherwiſe, for a greater difficulty remains, which is, to determine what proper uſe to apply the ground to. If it is cultivated by the plough, little good can be expected; for, the injuries which young trees conſtantly receive from implements in huſbandry, bruiſing and deſtroying them before they can have got full poſſeſſion of the ſoil, generally hurts

* For Mr. Bucknall's former obſervations on this ſubject, ſee our firſt volume, page 25, and our third volume, page 31.

them moſt eſſentially; and if, by a ſuperlative care, they ſhould ſurmount the evils ſo brought on, the crops of corn being regularly carried off the land impoveriſhes the ground ſo much, that the trees are ſoon ſtinted, and run to moſs.

There is not any culture we are acquainted with, equal to hops, for raiſing an orchard; and, when the proper time comes for grubbing up the hops, the trees may be ſecured, and the land turned to grazing. However, let the agriculture be what it may, the land ſhould never be ploughed, or dug deep, directly over the roots of a young-planted fruit-tree; for, as the roots collect their beſt benign ſap from their extreme points, if thoſe points are broken off from the upper ſide of the roots, that tree is compelled to ſubſiſt on nurture drawn from the under ſtrata, and conſequently the ſap will be of an inferior quality.

It may be regularly obſerved, that, where trees ſtand in ſuch a ſituation that the hogs and poultry are conſtantly running over the ground, thoſe trees very ſeldom fail of a crop, which is the beſt proof that manure is neceſſary, and any manure will ſuit an orchard; but there are ſeveral ſorts of

manure

manure which are overlooked, ſuch as the ſweepings of cow-houſes and ſlaughter-houſes, emptying of drains, and every thing filthy; and theſe are more diſpoſed to facilitate the growth and health of fruit-trees, than the manure from the ſtable.

An eſſential circumſtance to be attended to is, that the fruits be ordered of thoſe ſorts which thrive in the neighbourhood where the plantation is intended to be made, and a ſtrict regard ſhewn to that purpoſe, as the beauty and value of the whole orchard will greatly depend upon the trees being well ſuited. There is a ſtriking inſtance of this at Sittingbourne and its neighbourhood: the lemon-pippin is invariably a fine thriving tree, and the ſummer pearmain as conſtantly ragged and out of health; and this obſervation may be applied throughout the whole range of fruit-bearing trees, according to the ſoil and ſituation.

The ancient orchards of Kent, which were moſtly grubbed up about fifty years ſince, produced the Kentiſh pippin, lemon-pippin, ruſſet, cat's head, and other hardy keeping fruits; but, as the age refined in luxury, the more delicate apples were introduced. The ſharp north-eaſt winds, in many ſituations, were certainly too ſevere for theſe productions; though I entertain no doubt but this appearance of a caprice or particularity in nature may, by attention, be in part corrected; but any attempt to point out the cauſe would lead me too far from the preſent ſubject.

Care ſhould be taken, not to ſuffer trees to bear much fruit while young: it ſhould be gathered as ſoon as ſeen, except about half a dozen, to ſhew the ſize and quality. The young trees being kept clear will give them, if I may uſe the expreſſion, the habit of producing larger and finer fruit, but that is not the material reaſon; by being kept clear, the leading and collateral branches run ſtronger each year, and, be aſſured, if the tree can be brought to a proper ſize, there will be no doubt of its bearing afterwards. Obſerve thoſe gentlemen who pride themſelves for being maſters of fine ſtock, either horſes, cattle, or ſheep, and you will find the governing principle, with each of them, is to run the young ſtock to as *long bone* as poſſible in the firſt year; knowing, from experience, that, having once ſecured bone, fleſh, figure, and ſymmetry, will follow. Such trees as ſuit the ſoil may, by eaſy means, be induced to grow to a ſize beyond what we imagine: let the land be grazed or manured, and gather the fruit before it can be applied to any uſe. How long this cuſtom ſhould be continued, each orchardiſt muſt judge for himſelf; but no one will have the leaſt chance for the prize, who does not take off the fruit, for ſome time at leaſt.

There is no impropriety in deeming the heads of fruit-trees ſo many hemiſpheres: only ſuppoſe it poſſible, by any art, to induce each of the branches of one tree to grow two inches longer than thoſe of another tree, in the ſame year, that free-growing tree will, in eighteen years, double the head of the other: ſo much for ſize. Health is the certain conſequence.

No young-planted, or newly-engrafted tree, ſhould be ſuffered to run *mop-headed*; for, until each branch has acquired a determined leader, that tree will make no progreſs; and if a tree, like an animal, takes a ſtint, it is difficult to

throw

throw ſuch energy into the ſyſtem afterwards as will make it free-growing.

It has been objected, that, if no leading branches are to be ſhortened, the nurſery-man could not form the ſtems to ſupport the head.

Undoubtedly, while the plants are in the nurſery, the ſlighteſt practitioner knows that the head muſt be cut down, to give ſtrength and ſymmetry to the ſtem: it is alſo neceſſary that moſt of the grafts be ſhortened, or the wind will blow them out; and, during the time the plants are in an infant ſtate, ſhortening helps to ſwell out the buds. It was never meant to exclude ſhortening, until the plant was become a tree; and it is perfectly within the nurſery-man's art, to produce all his ſtandard fruit-bearing trees with ſtems large and ſmooth, buds full and round, and leaves broad and open, without the tree being much liable to canker, or gum; and this is given as the character of a perfect and valuable tree.

Moſs.

One of the greateſt obſtructions to good orcharding is moſs, which is merely the reſult of poverty and neglect, reflecting a diſcredit on the owner. Where trees are much overrun with moſs, a ſtrong man, with a good birch-broom, in a wet day, would do great execution. But, to enter more into the buſineſs, what is moſs? a plant, and, like other plants, may be eradicated on the firſt appearance: for that purpoſe, on young trees, the beſt method is, to rub all the branches, ſpring and autumn, with a hard ſcrubbing-bruſh and ſoap-ſuds; and the action of rubbing will ſo far invigorate the tree, as to overpay both trouble and expence. There is no damage can befal the tree from rubbing; and let it be performed as a groom does a horſe's legs. Others uſe oil, which gives a fine ſmoothneſs to the bark.

Certainly, the beſt ſoil to plant on is a fine deep loam; and no one, for profit, would think of planting on a ſtrong clay, chalk, or a cold ſharp gravel: but, where a gentleman, for the embelliſhment of his reſidence, would wiſh for an or-

chard

chard on either of thefe foils, never dig into the under-ftrata; for, that would be placing the trees in fo many well-holes, where certain deftruction muft enfue: therefore, rather plant the trees above ground, raifing over it a little mound of good frefh mould, about as large as an extenfive ant-hill, under a curve of eight inches by fixty, and fow the top with white Dutch clover.

Canker.

In pruning, the medication ought never to be omitted; for, from experience, the mercury is found to be fo ftrongly operative in removing the baneful effects of canker, in the more delicate fruit-trees, that it may be prefumed to enter into the œconomy of the plant, giving a fmoothnefs to the bark, and freenefs of growth; proofs of which will be produced to the Society, in a few years, by perfons who have attentively confidered the fubject.

I fhall here give an abftract of the fyftem of clofe-pruning and medication, as before laid down, that it may be feen at one point of view.

Let

Let every ſtump, the decayed or blighted branches, with all thoſe which croſs the tree, or where the leaves curl, be taken off cloſe, ſmooth, and even; pare down the gum cloſe to the bark, and rather a little within, but not to deſtroy the rough coat; open the fiſſures, out of which the gum oozes, to the bottom; cut away the blotches, and pare down the canker; then anoint all the wounds with the medication, ſmearing a little over the canker which was not large enough to be cut; ſcore the tree, and rub off the moſs; but do not ſhorten a ſingle branch; follow the ſurgeon's rule, go to the quick, and no more; act with obſervation, and each practitioner will improve the ſcience.

A tree under ſuch care muſt, with its remaining free ſhoots, run large, which, requiring a great flow of ſap, will keep the roots in conſtant employ, and from that very ſource neceſſarily eſtabliſh permannet health.

Canker ariſes, in great meaſure, from ſmall inſects, ſomething like the cochineal fly, and, where the only object is to remove it, I find hog's lard preferable to tar; but, where the wet is to be guarded againſt, tar is ſuperlatively better.

XIV. *Deſcription of an accurate Method of bevelling Wheels, by Means of a ſimple Inſtrument. By* Mr. WILLIAM KELLY, *of New Lanerk Cotton-Mills.*

WITH A PLATE.

Fig. 1. (Plate VII.) repreſents the inſtrument for bevelling wheels, which may properly be called a quadrant: the graduated ſcale F B being the fourth part of a circle, and divided into 90 degrees from F to B. A C B and D C E are the limbs of the quadrant, which move on the centre at C. The edges of the limbs A C B and D C E are each in a right line, and interſect each other exactly at the centre C, in order that the angles A C D and E C B may be equal.

The ſcale is attached to the end of the limb B, and ſlides through the end of the other limb at E, in in a dovetail, to which it can be fixed at pleasure by a small screw.

Bevelled wheels are generally such as run or work one into another; the one in a horizontal, and the other in a vertical situation, or, whose axes are at right angles to each other; as the two wheels in Figs. 2 and 3.

The bevels of the two wheels, running as above, are found by drawing a right line from the point B, (Fig. 2.) or *b*, (Fig. 3.) where the centre-line of the axes intersect each other, (and which may be properly called their common centre of motion, to which all the teeth in both wheels must point,) to the extremity of the circumferences where the two wheels meet, as B D, and *b a*.

In Fig. 2, where the two wheels have the same diameters, and the axes are at right angles, the bevel of the wheels, described by the line D B, will be equal each to an angle of 45 degrees, or half a right angle; for the sides and angles D, E, B, A, are equal; therefore the diagonal, or line D B, divides the right angles A D E and E B A into two equal parts.

The degree of bevel then is expressed by the angles described by the centre-line of the axis of the wheel, and the bevel line of the teeth D B falling upon it.

In Fig. 3, the wheel *a c e* is twice the diameter of that marked *a d f*: to find their respective bevels, from the point *b*, where the centre-line of the axes intersect each other, draw the line *b a* to the extremity of the wheels at *g*, as already noticed, which divides the parallelogram *c a d b* into two equal parts. But the base *a c*, of the angle *c b a*, is double the base *a d*, of the angle *d b a*; consequently the bevel of the large wheel *a c e* is double the bevel of the small one *a d f*: therefore, the bevels of wheels are, to one another, as the difference of their diameters.

To ascertain then the bevels of any two wheels that are intended to pitch or run into each other, it is only necessary to know their diameters, or what is the number of teeth in each: then say, as the sum of their diameters, or teeth, is to 90 degrees, so is the diameter, or teeth, of each wheel, to its respective angle or bevel. Suppose, for example, one wheel of 40, and another of

20

20 teeth; then, as $40+20=60 : 90 :: 40 : 60$. Again, as $60 : 90 :: 20 : 30$. The bevel of the wheel of 40 teeth then, by the above, is equal, to an angle of 60°, and the other of 30°; which, added together, is $=90°$. Or, having found the complement of one of the wheels, as above, ſubtract that from 90, and the remainder will be the complement of the bevel of the other. Where the axes of the wheels make either a greater or a ſmaller angle than 90, take the complement of the angle which they deſcribe for the middle term, in place of 90, and proceed, in finding the reſpective bevels of the wheels, as above.

To uſe the Inſtrument. Having found the bevel of the wheel of 40 teeth to be equal to an angle of 60 degrees, move the under edge of the limb E of the quadrant (Fig. 1.) to 60 on the ſcale, and then apply the upper edge of the limb D, to the under part or *ſole* of the wheel at X, Fig. 2, and the inner edge of the other limb A will deſcribe the bevel that the wheel muſt be worked or formed to. Then, for the wheel of 20 teeth, ſet the quadrant to an angle of 30°, and proceed in like manner with it, and ſo on for any other

bevel.

bevel. The bevel may alſo be expreſſed by the angle deſcribed by the *ſole* or under part of the wheel and the line of the bevel of the teeth, as XCB, Fig. 2.; in which caſe the bevels of two wheels, ſo expreſſed, will be to one another, in the inverſe proportion of their diameters; and the quadrant will equally apply to the above-mentioned purpoſe, by dividing the ſcale the contrary way to that in the drawing.

The inſtrument here deſcribed and the manner of uſing it are ſo very ſimple, that almoſt any mechanic, employed in machinery, may both make and uſe it.

The inſtrument may be made either of wood or of metal; and will be found particularly uſeful in bevelling ſmall metal wheels, where the apparatus commonly uſed in bevelling large wheels cannot be applied.

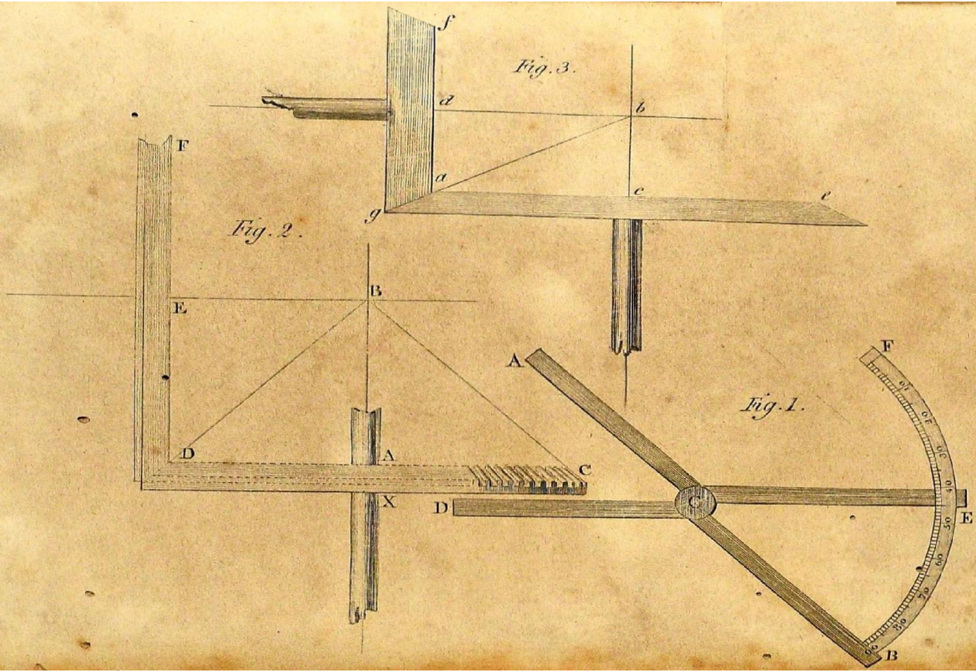


Fig. 3.
f
d
b
a
c
e
g
Fig. 2.
F
B
E
D
A
C
X
D
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E
F
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Fig. 1.
10
20
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70
80
90

XV. *Description of a movable Barn-Floor; invented by Mr.* John Upton, *of Petworth, Sussex.*

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

A Bounty of Thirty Guineas was voted to Mr. Upton for this Invention.

THE heavy and continual expences attending barn-floors, and the great consumption of valuable timber in the construction of them, has always been very injurious to the landed interest of the kingdom; and the great waste of corn in threshing upon them, as soon as they begin to decay, has ever been a heavy loss to the tenants and to the public; it was therefore very desirable that some new plan should be discovered, less wasteful, and more durable.

Mr.

Mr. John Upton, of Petworth, in Suffex, has conftructed a barn-floor in that neighbourhood, which he hopes will accomplifh both thofe objects. The barn-floors now in common ufe confume the large and valuable oak-timber, often fuch as might be converted into two-and-a-half-inch fhip-plank; and which is, at this time, very difficult to be procured at any price. They laft only from fifteen to twenty years; and, as they are fubject to frequent injuries, from the exertions of the horfes in drawing loaded waggons into the barn, they require frequent repairs; and, if one plank fails, it cannot be effectually repaired, without taking up all the planks from the door to the part which has given way. Hollow beech-floors, which were introduced a few years fince, on account of the very high price of oak-timber, are found not to wear more than feven or eight years, and confequently do not anfwer. Hollow floors, whether of oak or beech, are much better to threfh on than thofe laid on the ground; and, as the planks of the propofed floors are much thinner than thofe in prefent ufe, the vibration is ftronger, and confequently the corn more thoroughly

roughly threſhed out than on the common hollow floors.

The propoſed barn-floor effectually prevents a waſte of corn in threſhing. It gives an addition of at leaſt one foot in height at the doors, by which means a higher load of corn can be admitted; and alſo, as the horſes do not draw the waggon up an aſcent, and upon a ſlippery floor, but upon a hard bottom, and level with the farm-yard, two horſes can perform the work, where four are now generally uſed. It affords a warm and convenient ſhelter for hogs, when it is down; and, when it is turned up, it may be uſed as a ſtable, ox-ſtall, hovel, or cart-houſe. Two men can place or diſplace it in five minutes; and, from its allowing at all times an eaſy acceſs to dogs and cats under it, it affords no harbour for vermin.

The following are ſtatements of the materials uſed, and the expence of the barn-floors, reſpectively.

Barn-Floors now in common Uſe.

	£.	s.
The original floor, laid on the ground, with three ſills, and two-inch oak-plank, which in general laſts from fifteen to twenty years, - -	19	10
The hollow floors, on brick quoins, with two-and-a-half-inch oak-plank,	31	10

Mr. Upton's Barn-Floor.

	£.	s.
The new-conſtructed hollow floor is compoſed of oak-plank, five feet eight inches in length, and one inch and a half thick; whereas three-fourths of the planks uſed in the original floors are fourteen feet in length, - - - -	23	10

The

The plank for the laſt-mentioned floor may be compoſed of deal, beech, or elm, as they will be perfectly free from decay by damps, which will conſiderably leſſen the expence of this new-conſtructed floor. The eſtimates are made when the materials are ſupplied by a carpenter: when they are furniſhed from the eſtate, a very conſiderable farther advantage ariſes to the landlord, as the new-conſtructed floor is compoſed of ſmall ſcantlings, which may be had from ſhort timbers, much inferior in value to thoſe uſed for the other floors.

When there is more than one barn in a farm-yard, this floor may be farther uſeful; as it may be removed from one barn to another, and ſave the expence of at leaſt one out of three.

It is ſuppoſed, that a floor conſtructed in this manner will laſt for a hundred years, or indeed as long as the barn; becauſe it is perfectly free from damps, on account of the diſtance at which it lies above the ground, with a free current of air paſſing under it when down; and, when it is turned up, (which it probably will be at leaſt half the year,) it will be as free from decay as the poſts or beams of the barn.

REFERENCES to the Plate of Mr. Upton's Barn-Floor, one part of which ſhews the Floor laid down for threſhing on; the other, the part raiſed up, with racks for feeding Cattle, &c.

A A. (Plate VIII.) Rack-boards.

B B. Slip-boards, to admit air.

C. Wooden door-ſill, for the ſlip-board B to reſt on.

D D. Movable floors, to one part of which are wooden legs, ſerving to ſupport it, when it is neceſſary to put the diſplaced timber into the receſs E.

E. Receſs to receive the threſhed corn before it is winnowed, or to hold the movable timbers.

F. An iron hook to lift up the floor, when not uſed for threſhing on; there are two of theſe hooks uſed in the barn at large.

G. Movable timbers, which ſupport the floor, having grooves along their ſurfaces, to prevent the loſs of corn: two of theſe timbers are ſhewn larger at *g*, *g*; one being the croſs-piece, with a

leg

leg and a tenon for fixing in the ſtone mortice, the other deſigned to lie lengthwiſe, and level with the floor of the barn. In the ground are fixed ſtones, with mortices in them, to receive the tenons of the above-mentioned timbers, but which could not be expreſſed in the plate.

H. The ground, which ſhould be made of materials ſufficiently hard to prevent the horſes or waggon making impreſſion thereon.

I I. Poſts with iron haſps, to ſupport the floors when out of uſe.

K K K. Racks to feed cattle, when the barn is applied to other purpoſes than threſhing on.

When the Floor is not wanted for threſhing on.

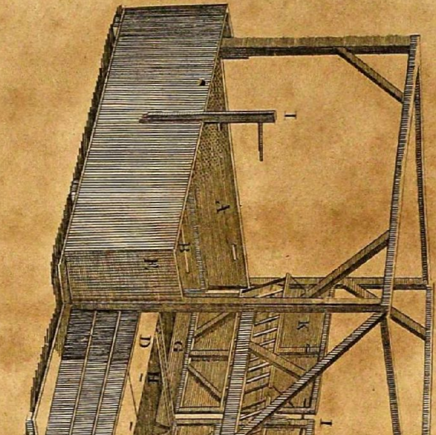
Firſt turn up the floors, and fix them faſt with the iron pins, bolts, and haſps; then take out the middle timbers; next, the croſs timbers: place them on the ground, on that ſide which is oppoſite to the receſs, where the timbers are to be depoſited when out of uſe; then let down that part of the floor which has legs to ſupport it; put the timbers into the receſs; and turn the floor up again.

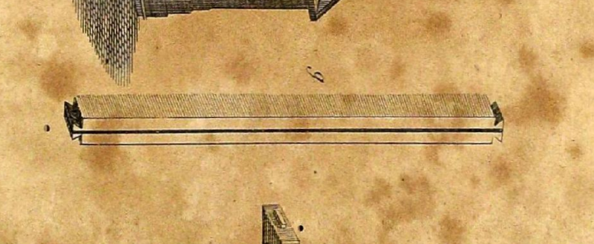
An-

Annexed to the foregoing account is a certificate, ſigned William Knight and Thomas Holt, ſtating that Mr. Upton's barn-floor exceeds every thing they have ſeen of its kind, particularly in threſhing, as its vibration aſſiſts the threſher beyond conception.

There is alſo a letter from Lord Egremont, who ſays that, beſides the advantages already enumerated, every ſtroke of the flail upon the new barn-floor reſounds ſo much, that it may be heard for a mile round; ſo that the farmer, when on any part of his grounds, can tell whether his men in the barn are working or idle.

XVI.





XVI. *Observations on the Advantages of planting Waste-Lands.* *By* THOMAS RICHARDSON, *Esq.*

From the MEMOIRS of the LITERARY and PHILOSOPHICAL SOCIETY of MANCHESTER.

IT has frequently been matter of concern to me, in travelling through different parts of the kingdom, to observe the decrease of timber-trees in almost every county, whilst many large tracts of land, very suitable to the growth of wood, remain in a wild uncultivated state, of no use to their owners, and indeed unfit for any other purpose than that of planting: of this kind may be fairly estimated one eighth part of the kingdom. Why these lands should remain in this unprofitable, comfortless, and disgraceful state to the owners, when they might be so easily converted into scenes of picturesque beauty, and yield so much benefit to the proprietors, is a circumstance

I have frequently been at a loſs to account for. To the enquiries I have made on this ſubject, the moſt general anſwer has been, "that wood would "not grow on ſuch land." But I am led to conjecture the true cauſe to be, that the expence is *immediate*, and the profit *at a diſtance.* This doubtleſs has appeared, at the firſt view, to many, a ſufficient bar to improvements of this kind; yet, I truſt, a fair and candid enquiry into facts, with the obſervations I ſhall adduce, on different plantations within my own knowledge, will ſufficiently demonſtrate, that a man may, within the compaſs of his own life, (if he begin to plant early,) reap the reward of his labour, and alſo enjoy the pleaſing reflection of the advantages he is preparing for his children, by this rational and amuſing employment, as well as the benefit and agreeable ſcenery the country will receive from ſo laudable an undertaking.

There are three kinds of land generally deemed unfavourable for the purpoſes of cultivation; and experience has proved, in moſt inſtances, that although more pains, labour, and expence have been beſtowed in endeavouring to cultivate and improve

improve ſuch lands, than they could poſſibly have repaid if the attempt had been ſucceſsful, the attempt was fruitleſs, and the money thrown away; whilſt, with a fourth part of the expence in planting, the advantages would have been certain, and the profits have taken place at an earlier period, and in a much greater degree, than could have been hoped for by any method of cultivation.

Theſe three kinds of land are included under the following heads:

I. Boggy wet lands, which, from their ſituation and nature, cannot be drained, without an expence far beyond any probable advantages to be derived from their cultivation.

II. Sterile hungry land.

III. Barren rocky hills.

Any perſon, who has attentively viewed this country, muſt have perceived, that lands of this deſcription form fully as great a portion of the whole land of the kingdom as I have eſtimated. To this may be added, that there are few eſtates where there are not ſeveral parts, either from ſituation or aſpect, of ſmall value for grazing, or the plough;

plough; which, by planting, might be turned to much advantage, by affording warmth and ſhelter to the cattle, keeping the bleak winds from the land, and ſupplying the farms with ſtore of wood for fuel, fencing, and all the various uſes for which it is perpetually demanded; and the eventual profit would be certain, from the growth of excellent timbet-trees, ſelected from the choiceſt and moſt valuable part of the plantation.

I ſhall confine myſelf, in the obſervations I have to offer, to the three kinds of land ſpecified, (which, being generally deemed barren, are not of the annual value of ſixpence an acre to the owners,) and endeavonr to prove the utility of applying ſuch lands to the purpoſes I ſhall afterwards mention.

And firſt, of the wet lands, and the trees beſt adapted for ſuch places.

I ſhall begin with the Alder, which thrives wonderfully in ſwampy ground, and there are few trees of greater general utility; but it is more particularly valuable in this neighbourhood, (Mancheſter,) where its uſes are ſo various as to adapt it to an almoſt endleſs variety of of purpoſes. The *wood* of this tree is in great eſteem and demand for machinery; the cogs for mill-wheels formed of it being proved, by experience, to be ſuperior to any other. It is commonly uſed for bobbins; and the country people wear ſhoes, or, as they are uſually termed, clogs made of it. Its excellent quality of reſiſting injury from water is univerſally acknowledged; hence its great value for pump-trees, pipes, drains, conduits to reſervoirs, piles under water, and all kinds of wood-work which is kept conſtantly wet. The pipes which are laid under the ſtreets of moſt large towns, to convey the water, are generally of alder; and indeed, in all works of the ſame nature, where it can be procured in ſufficient quantity, it is preferred to every other wood. But, it is much to be lamented, that the valuable properties of its *bark* ſhould be ſo little known, that in moſt inſtances it is buried with the tree. The black dyers of cotton ſtuffs know its value, and make much uſe of it; they purchaſe it at the rate of ſeven to eight pence the ſtone, laid down at their dye-houſes. It is not chopped, but ſold as it is ſtripped from the tree, after it has become moderately dry; ſo that there is no expence in chopping and cleaning it, as is the caſe with oak-bark. It might be uſed, to great advantage, as an excellent ſubſtitute for many woods uſed in dying, which we have from abroad, and on which we expend conſiderable ſums *.

* The *Koreki*, a ſavage nation inhabiting the borders of "Ruſſia, uſe deer-ſkins and dog-ſkins for their clothing, "which they dye with alder-bark reduced to a fine powder. "But their ſeal-ſkins, on which they ſet a higher value, they "dye in a nicer manner.

"They firſt clean off the hair, which they do very dex-"terouſly, by means of ſharp ſtones. They then ſew up the "ſkin in the form of a bag, turning the hairy ſide outward; in "this bag they pour a ſtrong decoction of alder-bark, leaving "it in this ſituation for ſome days; after which they hang it "upon a tree, and beat it with ſticks, until the colour has "penetrated quite through the ſkin, ſo as to tinge it equally "throughout. They then rip open the bag, and, ſtretching "out the ſkin, leave it in the air until it is quite dry; after "which they rub it with their hands till it becomes ſoft, "and fit for uſe. They alſo dye the hair of their ſeal-ſkins a "fine bright red colour, with a decoction of red whortle-ber-"ries, alder-bark, alum, and *lac lunæ*." *Muſeum Ruſticum*.

A friend

A friend of min, had a small piece of marshy ground, the produce of which never brought him a shilling for many years. He had some thoughts of draining, and endeavouring to improve it for meadow-land, (the situation being favourable,) but on my recommendation he planted it with alders. The extent of it was something less than an acre, and the whole expence of planting cost him no more than twenty shillings; the plants did not cost any thing. He had some land overrun with young seedlings; two men were employed, who drew them, and planted the whole in one week. In five years he cut them over, taking down every third or fourth plant, and thinning them judiciously, to afford room for the most thriving trees to expand in. These poles produced him fifty shillings, and the loppings for fuel more than repaid the expence of cutting down. In six years more, they were grown so strong and large, that he was under the necessity of taking down half of the remainder: these were of course the weakest trees; they produced, in bark and wood, 8*l.* 14*s.* The cord-wood became now so considerable as to be worth infinitely more than the expence of fall-

ing

ing and peeling, as many of the branches were fit for ſtakes for fencing, and other purpoſes. It is three years ſince the laſt falling; and the reſt, on a moderate calculation lately made, have been eſtimated at 13*l.* excluſive of the young poles or ſhoots. Thus, in fourteen years from the planting a piece of ſwamp, rather leſs than an acre, which had never before been productive to the owner, there have been already received eleven pounds four ſhillings; and timber is now ſtanding to the eſtimate of 13*l.* more; in all, 24*l.* 4*s.* or 1*l.* 14*s.* 7*d.* yearly. But theſe are not all the advantages reſulting from this plantation; for, the leaves fall in ſuch abundance each year, that they have added a tolerable ſoil, productive of a coarſe graſs, which, being cut with the ſickle in ſummer, is uſed as fodder for the young cattle within the houſe, during the heat of the day. I ought to obſerve, that, in this eſtimate, no account is taken of the expence of that very neceſſary article to all plantations, fencing, the ground having been already encloſed. But, on the other hand, it muſt be remarked, that I have ſtated the profits of the plantation to its extent of fourteen years only; and

that,

that, from the progressive state of its improvement, and the increased value which growing-wood annually acquires after a certain age, it cannot be doubted but, in the next seven years, it will at least equal the value of the preceding fourteen years; particularly when it is considered, that the shoots from the former cuttings, nine years ago, are now sprung up into poles, which are very numerous, and much larger than the parent plants were when cut down: the second cuttings are also in a proportionate state of increase.

The Willow will also grow luxuriantly in marshy ground; and produce great and lasting profit.

There are many species of this genus, all admirably adapted to various purposes; but, on the whole, I would recommend to the planter the three following, as entitled to a preference.

The White Willow (*Salix alba*).

The Sallow (*Salix caprea*).

And the Ozier (*Salix viminalis*).

These three are in the greatest esteem; and applicable to every use for which trees of this genus are commonly employed.

Of the White Willow I recollect a ſmall plantation being made, on a ſwampy piece of ground, in the year 1761, which grew ſo admirably, that the faireſt and beſt trees were cut down in 1786. One of theſe, which I meaſured, was, at five feet from the ground, ſix feet five inches, and, at the length of thirty-two feet, four feet ſeven inches, in circumference. There remained ſtanding about ninety of the ſmalleſt trees, which were then thought unfit for cutting, having been robbed of their growth by the ſhade of the others. I meaſured the beſt of theſe trees at the time the others were cut down, viz, in 1786: it was only three feet ten inches in circumference, at ſix feet from the ground. I again meaſured this tree in 1793, at the ſame height, and it was no more than four feet four inches.

I mention this circumſtance, to ſhew the ſlow progreſs made by this tree in the laſt ſeven years, compared with its growth in the former twenty-five years, under the diſadvantage of being choaked and crouded by its more luxuriant and lofty neighbours; a fact affording full proof of the quick attainment of theſe trees to perfection.

The

The wood, from its peculiar whiteness, is in high estimation; and bears a good price for butter-firkins, milk-pails, casks for liquors, boards for flooring, chests, boxes, and various kinds of husbandry; it is also excellent for the tilts and sides of waggons, being very light, and yet exceedingly tough and pliable.

The Sallow is a very quick-growing tree; and extremely useful where new enclosures are to be made, either for the improvement of land, or raising plantations, as it makes good stakes for hurdles.

I cut down one of these trees * in the winter, five years ago, from the stool of which, in the

* From the bark of this plant, in its green state, in the year 1788, were made at Mill-Bank, near Warrington, fifteen reams of strong paper. It appears, from the testimony of Mr. Greaves, the maker, that the paper made from ropes is sold at eight shillings and sixpence the ream; but that paper made from the bark of the Willow may be sold, with equal profit, at five shillings and eight-pence the ream; and that pasteboard for book-backs, made from ropes, is sold at twenty-five pounds *per* ton, long weight, of one hundred and twenty pounds to the hundred; but pasteboard of the same thickness, made from willow-bark, may be sold at seventeen pounds *per* ton.

following autumn, a numerous offspring had arisen, some of which had shot out to the amazing height of ten feet. In the spring of the present year, (1793,) having occasion for some hurdles, to protect a young hedge of hawthorn just planted, I cut down these shoots for stakes; they were something too slender, but answered the purpose tolerably well. No wood burns clearer, with a brighter flame, or for a greater length of time, than the sallow; it is even preferable, in this respect, to the beech; it emits little smoke, and is extremely sweet and wholesome.

TO BE CONCLUDED IN OUR NEXT.

XVII.

XVII. *Conclusion of M.* Bullion's *Memoir on procuring Saltpetre from the Earths which contain it, and on making Gunpowder.*

(From Page 59.)

Of Charcoal.

THE best kinds of wood for making charcoal are those which are of a soft texture; such as Willow, Lime, Hazel, Buckthorn, and, above all, the Berry-bearing Alder, *(Rhamnus Frangula;)* this last is preferable to any of the others; the charcoal produced from it is softer, and more easily reduced into an impalpable powder, consequently it is more capable of being intimately united with sulphur and saltpetre. To make charcoal, in the large way, from any of the woods above mentioned, they should have their bark taken off, and then be well dried: the best time for performing these operations is, when the tree is full of sap, as in the months of May and June. The branches are afterwards to be cut into pieces, of the

 length

length of common charcoal, which are to be burnt in the usual way. If a small quantity only of this charcoal is to be made, the wood, after being deprived of its bark, and dried, is to be split and cut into thin pieces, of only three or four inches in length. It is then to be enclosed in earthen pots, large or small, the cover of which is to be luted with clay, so that no air can get into them. These pots are to be encompassed with live coals; which are to be kept burning, with an equal degree of heat, for the space of an hour. The charcoal is not to be taken out of the pots till they are grown cold; it will then be found to be completely charred, without any mixture of ashes or dirt.

In the above manner, the woody parts of hemp, old linen, paper, &c. may be charred; and so perfectly as to be very fit for making gunpowder. Chemistry has other means of charring such substances; namely, by making use of distilling vessels, either of earth, of iron, of copper, or of glass. By means of these vessels, the products arising from the substances operated upon may be preserved.

On making Gunpowder.

To make gunpowder in the large way, the ſaltpetre, the ſulphur, and the charcoal, are ground ſeparately, in mills adapted for that purpoſe. Saltpetre may alſo be powdered in the following manner, which is called reducing ſaltpetre into flour. Take as much ſaltpetre as is meant to be powdered, and put it into an iron pot; heat it, till it is ſo hot that the hand cannot be borne in it; then pour as much water into the pot as will nearly cover the ſaltpetre. The whole is then to be boiled, ſtirring it with a ſtick, till the water is entirely evaporated, and the ſaltpetre dried, and reduced into a very fine powder. In this ſtate it is fit to be uſed for making gunpowder, either in large or ſmall quantities.

On the Proportion of the different Subſtances which enter into the Compoſition of Gunpowder.

I ſhall not ſpeak of the manner in which gunpowder is made in the large way, in arſenals, &c. as my intention is only to inſtruct thoſe individuals

viduals of the public who may wish to make some for their own use. The proportions from which I obtained the strongest gunpowder were as follows, *viz.* one ounce of well-purified saltpetre, one *gros* and a half of charcoal, (made of the berry-bearing alder,) and fifty-four grains of sulphur. Consequently, to make about one pound and four ounces of gunpowder, there would be required one pound of saltpetre, three ounces of charcoal, and one ounce and a half of sulphur.

Four times the quantity above mentioned may be put into a large mortar, of wood or marble; it must be well beat, for the space of twenty-four hours, with a pestle of hard wood; wetting it with water sufficient to make it into a paste, and adding a little fresh water, from time to time, as the paste grows dry. At the end of the above time, the paste is to be taken out of the mortar, and put between two boards; on the undermost of which it is to be spread, five or six lines thick. The uppermost board is then to be loaded with large stones, that the paste may be pressed as hard as possible: if a press can conveniently be made use of, so much the better, for the harder

harder the paſte is preſſed, the ſtronger the powder will be. About twenty-four hours after this preſſure, the paſte may be taken from between the boards: it will be found in the form of cakes, very hard, and very dry. In order to grain it, theſe cakes muſt be broken upon a table, with a rolling-pin or a wooden mallet. Then the powder is to be paſſed through a ſieve of leather, the holes in which ſhould be one line in diameter. What paſſes through this ſieve is to be put into another, the holes of which muſt be half a line in diameter. What paſſes through the ſecond ſieve is to be thrown into a hair ſieve of a middling fineneſs; and, laſtly, what paſſes through the hair ſieve is to be ſifted in a very fine ſilk ſieve, that it may be deprived of its duſt.

The powder which remains in the ſilk ſieve is the fineſt, and the moſt powerful: that which remains in the hair ſieve may ſerve for ſhooting game, &c. and that which remains in the leather ſieve, with the ſmall holes, is fit for charging cannon, or for blowing up rocks, &c. The powder which is left in the firſt ſieve is to be carried to the table,

table, to be again bruiſed, and then paſſed through the various ſieves as before. The duſt muſt be again made into a paſte with water, that it may be once more preſſed, and afterwards grained.

Another Manner of making Gunpowder, in ſmall Quantities, as practiſed by the Coſſacks.

They put their ſaltpetre, ſulphur, and charcoal, into a glazed earthen pot, after having ſifted them ſeveral times through a coarſe ſieve, that they may be well mixed together. By the help of a little water, they boil the mixture over a gentle fire, for the ſpace of five or ſix hours; evaporating the water, till there remains a paſte of a fit conſiſtence to be preſſed, and grained, in the manner already deſcribed. This way of making gunpowder appears to be dangerous; but I have ſeveral times practiſed it, without any accident.

Gunpowder may alſo be very eaſily made, by only grinding the mixture upon a table, with a wooden muller. When the paſte is of a proper conſiſtence, it is to be preſſed, grained, &c.

One

One of my friends (M. Carny) has invented a very ſimple machine, by means of which, two men can make one hundred pounds of gunpowder in about forty-eight hours. I am not at liberty to deſcribe it here, as it is his property; but he permitted me to try it, and my experiment ſucceeded very well, as I obtained very good gunpowder. If places which are in a ſtate of warfare were provided with a ſufficient number of theſe ſimple and commodious machines, magazines of powder would be unneceſſary; it would only be requiſite to have a ſtock of ſaltpetre, of ſulphur, and of charcoal, and gunpowder might be made as it was wanted; by this, we ſhould prevent the blowing up of powder-magazines, and the diſadvantage of letting gunpowder fall into the hands of the enemy, which ſometimes enables them to keep poſſeſſion of places they have taken.

When gunpowder is brought into grains, of the ſize we wiſh, it is to be glazed. This operation is performed, in the great way, by putting it into a caſk, through the middle of which paſſes the axis of the wheel of a mill: the caſk, by being

 turned

turned round, causes the grains of gunpowder to undergo a degree of friction, which rubs off their sharp angles, and gives them a gloss. When taken out of the cask, the gunpowder should be sifted in a silk sieve, to separate the dust which is formed in the operation.

A small quantity of gunpowder may be glazed, by shaking it with the hand, in boxes or small barrels; but this method of operating, as well as that already described, leaves the grains of an angular form.

In Switzerland, where the best powder in Europe is made, the grains are brought to a perfect roundness. I succeeded in making them so, in the following manner: when the powder is sufficiently beat, and while it is still wet, let it be passed through a coarse hair sieve, assisting its passage by a wooden roller, which rolls upon the powder, in consequence of the motion which is given to the sieve; by this means the powder is divided and grained. While it is yet moist, let it be put into a linen sack, of a close texture, capable of containing from three to fifteen pounds of powder; and let the mouth of the sack be tied, as close to the

the powder as can be done without compreſſing it very violently. The ſack is then to be placed upon a firm ſolid table, and, leaning with both hands upon it, is to be forcibly rolled forwards, taking care never to roll it in a contrary direction. As the ſack becomes flaccid, the ligature muſt be lowered, that the powder within may not have too much ſpace.

It is ſufficient that the powder be turned in the above manner for about an hour: the grains will then be perfectly round. When taken out of the ſack, it may be ſifted through various ſieves, to ſeparate the different-ſized grains, and the duſt. It muſt be obvious that powder, the grains of which are intended to be made round, cannot undergo the uſual degree of compreſſion, becauſe it would then be too dry to take that form; but the preſſure it receives from the hands gives it as much force as it is capable of acquiring by compreſſion; and indeed the round powder of Switzerland is equal in power to the royal powder which is made at Eſſonne. This laſt, which is as ſtrong as any kind of gunpowder we know of, owes its force only to the preſſure it receives from large mill-ſtones.

Compreſſion gives power to gunpowder only becauſe it forces a greater quantity of matter into an equal volume; but this operation increaſes the price more than one third.

Theory of the Effects and Force of Gunpowder.

Saltpetre is a ſalt, and every ſalt contains water of cryſtalization. This ſalt is compoſed of nitrous acid, fixed alkali, and water. Nitrous acid is compoſed of vital air or oxygene, and azote. Vital air is the aliment of fire; when it is pure, it produces the ſtrongeſt fire that can be. If ſaltpetre be thrown upon live coals it is decompoſed; the vital air becomes free, and conſumes the charcoal with a violent fire. The water of cryſtalization of the ſaltpetre is reduced into the form of vapour, and exhales in a thick ſmoke, with the carbonic acid which is formed during the combuſtion. The fixed alkali of the ſaltpetre is melted, and brought into the ſtate in which it was before it was ſaturated with the nitrous acid, ſo that it may be made into freſh ſaltpetre.

If, inftead of throwing faltpetre upon live coals, it is very intimately mixed with faltpetre and charcoal, this mixture forms gunpowder. If a fpark is fuffered to fall into the mixture, the fulphur and charcoal take fire; the faltpetre, inftead of burning gradually, is inftantly decompofed; and the vital air produces fo violent a fire, that the water of the faltpetre is reduced into vapour. If this operation is performed in the open air, the explofion is hardly perceptible; nothing is obferved but a large quantity of white fmoke, arifing partly from the water and the carbonic acid, and partly from the fulphur, which is not entirely confumed, and with a part of which the fixed alkali has formed a liver of fulphur. All thefe fubftances in the form of vapour are condenfed: the foulnefs of fire-arms is nothing but fixed alkali, fulphur, charcoal, and a fmall quantity of liver of fulphur.

A fmall quantity of good gunpowder, fired upon a piece of white paper, neither burns the paper, nor fouls it; confequently, all the fubftances of which fuch powder confifts are reduced into vapour. Every fubftance, when reduced into vapour, occupies a much greater fpace: water expands

pands more than any other ſubſtance; when reduced into vapour, it occupies a thouſand times its original ſpace. All aëriform fluids, when dilated, occupy about two hundred times more ſpace than before. If a quantity of any kind of gunpowder is exploded in a cannon, or other ſort of fire-arms, the powder is inſtantly decompoſed; the water of the ſaltpetre, which is one tenth part of it, is reduced into vapour, and occupies a thouſand times its former ſpace. The carbonic acid which is formed, by being very much dilated, conſiderably increaſes the volume of the vapour produced by the water; the ſulphur and the alkali undergo the ſame change, and ſtill farther increaſe the quantity of aëriform fluid.

From the foregoing obſervations I conclude, that a given quantity of gunpowder, when exploded in any kind of fire-arms, or in a mine, &c. is expanded to ſuch a degree as to occupy eight hundred times more ſpace than before; and that the force of that powder, and its terrible effects, are owing, partly to the water of cryſtalization of the ſaltpetre, and partly to the aëriform fluids which ariſe from the decompoſition of the powder.

Obſer-

Obſervations on the Saltpetre which is found in Vegetables.

A chemiſt of Montpellier affirms, that ſaltpetre exiſts, completely formed, in vegetables, particularly in the ſunflower, pellitory, bugloſs, &c. and one of his pupils has attempted to prove, that it is formed in all extractive matter that is capable of entering into fermentation. Both the maſter and his pupil are miſtaken in this reſpect, as alſo are many other chemiſts.

Saltpetre is found only in ſuch plants as have grown in earth which contains it. The earth in the neighbourhood of Paris, the gardens, and even the marſhes, in and about that city, are highly impregnated with ſaltpetre; and the plants which are cultivated in thoſe diſtricts, and conſequently their extracts, contain a great deal of that ſalt.

At Montpellier the ſoil is calcareous, and therefore is very ſuſceptible of becoming impregnated with ſaltpetre. The copious dews, and the burning ſun, of that country, furniſh a ſufficient quantity

quantity of vital air to generate it, and consequently it is not astonishing that the vegetables of the country, and their extracts, should be found to contain it. All soils which contain salt, limestone, gypsum, &c. may be considered as mines of saltpetre: flinty, quartzose, and sandy soils never produce it. Its generation may with certainty be prevented in houses, &c. merely by covering the ground with a few inches of sand.

I beg leave to present to the Society two stalks of sunflower, which I cultivated in my own ground, on a sandy soil. The one contains a great deal of saltpetre, because I watered it several times with water saturated with that salt; the other does not contain an atom of it, although it grew only six feet distant from the first, but was not watered with a solution of saltpetre. This experiment proves that saltpetre is not innate in plants, and also that it is not the product of vegetation. I shall, at a future time, give to the Society an account of some experiments made upon this subject, on a larger scale, in a memoir on the analysis of different vegetable earths, and on the various products of the plants therein cultivated.

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XVIII. *Specification of the Patent granted to Mr.* CHARLES HALEY, *of Wigmore-ſtreet, Cavendiſh-Square, Watchmaker; for his Invention of a Marine Timekeeper, for the better aſcertaining the Longitude at Sea.*

WITH A PLATE.

Dated Auguſt 17, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE, that I the ſaid Charles Haley, do hereby declare my ſaid invention, and declare that the ſame is of the deſcription and particulars, and to be performed in the manner, as will more fully and at large appear by the plan hereto annexed. In witneſs whereof, &c.

 DE-

Description of Charles Haley's new-invented Eſcapement for Marine and Pocket Time-keepers.

The utility of this invention is, to communicate to the balance an invariable and equal force, notwithſtanding the imperfections of the main ſpring, and the train of wheels, by which the motion is generally communicated; and this is effected in the moſt perfect and ſimple manner, by means of an immediate agent or ſpring, with a new apparatus, placed between the balance-wheel and balance, which is wound up 150 times in a minute, by the common movement; and as, in a train of 9,000 beats *per* hour, there are 150 beats *per* minute, juſt ſo often will the balance be impelled by the renovating-ſpring; but this matter will be particularly deſcribed hereafter.

Figs. 1 and 2 (Plate IX.) repreſent the principal parts of the movement that are more immediately connected with this new invention; the ſame letters of reference are put to both, ſo that, in in reading the defcription, the eye may be directed from the one to the other.

AB is the potence-plate, and T the balance; the pivots of whofe verge or axis PX are run into the cock C, and potence D; above the balance T is fixed a pendulum-fpring S, in the ufual way, by pinning the upper end of the fpring to a piece fcrewed upon the balance-cock, and the lower end of it to a piece which is twifted on the axis of the verge, immediately above the balance. Below the balance, and on the axis of the verge, (which is a fmall folid cylinder,) are placed two fmall fteel collets I and K; thefe collets turn ftiffly on the axis of the verge, fo as to be fet in any pofition, and each has a ruby pallet, fixed in the collet, and ftanding a little way beyond their furfaces. We call I the difcharging pallet, and K the impelled one: it is therefore obvious, that if the balance be made to vibrate ever fo little, the pendulum-fpring S, and pallets I and K, will vibrate to and fro along with it. E is the balance-wheel, of the ufual form, which is run juft free of the upper furface of the potence-plate; its upper pivot is run into a cock F, ſcrewed on the ſame ſide of the potence-plate; and its lower pivot into a cock G, ſcrewed on the lower ſide of the ſame plate. WV is the axis of the new-invented renovating-ſpring R, and its apparatus; the axis is a ſmall ſolid cylinder, and its upper pivot is let into a cock H, ſcrewed on the potence-plate, and its lower pivot V into another cock D, which is ſcrewed on the under ſide of that plate. This axis is placed directly between the balance-wheel and verge, conſequently the axis of the balance, or verge PX, the axis of the renovating-ſpring WV, and balance-wheel E, have their centres all placed in the ſame right line AB. (See Fig. 2.)

On the axis of the renovating-ſpring, and in the ſame plane with the balance-wheel E, is ſtopped the round ſteel pallet M; it is juſt ſo large as to turn round without touching the points of the teeth of the balance-wheel at N° 1 and 2. (See Fig. 2.) There is a notch cut in this round pallet, ſo that the teeth of the wheel may be at liberty to act into it. The face or notch of the pallet is repreſented as having moved from a poſition point-

ing

ing to the tip of the tooth 2, to 1, by the tooth 1 of the wheel acting into it. On the upper ſide, and cloſe to this round pallet, is twiſted a ſteel pallet N, in form of a ſnail: this new contrivance may be called a ſnail-pallet. There is a ſmall dovetail cut in this pallet, near the centre, into which is fixed a ſmall ruby pallet: it points directly to the face of the notch of the round pallet M, or to the tip of the tooth 1 of the balance-wheel. Above this ſnail-pallet is twiſted a cullet O, (ſee Fig. 1,) to which the lower end of the helical renovating-ſpring R is pinned, and the upper end is attached to a piece which is ſcrewed upon the cock H, near W. On the ſame axis of the renovating-ſpring, but on the lower ſide of the potence-plate, is twiſted the pallet L; it may be called the impelling-pallet, becauſe, when the renovating-ſpring is diſcharged, it communicates that motion to the balance, by ſtriking upon the pallet K, which is placed upon its arbour. It is neceſſary to obſerve, that the renovating-ſpring with its collet O, the ſnail N with its ſmall ruby pallet, the round pallet M, and impelling-pallet L, being all attached to the ſame axis WV,

will

will all move backward and forward together, with the ſame velocity, and keeping the ſame diſtance as under. In Fig. 2, *a* is a detent-ſpring, faſtened on the upper ſide of the potence-plate, by a ſcrew and ſteady-pin *n*: this ſpring points directly to the verge, (that is, the centre of the verge,) and approaches very near it. The breadth and height of it above the ſurface of the potence-plate is repreſented at Fig. 3, which is equal to the height of the diſcharging-pallet I above that plate.

Upon the ſide of the ſpring *a*, next the balance-wheel, is faſtened a very tender ſpring *m*, (Fig. 3.) by means of two pins near *a*: this ſpring projects a little way beyond the end of the other, and is therefore nearer the centre of the verge; there is alſo fixed, near the end of the ſtronger ſpring, a ruby pallet *r*.

The cock *b* (Fig. 2.) is ſcrewed upon the potence, and the hole at *i* is tapped, to admit the thread of the adjuſting-ſcrew *c*, its head being placed towards the centre of the ſnail; and the ruby *r*, of the detent-ſpring *a*, is made to bank againſt the inſide head of this adjuſting ſcrew, bearing with a

ſmall

ſmall degree of elaſticity. This adjuſting ſcrew *c* is purpoſely put at ſome diſtance from its place, and connected by a dotted line, becauſe it would cover the ſmall ruby pallet *r*, and acting face of the ſnail, and thereby prevent their action from being ſeen.

When the ſnail-pallet N is brought from the balance-wheel E towards the verge, the renovating-ſpring is wound up; but, when it moves from the poſition it has in Fig. 2, towards the balance-wheel E, it is let down. When the renovating-ſpring is wound up, the inclined or rounded-off part of the ſnail acts on the inclined part of the back of the ruby pallet *r*, and thereby preſſes the detent-ſpring *a*, and ruby pallet, outwards, or from the balance-wheel, until the ſnail paſſes over the ruby pallet; when, the detent-ſpring returning to its former place, the ſnail is prevented from returning, and therefore the renovating-ſpring remains ſuſpended in a ſtate of tenſion. If the diſcharging pallet I, on the axis of the verge, is moved from its preſent poſition to the other ſide of the detent-ſpring *a*, it will lift the delicate ſpring *m* until it paſs on the other ſide of it, but without af-

fecting

fecting the detent-ſpring *a*, which is banked upon the head of the adjuſting-ſcrew; but, when the diſcharging-pallet returns to its point of reſt, it will carry both ſprings with it; and, when the ruby *r* is lifted beyond the reach of the ſnail, the renovating-ſpring will be diſcharged, and move with conſiderable volocity towards the balance-wheel.

There is alſo placed on the other ſide of the balance-wheel E another detent-ſpring *d*, but without any other ſpring attached to it; nor does the pallet which lifts it ever paſs on that ſide which is oppoſite to the wheel E: it is ſcrewed on the upper ſurface of the potence-plate, and points directly to the centre of the axis of the ſnail, which it almoſt touches. The height of this detent-ſpring above the ſurface of the plate is ſhewn in Fig. 4. *s* is a ſapphire-pallet, which is ſet into it, and the tooth 3 of the balance-wheel is repreſented as reſting upon it. *y* is an adjuſting-ſcrew, which moves the detent-ſpring *d* nearer or farther from the verge, ſo that the teeth of the balance-wheel 1 and 2 may be equally free of the round pallet M.

The

The balance-wheel E moves in the direction of the arrow Z, and therefore will extend the spring *d*, when locked upon it. *e* is a cock, and *f* an adjusting-screw, which is screwed into the end of the cock *e*, with its head towards the centre of the balance-wheel E, on which the sapphire-pallet *s* banks, in the very same manner that the detent-spring *a* banks upon the adjusting-screw *c*, already described. *g* is a small cock or stud, in which there is an adjusting-screw, to bank the detent-spring *d*, when it is lifted from the balance wheel outward. Let any force move the balance-wheel in the direction of the arrow Z; then, when the small ruby pallet near the centre of the snail, facing the tip of the tooth 1, comes to strike the detent-spring *d*, the sapphire-pallets *s* will be lifted beyond the tooth 3, so that the wheel may escape, but the face of the round pallets will be brought into a position pointing to the tooth 2; at that instant, the balance-wheel will strike on the face of the round pallet, and carry it back again to 1, when the snail will have passed beyond the ruby *r*, and thereby wind up the renovating-spring.

Here it is plain that the force of the train muſt be ſufficient to wind up the renovating-ſpring, the ſtrength of which may be increaſed or diminiſhed at pleaſure.

Having conſidered the action of the principal parts of the eſcapement ſeparately, it now remains to deſcribe the operation of the whole together. When the balance is at reſt, and the renovating-ſpring wound up, the whole will appear ready for action, as in Fig. 2; we muſt alſo imagine the balance-wheel to turn round in the direction of the dart Z, and that it is preſſing againſt the ſapphire *s* of the detent-ſpring *d*, with a force equal to what remains of the main-ſpring, after paſſing through a train of wheels; and we are farther to ſuppoſe the force of the balance-wheel, renovating-ſpring, and weight of balance, adjuſted to one another; if, in this ſituation, the balance and its ſpring, are made to vibrate, ſo that the diſcharging-pallet I, on its axis, paſſes on the other ſide of the detent-ſpring *a*, by lifting the tender ſpring along with it until it drops, but, when the diſcharging-pallet returns, it lifts both ſprings of the detent *a*, the ruby *r* being carried beyond the reach

reach of the ſnail-pallet, the renovating-ſpring is diſcharged, and immediately the impelling-pallet L, fixed on its axis, ſtrikes the pallet K, on the axis of the verge; carrying with it the balance, with its pendulum-ſpring, until ſuch time as the pallet L has carried the pallet K as far on the other ſide of the line A B, which joins the centres, and is juſt ready to quit it. During this time, the round pallet, ſnail, and other apparatus belonging to the renovating-ſpring, are perfectly detached from the balance-wheel; but, preſently after the two pallets K and L have left one another, the ſmall ruby-pallet, near the centre of the ſnail, has advanced to diſcharge the detent-ſpring *d*, and the acting face or notch of the round pallet will point to the tooth 2; but the ſapphire-pallet *s*, of the detent-ſpring *d*, being lifted beyond the reach of the tooth 3, the tooth 2 of the balance-wheel drops on the face of the round pallet, and returns it back to its former poſition, and winds up the renovating-ſpring. In the mean time the balance, from the impulſe it has received, continues to vibrate above a ſemi-circle, more or leſs at pleaſure, from the point of reſt.

On returning back, it will paſs the point of reſt, and move the tender ſpring, without meeting with any obſtacle in the way, for the impelling-pallet L was, at the ſame moment of renovating the ſpring, ſhifted back to its proper place. The balance now returns back, diſcharges the renovating-ſpring, which impels the balance, and is again renovated by the train; and thus the motion is continued.

Although we have made choice of a train of 9,000 beats per hour, it is left to the diſcretion of the artiſt to fix upon a quicker or ſlower train. The timekeeper may be made to go 30 hours, 50 hours, or a week, without winding. The renovating-ſpring may be a ſpiral having all its coils in the ſame plane, or in the ſurface of a cone or cylinder, and may be made of ſteel, gold, platina, &c. and the principle of renovating may be applied ſeveral ways. Inſtead of the detents acting as ſprings, they may be made to move on pivots, and may be placed either above the potence-plate or below it.

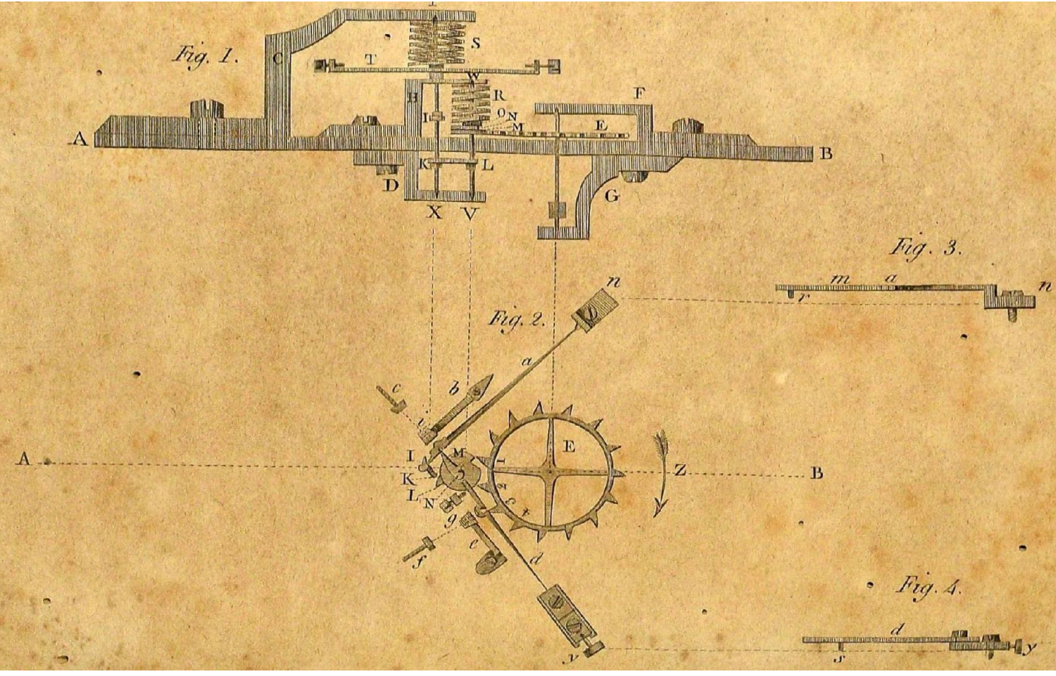


Fig. 1.
A
B
C
D
E
F
G
H
I
K
L
M
N
O
R
S
T
W
X
V
Fig. 2.
a
b
c
d
e
f
g
n
x
E
I
K
L
M
N
Z
A
B
1
2
3
4
Fig. 3.
m
a
n
r
Fig. 4.
d
s
y

XIX. *Specification of the Patent granted to Mr.* WILLIAM MOORCROFT, *of the Pariſh of St. Mary le Bone, Veterinary Surgeon; for his Invention of an improved and expeditious Method of making and manufacturing Horſe-ſhoes, and other Articles formed of Metals.*

Dated April 16, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid William Moorcroft do hereby declare, that the following is a particular deſcription of the nature of my ſaid invention, and of the manner in which the ſame is be performed; that is to ſay, firſt, I take bars of iron, or ſteel, or a compoſition of metals, of a breadth and thickneſs ſuitable to the horſe-ſhoes I intend to make. Having heated theſe bars red-hot, (as is uſual in the proceſs of rolling and ſlitting iron,) I run them betwixt and through a pair of grooved rolls,

rolls, turned by a horſe-mill, or other power. The grooves in theſe rolls are various, according to the ſurfaces of the ſhoes intended to be made, and form the groove, and impreſſions for the heads of the nails, and regulate the thickneſs of the ſhoes; or ſimply regulate the thickneſs of the ſhoes, without making the groove, or impreſſions for the nails. Secondly, after the bars have been run betwixt and through the rolls, I cut them into different lengths, according to the ſize of the ſhoes intended to be made. Thirdly, I bend or turn them into the proper ſhape, either by hammer and anvil, or otherwiſe. Fourthly, when the ſhoes have been ſo turned, I heat them again red-hot, and ſtrike them between dies fixed in a common fly-preſs, (ſuch as is uſed for coining money,) or in ſtamps, ſuch as are uſed for the ſame operation, or for giving impreſſions to other pieces of metal. Theſe dies are engraved and formed in ſuch a manner as to confirm to the ſhoe the proper thickneſs in the uſual parts, and alſo to form the groove, and impreſſions for the nails, when not formed by the operation of rolling, as above mentioned, or by any other operation;

or they give the groove, without the impreſſions for the nails; or they give the impreſſions for the nails, without the groove. The rolls and dies reſpectively are to be cut with projecting parts, adapted to give the impreſſions for the nails, or groove, if ſuch impreſſions, or groove, are intended to be made; or plain, if thoſe impreſſions, or groove, are not to be made by the rolls and dies reſpectively. The dies for theſe ſhoes muſt be formed in ſuch a manner as to correſpond with thoſe parts of a horſe's foot to which ſhoes are uſually affixed; and, in conſequence of the dies being ſo formed, the ſhoes ſtruck by them are more perfect in their ſhape, and afford truer and better ſupport to the foot of the horſe, than the ſhoes in common uſe, and prevent many of the diſeaſes incident to that part, from the manner of manufacturing horſe-ſhoes now in common uſe. In witneſs whereof, &c.

XX. *Specification of the Patent granted to Mr.* THOMAS POTTS, *of Sanctuary, in the Parish of Penrice, in the County of Glamorgan, Farmer; for his Invention of a Machine, attached to the Stern of any Vessel, Boat, or Barge, for the Purpose of moving the same on navigable Canals or still Waters.*

WITH A PLATE.

Dated July 20, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Thomas Potts do hereby declare, that my said invention is described in the plan and description thereof hereunto annexed. In witness whereof, &c.

Fig. 1. (Plate X.) is an end-view of a barge and apparatus. *a a* is the bolt which holds the two bars B B together at the top, and suspends the cord,

cord, bar, or chain, D, with the vertical oar E, and its pole *e e*, as in Fig. 2. CC, two projecting pieces, to faſten the braces of BB. *ff*, the ſtays of the vertical oar E, faſtened to the projecting part of the pole *e e*, as in Fig. 2. FFFF, a ſtern-ſection of the barge, &c. the ſtem of the vertical oar E fixed to it by nails, rivets, or nuts and ſcrews. *ggg*, mortices in the ſtem *k*, to raiſe or lower the oar E, according to the immerſion of the boat, barge, or veſſel.

Fig. 2. is a ſide view of the barge and apparatus. *b b*, the braces for the bars BB, Fig. 1, faſtened to external and internal parts of the projecting pieces CC. *h h*, *h h*, croſs bars for puſhing or pulling the oar or oars faſtened to the pole *e e*. *w*, a ſliding-weight, to balance E. *q*, a wedge, to fix the ſliding-weight. HH, the ſurface of the water in which the veſſel is immerſed.

As this apparatus may be adapted to barges, &c. of various ſizes, it is impoſſible to deſcribe what may be its proper dimenſions; it is to be obſerved, however, that the greater the power to be uſed, the wider the oar may be made: it ſhould be made of ſuch timber as is leaſt liable to be warped. To make the apparatus work eaſy, care muſt be taken to place the ſliding-weight *w* to balance the oar E, ſuſpended by D; then the men, holding the croſs bars *h h*, *h h*, may raiſe or lower the oar E at pleaſure, and make the ſtroke long or ſhort, deep or ſhallow, as they pleaſe, by raiſing or lowering the pole *e e* where the croſs bars are applied; and exert their whole force, together with that of the deſcending weight *w*, againſt a column of water equal to the immerſed part of the oar; which, having performed its ſtroke will return to its place by means of the deſcending weight and depreſſion of the end where the croſs bars are applied; and then, by elevating the ſaid end anew, the oar will dip perpendicularly, and be ready for repeating the ſtroke. When uſed at the head of a veſſel, the pole *e e* ſhould be of ſuch a length as not to cauſe the water, impelled by the oar, to act againſt the head of the veſſel: when at the ſides, the length may be diſcretionary.

Fig. 1.

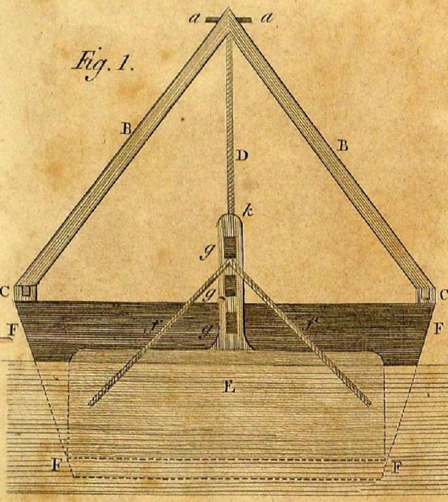
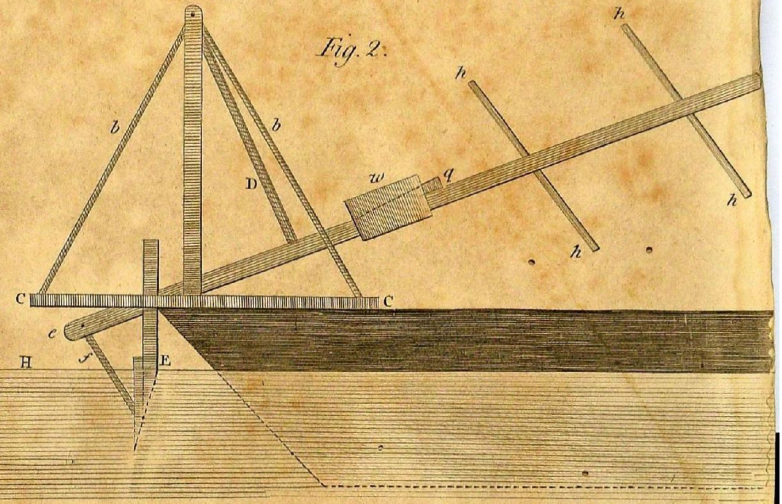


Fig. 2.



XXI. *Specification of the Patent granted to Mr.* WILLIAM BACHE, *of Birmingham, in the County of Warwick, Chemiſt; for his Invention of an Inſtrument called a* Propeller, *for communicating Motion to Mills and Forges, and for ſundry other important Purpoſes.*

Dated May 4, 1780.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid William Bache do hereby declare, that my ſaid new-invented inſtrument, called a *Propeller*, is formed in manner following; that is to ſay, either by a ſtraight or bent tube, made with metal, wood, ſtone, or bricks, with proper cements; and, by a pump or otherwiſe, to be filled with water, or any other denſe fluid; the tube having, near its baſe, one or more valve or valves, to act alternately for the admiſſion of an aſcending fluid; and, as an oppoſing power, to prevent the deſcent of that fluid under other circumſtances, near the upper end of the tube muſt alſo be formed one or more valve or valves, for the diſcharge of the fluid, together with ſuch other tubes and receivers as may be neceſſary to anſwer ſuch purpoſes as may be required of it, at that or any inferior height. The head of the tube muſt be made air-tight by a cover, through which muſt be made to paſs, either a large movable ſcrew, or rod, or other compreſſive power, having a connection in the inſide of the tube with a broad body, which I ſhall call a *Forcer*. Its extent muſt be ſuch as nearly to fill up the area of the tube; that, when the ſcrew or rod is made to deſcend, either by preſſure, the ſpring of an elaſtic fluid, or mechanic power, the *Forcer* may ſo preſs upon the ſurface of the fluid, as to cauſe a part thereof to open the valve or valves laſt mentioned, and eſcape. The powers expreſſed to be jointly or ſeparately applied, as may beſt ſuit the ſituation and uſe of the machine; and, where required, muſt be ſubjoined the whole or part of the following apparatus, pertaining to the ſaid inſtrument or machine, *viz.* a reſervoir, for the reception of the propelled

propelled fluid, and an aperture pipe or pipes, for the deſcent of the fluid upon one or more wheel or wheels, for the purpoſe of effecting a rotary motion, or to anſwer any other intent or end that may be thought uſeful or agreeable; and the fluid may be again received into a reſervoir inferior to the former, prepared for it, and be again employed to increaſe the powers of the ſame, or other wheels, by its *impetus*. And, upon the wheel, or ſhaft of the wheel or wheels, may be fixed a crown, or other wheel or wheels, drum or drums, trundle or trundles, cogs or ſpokes, for the purpoſe of turning other wheel-work, or depreſſing or raiſing a lever, or other-wiſe, to communicate to the large ſcrew or rod with the *Forcer* annexed, or for any other purpoſes that may be deemed uſeful. And it is ſo contrived, that the fluid before mentioned, after having been applied to the wheel or wheels, as deſcribed, may have a proper deſcent to the baſe of the great tube, to be repeatedly forced up into it again by the influence of the atmoſphere, or any other compreſſive power, at ſuch periods as the *Forcer*, connected with the large ſcrew or rod, is

raiſed

raiſed towards the cover of the great tube, that, upon the repeated deſcent of the *Forcer*, the fluid may be again driven out of the tube, at the ſuperior valve or valves, as before ſpecified, and act again, by its weight and velocity, upon the inferior parts of the machine.

The principle of this machine may be applied, in different forms, to all the following purpoſes: raiſing water for culinary uſes, in cities, towns, and villages; waſhing of ſtreets and roads; floating of paſture-grounds; draining of lands; communicating power to all kinds of mills and forges; raiſing of water from the holds of ſhips, from mines, rivers, ſprings, pools, ponds; and, for the improvement of pleaſure-grounds, in contributing to the formation of rivulets, caſcades, *jets d'eau*, and various other purpoſes. In witneſs whereof, &c.

XXII. *Description of a Machine for clearing navigable Rivers and Canals from Weeds. By the* Chevalier *de* Betancourt Molina.

WITH A PLATE.

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

A Premium of Forty Guineas was given to the Chevalier de Betancourt Molina for this Invention.

To clear navigable canals and rivers from weeds, which commonly grow in their bottoms and banks, two operations are requisite; first, either to cut or pluck them up by their roots; and next, to take them out of the water, if the current be not strong enough to carry them away.

The

The second operation is evidently of small importance; the first is the only one for which a machine seems necessary to be proposed to the public, by the society for the encouragement of arts, manufactures, and commerce.

A machine calculated for plucking up weeds by the roots would necessarily require a great variety of motions, and parts of different shapes, adapted to the different sorts of plants, which would render the machine too complicated for the skill of that class of people for whose management it is intended; besides, in stiff clays, in which the roots penetrate a considerable depth, it would require not only a very great power, but also such a waste of time as to render the operation too slow and expensive. Another inconvenience, still greater, attending such an operation, would be the destroying the texture which the fibres of the roots form with the earth, particularly in banks, thereby preserving them from being destroyed by the current. The loss of this protection would occasion a gradual accumulation of earth in the bottom of the rivers and canals, and thereby render their navigation either difficult or imprac-

impracticable. The machine hereafter described, and shewn in Plate XI, is therefore intended for cutting or mowing the weeds, and not for plucking them up by the roots, as I am persuaded the former method is more conformable to the intention of the society.

References to the Figures.

(See Plate XI.)

Figs. 1 and 2, AB, a barge, or flat-bottomed boat, which supports the machine: its length, from eighteen to twenty feet; its breadth, at the top, five feet six inches; and its depth, two feet six inches: these dimensions may vary, according to the situations and uses to which the machine is to be applied.

C, D. Two pieces of wood, fixed in the segment E, (Fig. 3,) and with which the machine is held fast to the barge.

E. A wooden segment, whose arch is described from the centre X: this segment measures 90 degrees, and each 5th degree has a hole to receive an iron pin, with which the beam II is fixed in a dia direction perpendicular to the plane in which the weeds grow.

F. A quarter of a circle of caſt iron, with teeth, fixed upon the ſegment E.

G. An upright poſt, (fixed at one end upon the ſegment E, and upon a croſs poſt H,) in which the axis X is faſtened.

H. A croſs poſt, which pins through, and is fixed to the bottom of the barge, ſupporting the upright poſt G.

II. A beam (with a croſs poſt J) which moves upon the axis X: its length, from its axis X to its lower end, ought to be in proportion to the depth in which the machine is to cut.

K. Two iron pieces faſtened to the beam II, and to the croſs poſt J, and which are to receive between them a worm L, which is to take into the teeth of the quarter of a circle F.

L. An iron worm, whoſe axis paſſes through the two iron pieces K, by which the beam II is to be brought to a direction perpendicular to the plane in which the weeds grow.

M. Axis fixed upon the croſs poſt J, on which turns the lever N.

N. A lever which turns on the axis M, and whoſe ſhorter end terminates in a toothed ſegment, of about a third part of a circle.

O. A toothed wheel, whoſe diameter is one half the diameter of the ſegment in which the ſhorter end of the lever terminates, and whoſe teeth take into thoſe of the ſegment.

PP. A rod of bolt iron, which paſſes through the centre of the wheel O, and through a ring Y, fixed near the bottom of the beam II; on the lower end of which rod is fixed the handle of the cutter. This rod, at its upper part, has ſeveral holes, ſix inches diſtant from each other, and which are to receive an iron pin, which is to fix the wheel O, and to raiſe or lower the cutter, according to the depth of water.

Q. The cutter, with its handle, which is fixed on the iron rod PP, and which may be made of a variety of forms, to cut the weeds with a ſtroke neither too oblique nor too direct, which practice will beſt determine; but perhaps the ſimple form expreſſed in the figure would be as good as any. It is evident, that the lever N being moved by one or two men, the wheel O will turn,

 and

and with it the rod PP, together with the cutter. It is equally clear that, during the time in which the lever N deſcribes a quarter of a circle, the cutter will move a complete ſemi-circle; the ſpace *a c b d* will be cut at each ſtroke, the diſtance from *b* to *c* being the ſpace paſſed by the the boat between the ſtrokes, which muſt be leſs than the length *e f* of the cutter.

Having thus deſcribed the conſtruction of this machine, and the manner in which it acts, let us now conſider how it is to be uſed.

In every river or canal intended to be cleared from its weeds, the firſt thing is, to meaſure the depth of the water, and arrange the machine in ſuch a manner, that the end of the beam II be at leaſt one foot, and the cutter about ſix inches, higher than the bottom. This being done, the barge may be drawn by a rope againſt the current, in order that the weeds may be carried away as they are cut; if the ſtream be not ſufficient for that purpoſe, a man or two, at the lower end of the barge, may eaſily draw them up into it by hooks, nets, or otherwiſe.

As weeds often grow on banks that have more or leſs obliquity, the beam may be placed in a direction perpendicular to the bank, by firſt taking out the iron pin which faſtens the croſs poſt J and beam I I upon the ſegment E; then turn the worm L till the beam comes into the required poſition, and fix it by the iron pin into the ſegment, as before. As the inclination of the ſides of navigable canals is never ſo great as an angle of 45 degrees, neither the arch of the ſegment E, nor that of the toothed piece F, need be greater than the quarter of a circle.

To ſharpen the cutter when neceſſary, the beam, by turning the worm all over the quarter-circle F, is to be completely turned, ſo as to preſent its lower end, and the cutter, upwards, which will be very eaſily done with the hand.

The repeated ſtrokes of the cutter may be preferable, when either the plants are ſo hard, or ſo thick, as to require a great force to cut them; but otherwiſe, the rotary motion will be far more expeditious. In which caſe, there may be two oppoſite cutters; (Fig. 5;) and the lever N, together

gether with the wheel O, (Figs. 1 and 2,) being taken off, two bevel-toothed wheels S and T, may be placed, as in Fig. 4, to be turned by the winch V. These cutters may be sharp on both sides, and, by changing the motion of either edge, may be used according to the nature of the weeds; and here it may be remarked, that the quicker the motion of the cutter, the easier will the weeds be cut, and less power lost by their resistance.

The diameter of the bevel-wheels in the figure is as two to three; but practice and judgement may suggest some alteration in the proportion of these as well as other parts of the machine, from the different resistance required to be overcome.

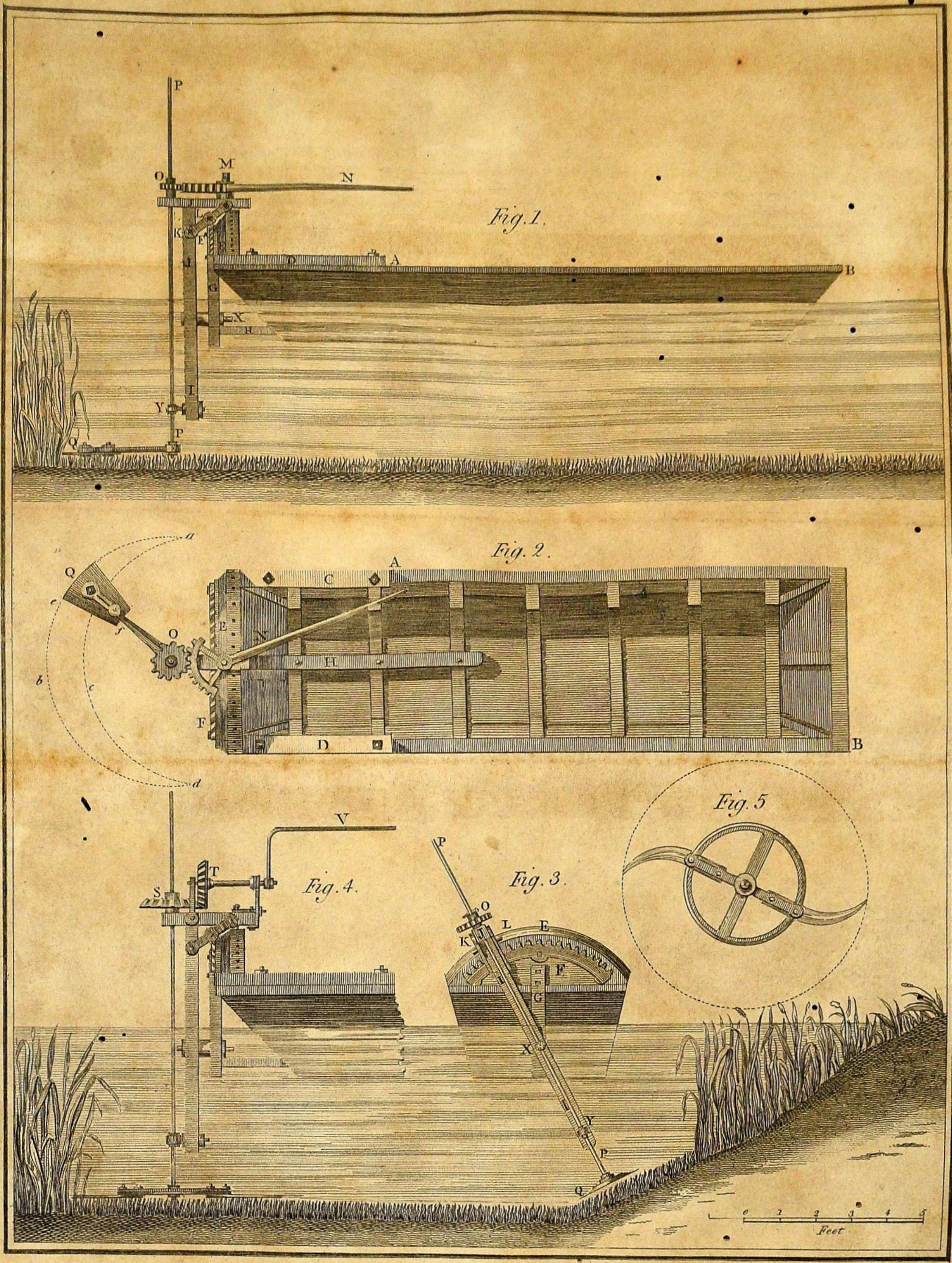


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5
Feet

XXIII. *Conclusion of Mr.* Richardson's *Observations on the Advantages of planting Waste Lands.*

(From Page 130.)

It is almost unnecessary to speak of the value of the Ozier; for, whoever contemplates the consumption of this estimable twig, in the immensity of wicker and basket work which is used, must be convinced of the importance of its cultivation, The ingenious Dr. Hunter says, that a plantation of Oziers will produce from five to six pounds the acre annually, provided such plantation be in the neighbourhood of the basket-maker, and by the side of some river, which may enable him to send his wares by water, at a small expence, to a proper market. Yet surely, at these prices, there are not many places in the kingdom, such as have been described, which may not be successfully cultivated, and yield a very handsome profit, ex-

clusive

clusive of the expence of carriage, especially since the great extension of our canal-navigation.

The Poplar, being termed by many writers an aquatic, has been frequently planted in an improper situation. In lands constantly wet, it may live for a few years, but it never arrives to any perfection in them; for, where its roots are perpetually wet and cold, symptoms of decay soon appear. With the exception of those now mentioned, this tree adapts itself to most situations: it will thrive most luxuriantly on boggy moor-land, after it has been drained, of which I have a striking proof. I had some land of this description, so wet as to be totally impassable by man or beast: after it had been well drained, in the winter of 1790, it was planted in the ensuing spring with Poplars of the following kinds: the White Poplar, (*Populus alba*,) the Black Poplar, (*Populus nigra*,) the Aspen, (*Populus tremula*,) and a few of the Carolina or Balsam Poplar. These trees, when planted, were generally from two feet to two feet three inches in height, and an inch and a half in circumference at the thickest part. I measured several of them in July, 1793, and they were, on the average, ſeventeen feet and a half in height; in girth, at the ground, twelve inches and one third; and, at a foot from the ground, ten inches and one-fourth.

I have heard of more extraordinary ſhoots in trees of the ſame kind, but I never ſaw any, the growth of which, on the whole, equalled theſe. I planted ſeveral thouſands of them, in different ſoils, aſpects, and ſituations, but none have yet come near to thoſe planted in this drained moraſs. Thoſe on the edges of the brooks, in good ſoils, have ſucceeded next to theſe; then thoſe on ſandy ſoils, and dry heath-lands; and, laſtly, thoſe on ſtiff clay-lands, which, although they have made pretty good progreſs, are yet the worſt of all.

Having a few plants left after the drained part was planted, and having heard it frequently aſſerted, as well as ſeen it ſupported by many authors, that they would ſucceed in the wetteſt places, I put them into the adjacent ground, which had not been drained, for the purpoſe of experiment. They ſeemed to ſtrike tolerably well in the firſt year; but, in the ſummer of the next, they grew ſickly, and turned yellow. I ordered a drain to be cut around them in the winter of that year: this had the deſired effect; for, the following ſpring, they regained their former healthy hue, but the leaves were conſiderably ſmaller than in the others, and the plants were much leſs, both in height and thickneſs; a ſure proof that they will not thrive, or indeed live long, where the ſituation is too wet.

Of the kinds thus planted, in the ſame ſituations, the White and Black Poplar grew the beſt; and on every account I prefer them, particularly the former. It is ſcarcely poſſible to enumerate the many excellencies of this tree: to its valuable quality of adapting itſelf to ſo many different ſoils and ſituations may be added, the eaſe with which it is propagated. If the ſide-ſhoots be taken from the parent-tree, planted in the ground, and defended from the bite of cattle, they will need no farther attention. I put a number of cuttings, about a foot in length, into ſome ground well trenched, in the ſpring; and, in the autumn of the ſame

year,

year, they were grown to the height of upwards of four feet, were well rooted, and remarkably fine plants. They are of ſuch rapid growth, that I ſaw a fall of this timber, which grew in a hedge-row, and had been planted twenty-five years, fell, on an average, at twenty-one ſhillings each tree; and I was afterwards informed, that this price was much beneath their real value.

I planted ſome Poplars, (what we term Lombardy Poplars,) about twelve years ago, which are now three feet two inches in circumference, at the thickeſt part, and upwards of forty feet high. This is a pleaſant-looking tree, and does well enough in an ornamental plantation; but the wood is of little or no value.

Another conſiderable advantage in the White or Black Poplar is, that a greater number of them will grow on the ſame ſpace of land than of any other tree; for, it is requiſite that all the ſide-branches be dreſſed off, every two or three years, nearly to the top of the tree. This gives ſo much freedom to the circulation of the air, and admits the ſun ſo freely among them, that, on the ſame ſpace of land,

 may

may be brought to perfection a number double to that of any other tree. For this reason we see them so frequently planted in hedge-rows, by the sides of meadows and corn-fields, in Lancashire and Cheshire; the farmers holding an opinion, that, from the loftiness of the trees, and from their being kept lopped as I have described, they do no damage, by their shade, to the herbage or grain beneath them. It must be admitted, that they will do less injury than trees whose numerous branches and thick foliage are impervious to the sun and air, but I cannot agree that they do none at all; and, notwithstanding the beautiful appearance which trees, planted in this manner, give to the face of a country, I must condemn the measure of planting timber-trees of any kind in hedge-rows, as being highly injurious to the fences beneath their branches, and the lands within their shade.

The wood of this tree is applied to many purposes: it makes excellent boxes and packing-chests, in which the manufactures of this town are conveyed abroad; indeed there are few uses to which it is not applicable. With many peo-

ple

ple it is in high repute for flooring-boards, on account of its quality of reſiſting fire; for, it burns with difficulty, and ſeldom burſts into a flame; on this account it is certainly very valuable in buildings. I am of opinion, that no wood can be better adapted for falſe keels, or planking the inſide of ſhips, than this; and, in the ſcarcity of oak timber, every thing which can be found as a ſubſtitute, or may tend to leſſen its conſumption, muſt be conſidered of importance to the country.

The loppings and underwood of this tree afford excellent poſts, rails, hurdles, and fencing: young cattle delight to feed on the leaves and freſh ſhoots of it more than any other; and, where there are large plantations of it, in dry ſcorching ſummers, when the paſtures afford little graſs, the leaves will be found an excellent relief to farmers who have a large ſtock of young beaſts. If gathered in ſummer, and cured like hay, they ſupply a valuable ſubſtitute for that article in ſeaſons of ſeverity.

The leaves fall in autumn in great abundance, and, when left on the ground, improve it ſo much as to render barren moor-land fertile in a few years; and, to thofe who live at a diftance from great towns, and find a difficulty in procuring manure, I know few things of equal value in the improvement of all foils, but efpecially the light, thin, poor ones. Mixed with earth, they form a ufeful compoft; and, with the addition of a little kelp and lime, a cheap and excellent manure, as I can affert with confidence derived from experience.

The Birch is alfo a tree which will grow well in the fituation I have been defcribing; but, as this tree alfo delights in a light fandy foil, and as we need not its additional evidence to prove the advantages of planting barren wafte-lands, while we have many fuperior to it in value and in beauty, I fhall pafs over it, and proceed to land of an oppofite defcription to what has been now confidered.

II. Several parts of this kingdom abound in dry burning fands, in barren heaths, and moors unfavourable to every purpofe of cultivation. The advantages which may refult from planting fuch lands, may, in fome degree, be appreciated by the

the recital of a few circumſtances which have fallen within my knowledge.

I ſhall begin with a ſmall plantation of Scotch Firs, (*Pinus ſylveſtris,*) growing on a moor in the north riding of Yorkſhire. This plantation is on a high mound of grey ſand, in extent not more than three-fourths of a ſtatute acre, which was laid down for this purpoſe thirty years ago. Its utmoſt value could not be eſtimated at two ſhillings and ſixpence an acre annually; but, that the ſubject I treat of, and its advantages, may not be over-rated, and that no one may be led into error, I will allow at the rate of five ſhillings an acre, and calculate the benefits ariſing from it; ſtating the expences of planting and fencing, agreeably to what I have paid myſelf for the ſame kind of labour, and eſtimating the timber according to the valuation of an experienced perſon, who examined it carefully, and offered the prices he ſtated, for the trees as they ſtood.

The whole fence was thirty-four rods in extent, of ſeven yards to the rod.

Caſting

		s.	d.		£.	s.	d.
Cafting the bank, *per* rod, - -		1	0				
Quicks coft, - - -		0	3				
Pofts and rails, - - - -		1	3				
34 rods, at -		2	6	is	4	5	0
Planting 1200 Firs { coft *per* 100 raifing, -	1*s.*	0 12	0	}	1	4	0
Planting 1200 Firs { making holes and planting,	1*s.*	0 12	0	}			
Thirty years rent of three fourths of an acre, at 3*s.* 9*d.* *per annum*, -					5	12	6
Incidental expences (fuch as cleaning the plantation the firft four years, keeping up the fence, and putting in trees, where any failed,) I efti-mate at, - - - - - - -					6	0	0
					17	1	6
There were ftanding 980 large trees, which, at a low valuation of 2*s.* 6*d.* each, is - - - - - - -					122	10	0
Neat profit in thirty years, - -					105	8	6

Therefore,

Therefore, after eſtimating the land much beyond its value, and making a full allowance for the coſts and expences, it appears, that this ſmall plot of ground produced 3*l.* 10*s.* annually.

Here then is another proof of the great benefit reſulting from planting ſuch grounds: I have taken the eſtimate of the quantity of trees firſt planted at 1200, to allow for ſome failing; but I have made no account whatever of the trees which were taken out as they grew up, to give room for the increaſe of others, which would doubtleſs have more than repaid the labour of weeding and cleanſing the plantation for the firſt four years; and alſo abundantly ſupplied the fences, if any were broken down before the quicks grew up ſufficiently.

As I have ſtated my concern at the general decreaſe of timber-trees in the kingdom, and the extent of land, ſo admirably adapted for the purpoſes of planting, now lying waſte, it is but juſtice to mention, that there are ſpirited individuals, both in England and Scotland, who have raiſed noble plantations of trees, in a ſtate of annual improvement, on land which before produced little or nothing, being of ſo poor a quality, that an acre of it would ſcarcely afford maintenance to a ſingle ſheep: on ſuch are now growing thouſands of valuable trees, rapidly advancing to profitable timber. Among the foremoſt of theſe, may be ranked the plantations of the Earl of Fife, in the counties of Aberdeen, Bamff, and Moray, in North Britain. This nobleman, in the ſpace of thirty years, has planted ſeven thouſand acres of bleak inhoſpitable moors, and covered with beautiful foreſts a large extent of country, on which a ſingle tree never grew before; and where it was a general opinion, that trees could not thrive, from the poorneſs of the land, and its vicinity to the ſea-coaſt. Another ſpirited undertaking of the ſame kind in the North of England, at Butsfield, on Lancheſter Moor, in the county of Durham, has been executed by Mr. White, of Retford, in Nottinghamſhire. Accounts of both theſe plantations, and their increaſe, are detailed in a letter from the owners, addreſſed to the Society for the encouragement of Arts, Manufactures, and Commerce, and inſerted in Vols. V. and VI. of that Society's Tranſactions.

An

An acquaintance of mine, who formerly reſided near Butsfield, before Mr. White began his plantation, told me, that no land ever exhibited a more forbidding appearance, and that it was a prevailing notion in the country, that the ſum expended for its improvement would be thrown away; an opinion to which, at the time, he was much inclined to accede. On his return, however, after an abſence of a few years, with equal pleaſure and ſurprize, he beheld the ſpot, which he had left a barren waſte, covered with goodly trees, at once an honour and benefit to the ſpirited undertaker, and an ornament to the country.

Thoſe who forbear to plant their heath, or moor-lands, from a ſuppoſition that they are incapable of rearing trees, may take an example of the fallacy of that idea, from the thriving ſtate of the plantation which the Duke of Bedford has raiſed on Woburn ſands. A few years ago the ground was a barren waſte of hungry, ſterile, devouring ſand, which ſcarcely yielded ſuſtenance to a blade of graſs; the laſt time I paſſed the place it was changed into a wood of healthy thriving Firs. I mention this young and ſmall plantation,

 becauſe

because every one who has paſſed that road muſt be convinced that no land could have a more unpromiſing appearance, for the growth of wood, than this had.

I truſt it has been proved, by the foregoing facts, that two of the moſt unpromiſing kinds of land, in which this kingdom abounds, and which have hitherto been deemed barren, may, by attention, be brought to be equally if not more profitable than lands of the beſt quality in the uſual courſe of huſbandry.

Among the obſervations made, I have only pointed out ſuch trees as ſeem beſt adapted to each ſituation; but I wiſh it not to be inferred from this, that others of our beſt and moſt valuable timbers will not alſo grow on the ſame ſituations. The contrary is the fact; and it is neceſſary that a judicious mixture of Oak, Aſh, Elm, and many other woods, ſhould be made in forming a plantation. The kinds I have deſcribed as moſt deſiring theſe ſituations, and being of quick growth, will become excellent nurſes to others; and, as they attain maturity, or grow too thick, may

may be removed to make room for the reſt, and thus furniſh a conſtant ſucceſſion of profits from the firſt planting. I cannot here refrain from ſpeaking greatly in favour of the Larch Fir, *(Pinus Larix,)* both as a tree of great beauty, which will make prodigious advances in ſuch land as I have laſt deſcribed, and alſo as a wood of great value, and an excellent defence for other trees, forming, in a ſhort time, a comfortable ſcreen around thoſe that are leſs hardy. I have planted large numbers of them round ſome plantations I have made; and nothing can exceed the beautiful appearance theſe lively ſkirts of green exhibit early in the ſpring.

III. The laſt kind of land I ſhall notice in theſe obſervations, are thoſe mountainous tracts of barren rocky hills which are met with in many parts of the country, and which, at preſent, are nearly uſeleſs. It is unneceſſary to enlarge much upon this ſubject, where the facts lie ſo much within the range of common obſervation. View the large chain of hills, or rather rocks, which ſeparates the vale of Cleveland from the moors in the north riding of Yorkſhire. Theſe hills are clad with

with Oaks from the foot to the ſummit: between Thirſk and Stokeſley, woods of this deſcription afford a moſt charming and delightful appearance for miles together; where the land in general, a flinty rock ſloping to the north, is incapable of cultivation, having little or no ſoil, except the ſcanty portion which the rains have waſhed into fiſſures and crevices. In theſe, Oaks have fixed their roots, and made ſuch growth, that, on one of the hills, a ſurvey of the timber made about two years ago, as I am informed, eſtimated its value at thirty thouſand pounds. What a noble fortune to the younger branches of the family to whom this wood was left!

Evelyn tells us, in his *Sylva*, of an Italian nobleman, who, after his lady was brought to bed of a daughter, (conſidering that wood and timber were a revenue coming in whilſt the owners were aſleep,) ordered his lands to be planted with 100,000 trees; calculating that each tree might be worth twenty-pence by the time his daughter became marriageable, which would amount to near 10,000*l.* which he intended to be her portion.

This

This practice I am told is not uncommon in Holland, where they plant the Abele for the purpoſe of portioning out the younger branches of families; and this ſyſtem muſt have our warmeſt approbation, if we conſider the certain advantages reſulting from it, and the benefit derived to a country from keeping up a ſucceſſion of timber. Boucher reports, that he ſold Elms of his own raiſing, at twenty-four years growth, for one guinea each, and theſe not ſelected, but a whole line of them together, conſiſting of above ſixty in number: and, he farther informs us, that he planted the eighth part of an acre of ſterile red clay-land with Aſh-trees, the product of which, in twenty-three years, was after the rate of 115 *l.* 10 *s.* an acre, or 5 *l. per* acre annually. But, to detail proofs of advantages of this kind, eſtabliſhed on unexceptionable authority, would require a volume. One circumſtance, however, I cannot avoid mentioning; it is on the authority of Evelyn. He ſays, "It is ſuppoſed there may "be twenty-ſix millions of ſquare acres in the "kingdom, excluſive of fens, highways, rivers, "&c. &c. not eſtimated. 'Now, value but the

"annual

"annual growth of timber at fourpence each acre, "and it will amount to nearly half a million fter- "ling, exclufive of the maft and loppings." But, if I eftimate right, that, out of thefe twenty-fix millions of acres, one-eighth part is deftitute of any profits whatever, and yet capable of being improved, (as I truft has been fhewn,) allowing the annual growth of each acre to be no more than ten fhillings, on the average, the benefit to the country is upwards of one million five hundred thoufand pounds each year, exclufive of the timber growing on the remaining twenty-three millions of acres. And, when we confider the large fums paid to foreign countries for timber, and its increafing fcarcity in this, it will furely be worth the confideration of every true friend to his country, and every benevolent and patriotic mind, to reflect for a moment on the eftimate thus moderately calculated. Let him then draw the conclufion in his own mind, what profits will accrue to every judicious planter of timber, and what advantages our pofterity and our country may reap from fuch exertions.

XXIV. *Obſervations on the Grafting of Trees.* By THOMAS ANDREW KNIGHT, *Eſq. of Elton, Herefordſhire.*

From the TRANSACTIONS of the ROYAL SOCIETY of LONDON.

THE diſeaſe from which thoſe varieties of the Apple and Pear which have been long in cultivation ſuffer moſt, is the canker; the effects of which are generally firſt ſeen in the winter, or when the ſap is firſt riſing in the ſpring. The bark becomes diſcoloured in ſpots, under which the wood, in the annual ſhoots, is dead to the centre, and, in the older branches, to the depth of the laſt ſummer's growth. Previous to making any experiments, I had converſed with ſeveral planters, who entertained an opinion, that it was impoſſible to obtain healthy trees of thoſe varieties which flouriſhed in the beginning and middle of the preſent century, and which now form the largeſt orchards in this country. The appearance of the young trees which I had ſeen, juſtified the concluſion they had drawn; but the ſilence of every writer on the ſubject of planting, which had come in my way, convinced me that it was a vulgar error, and the following experiments were undertaken to prove it ſo.

I ſuſpected that the appearance of decay, in the trees I had ſeen lately grafted, aroſe from the diſeaſed ſtate of the grafts, and concluded, that if I took ſcions or buds from trees grafted in the year preceding, I ſhould ſucceed in propagating any kind I choſe. With this view I inſerted ſome cuttings of the beſt wood I could find in the old trees, on young ſtocks raiſed from ſeed. I again inſerted grafts and buds taken from theſe, on other young ſtocks; and, wiſhing to get rid of all connection with the old trees, I repeated this ſix years; each year taking the young ſhoots from the trees laſt grafted. Stocks of different kinds were tried; ſome were double-grafted; others obtained from Apple-trees which grew from cuttings; and others from the ſeed of each kind of fruit afterwards inſerted on them: I was ſurpriſed to find that many of theſe ſtocks inherited all the diſeaſes of the parent-trees.

The wood appearing perfect and healthy in many of my laſt-grafted trees, I flattered myſelf that I had ſucceeded; but my old enemies, the moſs and canker, in three years convinced me of my miſtake. Some of them, however, trained to a ſouth wall, eſcaped all their diſeaſes, and ſeemed (like invalids) to enjoy the benefit of a better climate. I had before frequently obſerved, that all the old fruits ſuffered leaſt in warm ſituations, where the ſoil was not unfavourable. I tried the effects of laying one kind, but the canker deſtroyed it at the ground. Indeed, I had no hopes of ſucceſs from this method, as I had obſerved that ſeveral ſorts, which had always been propagated from cuttings, were as much diſeaſed as any others. The wood of all the old fruits has long appeared to me to poſſeſs leſs elaſticity and hardneſs, and to feel more ſoft and ſpongy under the knife, than that of the new varieties which I have obtained from ſeed. This defect may, I think, be the immediate cauſe of the canker and moſs, though it is probably itſelf the effect of old age, and threfore incurable.

Being at length convinced that all efforts, to make grafts from old and worn-out trees grow, were ineffectual, I thought it probable that thoſe taken from very young trees, raiſed from ſeed, could not be made to bear fruit: the event here anſwered my expectation. Cuttings from ſeedling Apple-trees, of two years old, were inſerted on ſtocks of twenty, and in a bearing ſtate; theſe have now been grafted nine years, and, though they have been frequently tranſplanted, to check their growth, they have not yet produced a ſingle bloſſom. I have ſince grafted ſome very old trees with cuttings from ſeedling Apple-trees, of five years old; their growth has been extremely rapid, and there appears no probability that their time of producing fruit will be accelerated, or that their health will be injured, by the great age of the ſtocks. A ſeedling Apple-tree uſually bears fruit in thirteen or fourteen years; and I therefore conclude, that I have to wait for a bloſſom until the trees from which the grafts were taken attain that age; though I have reaſon to believe, from the form of their buds, that they will be extremely prolific. Every cutting, therefore, taken from the

the Apple, and probably from every other tree, will be affected by the ſtate of the parent-ſtock. If that be too young to produce fruit, it will grow with vigour, but will not bloſſom; and, if it be too old, it will immediately produce fruit, but will never make a healthy tree, and conſequently never anſwer the intention of the planter. The root, however, and the part of the ſtock adjoining it, are much more durable than the bearing-branches; and I have no doubt but that ſcions obtained from either would grow with vigour, when thoſe taken from the bearing-branches would not. The following experiment will at leaſt evince the probability of this in the pear-tree. I took cuttings from the extremities of the bearing-branches of ſome old ungrafted Pear-trees, and others from ſcions which ſprang out of the trunks near the ground, and inſerted ſome of each on the ſame ſtocks. The former grew without thorns, as in the cultivated varieties, and produced bloſſoms the ſecond year; whilſt the latter aſſumed the appearance of ſtocks juſt raiſed from ſeeds, were covered with thorns, and have not yet produced any bloſſoms.

The

The extremities of thoſe branches which produce ſeeds, in every tree, probably ſhew the firſt indication of decay; and we frequently ſee (particularly in the oak) young branches produced from the trunk, when the ends of the old ones have long been dead. The ſame tree, when cropped, will produce an almoſt eternal ſucceſſion of branches. The durability of the Apple and Pear, I have long ſuſpected to be different in different varieties; but that none of either would vegetate with vigour much, if at all, beyond the life of the parent-ſtock, provided that died from mere old age: of the Apples mentioned and deſcribed by Parkinſon, the names only remain, and thoſe ſince applied to other kinds are now alſo worn out; but many of Evelyn's are ſtill well known, particularly the red-ſtreak. This Apple, he informs us, was raiſed from ſeed, by Lord Scudamore, in the beginning of the laſt century. (Probably about the year 1634.) We have many trees of it; but they appear to have been in a ſtate of decay during the laſt forty years. Some others, mentioned by him, are in a much better ſtate of vegetation; but they have all ceaſed to deſerve the

attention

attention of the planter. The durability of the Pear is probably ſomething more than double that of the Apple.

It has been remarked by Evelyn, and by almoſt every writer ſince, on the ſubject of planting, that the growth of plants raiſed from ſeeds was more rapid, and that they produced better trees than thoſe obtained from layers or cuttings. This ſeems to point out ſome kind of decay attending the latter modes of propagation; though the cuſtom in the public nurſeries, of taking layers from ſtools (trees cropped annually cloſe to the ground) probably retards its effects, as each plant riſes immediately from the root of the parent-ſtock.

Were a tree capable of affording an eternal ſucceſſion of healthy plants from its roots, I think our woods muſt have been wholly over-run with thoſe ſpecies of trees which propagate in this manner; as thoſe ſcions from the roots always grow, in the firſt three or four years, with much greater rapidity than ſeedling-plants. An Aſpen is ſeldom ſeen without a thouſand ſuckers riſing from its roots; yet this tree is thinly, though univerſally, ſcattered over the woodlands of this

country.

country. I can ſpeak from experience, that the luxuriance and exceſſive diſpoſition to extend itſelf, in another plant which propagates itſelf from the root, (the Raſpberry,) decline in twenty years from the ſeed. The common Elm, being always propagated from ſcions or layers, and growing with luxuriance, ſeems to form an exception; but, as ſome varieties grow much better than others, it appears not improbable that the moſt healthy are thoſe which have laſt been obtained from ſeed. The different degrees of health in our Peach and Nectarine trees may, I think, ariſe from the ſame ſource. The Oak is much more long-lived in the north of Europe than here; though its timber is leſs durable, from the numerous pores attending its ſlow growth. The climate of this country, being colder than its native one, may, in the ſame way, add to the durability of the Elm; which may poſſibly be farther increaſed by its not producing ſeeds in this climate; as the life of many annuals may be increaſed to twice its natural period, if not more, by preventing their ſeeding.

I have been induced to ſay a great deal more on this ſubject than it may appear to deſerve, from a conviction that immenſe advantages would ariſe from the cultivatior of the Pear and Apple in other counties; and that the ill ſucceſs which has attended any efforts to propagate them, has ariſen from the uſe of worn-out and diſeaſed kinds. Their cultivation is ill-underſtood in this country, and worſe practiſed; yet an acre of ground, fully planted, frequently affords an average produce of more than five hundred gallons of liquor, with a tolerably good crop of graſs; and I have not the leaſt doubt but that there are large quantities of ground, in almoſt every county in England, capable of affording an equal produce.

XXV. *Obſervations on the Nature and Action of Manures.* *By M.* Parmentier.

From the Memoirs of the Royal Society of Agriculture of Paris.

A WANT of manure, or an improper manner of uſing it, are the principal cauſes of the ſterility of a country. In vain may we unite our efforts to diſcover new methods of culture, to improve thoſe already known, and to bring to perfection the inſtruments uſed therein, if the firſt ſource of fruitfulneſs be neglected; the produce of our land will, in that caſe, always be ſmall in quantity, and uncertain, however favourable the ſeaſon may be. The uſe of manures has been known in all ages, but we are yet far from having any clear and preciſe ideas of the nature of the juices which are deſtined for the nouriſhment of vegetables, and of the manner in which they are tranſmitted to their organs.

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The writers on agriculture who have endeavoured to explain theſe matters, perceiving ſalts in moſt plants, were perſuaded that theſe ſalts, by the help of water and heat, paſſed, in a ſaline form, through the vegetable filter. Theſe firſt philoſophers did not heſitate to conſider every thing that has been done by the induſtry of man, to improve the nature of land, and its productions, as merely forming reſervoirs of theſe ſalts, which they conſidered as the principle of fertility. This opinion was ſo well eſtabliſhed among the improvers of land, that, to this day, many of them have no object in view, in their operations, but to diſengage ſalts; and, when they attempt to explain certain phænomena which take place in their fields or orchards, they talk confidently about the *nitre of the air*, *of rain*, *of ſnow*, *of dew*, *and fogs*; of the *ſalts of the earth*, *of dung*, *of marle*, *of lime*, *of chalk*, *&c.* and make uſe of thoſe vague terms, *oil*, *ſulphur*, *ſpirit*, *&c.* which ought henceforward to be baniſhed from our elementary books on agriculture.

Among the authors who have attacked, and combated with moſt ſucceſs, the opinion that the fruitfulneſs of soils, and the aliment of vegetables,

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reſide in ſaline ſubſtances, muſt be reckoned Eller and Wallerius. Theſe philoſophers examined, by every means which chymiſtry at that time could furniſh, the various kinds of earth proper for cultivation, and alſo thoſe ſubſtances which have always been conſidered as the moſt powerful manures, without being able to obtain, from any of them, any thing more than mere atoms of ſalt.

Animated with the ſame zeal, and taking advantage of the inſtructions found in their writings, I thought it neceſſary to determine by experience, whether, as has been aſſerted, there really exiſt neutral ſalts in earths; and alſo whether thoſe earths are more fertile in proportion to the quantity of ſuch ſalts they contain. With this view, I lixiviated, by means of diſtilled water, many ſpecies of cultivated earths, taken in various ſtates, from freſh earth to that which had been impoveriſhed by the growth of ſeveral crops; I alſo tried dung, reduced more or leſs into the ſtate of mould; and likewiſe the moſt active manures, ſuch as the offal of animal ſubſtances rotted by putrefaction; but in none of theſe, however carefully analyzed, were found any ſalts in a free ſtate. They contain indeed the materials proper

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for forming ſalts, but, if they contain any ready formed, it is merely by accident.

An abſtract of theſe experiments, added to thoſe of M. André, an eminent chymiſt of Hanover, (whoſe labours were undertaken in order to teach thoſe who were engaged in cultivation, how they might themſelves aſcertain the nature of the land they had to cultivate,) is printed in my tranſlation of the works of Model. And, if ſuch experiments were continued with the ſame view, they would throw ſome light upon the rules to be obſerved in improving one ſort of land by means of another, and might help to fix the proportion of each adapted to different plants.

The reſearches of Kraft, and thoſe of Alſton, were not attended with different reſults. Having ſown ſome oats in aſhes, not lixiviated, and in ſand ſtrongly impregnated with potaſh and with ſaltpetre, and having found that the oats did not grow, they concluded that neutral ſalts, and alkalies, not only retarded the growth of vegetables, but that they abſolutely prevented it. It is well known that in Egypt there are diſtricts where the earth is entirely covered with ſea-ſalt, and theſe diſtricts are quite barren. It is probably owing to this property of sea-salt, that the Romans were accustomed to scatter large quantities of it over fields where any great crime had been committed, and of which they wished to perpetuate the remembrance, by rendering the part barren for a certain time. This circumstance renders me anxious to prevent the mischief which may arise from the use of sea-salt as a manure. Let us employ this article in a more advantageous manner; it is particularly useful to animals of the poultry-yard, and to cattle, being, at the same time, a preservative and a remedy to them. By being mixt with fodder, it gives tone and energy to the organic parts of animals; increases the quantity of their milk, and makes it more rich; renders their flesh more succulent, and causes their litter, when used as manure, to be more powerful in its effects.

The idea that salts had great influence in vegetation, ought to have been greatly weakened by the following simple reflection. Supposing that salts existed in garden mould, they would be very soon dissolved by the rain, and carried away, towards the lower strata of the earth, to a depth to which the longest roots would not reach. Indeed the famous experiment of Vanhelmont would have

been

been ſufficient to have deſtroyed the above opinion, if it did not generally happen, that we are no ſooner ſet free from one error than we fall into another not leſs extraordinary. The ſurpriſing effects of vegetation brought about by the overflowing of water, and in the neighbourhood of ſalt marſhes, and the infinite number of inhaling capillary tubes obſerved upon the ſurface of vegetables, led to an opinion that the air and water, abſorbed by the roots and leaves of plants, were only vehicles loaded with ſaline matter, analogous to the vegetables nouriſhed by them.

To the experiment of Vanhelmont, which was repeated by many accurate obſervers, ſucceeded thoſe of modern philoſophers; from which it clearly appeared, that plants could grow, and produce fruit, in the air of the atmoſphere, and in diſtilled water, alſo in pure ſand, in powdered glaſs, in wet moſs or ſponge, in the cavity of fleſhy roots, &c. and that plants which had nothing but the above-mentioned fluids for their nouriſhment, gave, when ſubmitted to chymical analyſis, the ſame products as thoſe which had undergone their proceſs of vegetation in a ſoil perfectly well manured.

nured. It was alſo obſerved, that the moſt barren ſoils were rendered fertile when they were properly ſupplied with water by canals; and the efficacy of irrigation was repeatedly evinced in different ways: from theſe obſervations was formed the following ſyſtem, that water riſes in plants in the form of vapour, as in diſtillation; that air introduces itſelf into their pores; and that, if ſalts contribute to the fruitfulneſs of ſoils, it is only in conſequence of their containing the two fluids above mentioned, in great abundance.

In ſupport of this reaſoning, the curious experiments of M. Tillet were publiſhed, which I thought ſo worthy of attention, that I haſtened to confirm them by new facts, at a time when the philoſophy of gaſes was very little underſtood, and when it was not known that air and water, (which had been ſo long conſidered as elements,) far from being ſimple ſubſtances, were capable of being decompoſed by a great variety of operations, both of nature and art, and particularly by vegetation. Aſſiſted by the reſearches of ſo eminent a coadjutor, I twenty years ago hazarded an opinion reſpecting the matter in queſtion, which I ſhall

here

here take the liberty briefly to repeat, without altering the ſenſe of my former expreſſions.

The more I reflect upon the reſpective properties of ſoils fit for cultivation, and the manures which are added to them to increaſe their fruitfulneſs, the leſs I think myſelf wrong, when I maintain that ſaline ſubſtances have no ſenſible effects in promoting vegetation, except in as much as they are of a deliqueſcent nature, have an earthy baſis eaſily decompoſed, and are uſed only in ſmall quantity. In thoſe cimcumſtances they have the power of attracting, from the immenſe reſervoir of the atmoſphere, the vapours which circulate in it; theſe vapours they retain, along with the moiſture that is produced from rain, ſnow, dew, fog, &c. which moiſture they prevent from running together in a maſs, or from being loſt, either by exhaling into the air of the atmoſphere, or by filtering itſelf through the inferior ſtrata of the earth, and thereby leaving the roots of vegetables dry; they diſtribute that moiſture uniformly, and tranſmit it, in a ſtate of great diviſion, to the orifices of the tubes deſtined to carry it into the texture of the plant, where it is afterwards to undergo the laws of assimilation. As every kind of vegetable manure possesses a viscous kind of moisture, it thereby partakes of the property of deliquescent salts. In short, the preparation of land for vegetation has no other object in view but to divide the earthy particles, to soften them, and to give them a form capable of producing the above-mentioned effects. It is sufficient, therefore, that water, by its mixture with the earth and the manure, be divided, and spread out so to as to be applied only by its surface, and that it keep the root of the plant always wet, without drowning it, in order to become the essential principle of vegetation. But, as plants which grow in the shade, even in the best soil, are weakly, and as the greater part of those which are made to grow in a place that is perfectly dark neither give fruit nor flowers, it cannot be denied that the influence of the sun is of great importance in vegetable œconomy.

Such is the opinion I then gave of the manner in which salts act in vegetation; nothing was wanted to that theory, but to know that air and water act their part, in this important operation,

only

only in a ſtate of decompoſition; and that, if earth well manured is a better matrix than water itſelf, it is becauſe ſuch earth has the power of converting the water into gaſes which are eaſily abſorbed, and which, while their abſorption takes place, communicate to the plants a motion and heat which they received when taking the form of gas, and which they loſe when they enter again into combination; whence it is natural to conclude, that this motion and this heat muſt neceſſarily develope themſelves in ſeeds, and maintain the vital action in plants.

What is a vegetable, conſidered chymically, according to the preſent ſtate of our knowledge? It is, ſay the chymiſts, a compound of hydrogen, oxygen, and carbon, the proportions of which vary, according to the agents which have concurred to its developement, and according to the matrix which received and aſſimilated them, in order to create thoſe combinations which are varied to infinity, by their forms and properties, and known by the generic terms of ſalt, oil, and mucilage. It appears, therefore, needleſs to ſeek theſe combinations in the different ſubſtances which are used for manure, when we wish to determine the nature of them, and explain their manner of acting in vegetation; because, supposing it true that these salts, these oils, or these mucilages, exist in their combined state, nothing but their constituent elements namely, hydrogen, oxygen, and carbon, can possibly have any action.

The superiority of animal substance, as manures, and the remarkable luxuriance of those plants which are watered with putrid water, prove incontestibly, that the putrid state is favourable to vegetation, and that every substance which is liable to enter, to a certain degree, into that state, contributes very powerfully thereto. The most aërated waters are, in this case, the most beneficial; it is observed, that rain, particularly in stormy weather, quickens vegetation so much, that the gardeners, in the neighbourhood of Paris, are often obliged to drench their plants with water taken from their wells, which, in consequence of its rawness, or its want of air, retards the vegetation of the plants; either because it precipitates the meteorized or electrified water, or because, by being mixed with the other water, it diminishes its fertilizing

tilizing quality; whereas, in ſummer, this ſame well-water, by being expoſed to the ſun for ſome days, acquires a ſmell like that of ſtale eggs, loſes its rawneſs, and becomes very fit for accelerating vegetation. An atom of vegetable or animal matter is, at that time, ſufficient to bring about more qucikly this ſtate of putrefaction; while theſe ſame ſubſtances, by being employed in certain proportions, far from acting as a leaven on the liquids which hold them in ſolution, preſerve thoſe liquids, or at leaſt make them more ſlow to change.

Salts and dung, therefore, are not merely decompoſed by the power of vegetation: by furniſhing the reſults of their decompoſition, they alſo act in the manner of leavens, the action of which is ſcarcely perceptible in cold or dry weather; but, when they are heated by the ſun, and ſufficiently penetrated with moiſture, they very ſoon enter into a ſort of fermentation, ſuffering the various gaſes with which they are provided to eſcape. Thus, manures may be conſidered as decompoſing inſtruments, provided by nature, and prepared by art, to act upon water, ſo as to bring it to a proper ſtate of attenuation. The ſubſtances which enter into the compoſition of plants,

plants, are therefore nothing but products of the decompoſition of air and water, and combinations of the conſtituent principles of theſe two fluids, determined by the power which preſides in the ſeed, and which thence has paſſed into the plant.

It is now eaſy to account for the effects of charcoal-powder, ſtraw, &c. which are made uſe of to cover ground, during long droughts, with undoubted benefit: they are mechanical means of preventing the diſſipation of moiſture, and of determining it to take the form of thoſe gaſeous fluids which have ſuch powerful effect in vegetation. As water is compoſed of hydrogen and oxygen, it is not ſurpriſing that, when aſſiſted by the influence of the ſun, and that of electricity, it is capable of forming, almoſt by itſelf, the ſolids and fluids of vegetables; taking from the atmoſphere the carbon it ſtands in need of, to give them their moſt eſſential characters. I ſay their moſt eſſential characters; for thoſe terreſtrial plants which have grown in air and water, do not abound in principles, and their offspring, when they have any, is by no means vigorous. We ſee alſo, that plants which are naturally of an aquatic nature,

have,

have, in general, but little ſmell, becauſe the medium in which they live and grow furniſhes only a ſmall quantity of carbon, in proportion to the hydrogen and oxygen, which are the conſtituent principles of water. This is the reaſon why, in cold and wet years, flowers are leſs odoriferous, fruit leſs full of flavour, and more difficult to be preſerved. The germ of their re-production is weak; and they are, if I may make uſe of the expreſſion, in a ſort of dropſy; that is to ſay, they are loaded with the principles which conſtitute water, and even with water itſelf.

Theſe obſervations, to which I could add many more, may ſerve to explain why vegetation is ſlow and weak in a ſoil which is too much charged with ſaline matter, while it is rendered quick and vigorous by a ſmall quantity of this ſame matter; and why earth which is perfectly lixiviated, and watered, from time to time, with diſtilled water only, is capable of giving to bitter plants their bitterneſs, to ſweet ones their ſweetneſs, to acid ones their acidity, to aromatic ones their ſpicineſs, and to poiſonous ones their deleterious qualities; in ſhort, why the inherent characters of plants are more ſtrongly marked, in proportion as the ſoil in which they grow is furniſhed with natural or mechanical means to produce a quantity of gas neceſſary to the formation of the ſubſtances on which thoſe characters depend.

If a nitrous or marine plant can, even when growing in a ſoil deſtitute of nitre or ſea-ſalt, occaſion the production of theſe ſalts, it muſt be allowed that ſuch plants would vegetate more ſtrongly, and contain more of ſuch ſalts, if they grew in ſoils more abounding in materials proper to form them. Thus, the different ſpecies of ſamphire, glaſſwort, ſea-wrack, &c. flouriſh on the borders of the ſea, ſuch ſoils being ſtrongly impregnated with the fluids neceſſary to form the muriatic gas and ſea-ſalt which enter into the compoſition of thoſe plants; while the ſun-flower, pellitory, &c. ſucceed beſt in earth which is mixed with the ruins of old buildings, in which the materials for the production of nitrous gas, and even of nitre itſelf, are very abundant. In ſhort, the organization of theſe plants is a real elaboratory for forming the forementioned ſalts.

TO BE CONCLUDED IN OUR NEXT.

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NUMBER XXXIV.

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XXVI. *Specification of the Patent granted to Mr.* JOSEPH HATELY, *of the City of Worceſter, Engineer; for his Diſcovery of a Method of extracting and making, from vegetable Bodies, a new aſtringent acid Liquid, applicable to Improvements in divers Arts and Manufactures.*

Dated Feb. 19, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in obedience to the ſaid letters patent, and the proviſo therein contained, I the ſaid Joſeph Hately do hereby deſcribe and aſcertain the nature of my aforeſaid invention, and the manner in which the ſame is to be peformed, in manner following; that is to ſay, retorts, compoſed of glaſs, earth, or other calcareous ſubſtances, muſt be made, erected, and prepared, of a convenient ſize or ſhape, (ſuch as cupolas, kilns, ovens, or air-furnaces, &c.) with apertures for the reception of the vegetable bodies, for which the aſtringent acid liquid is intended to be extracted or made, according to my ſaid invention. To theſe retorts, receivers, made either of wood, or of glaſs, or other calcareous ſubſtances, muſt be connected, and placed in cold ſituations; or, vermicular tubes, ſurrounded by water, may be connected with the retorts. Theſe receivers, or vermicular tubes, muſt be united to the retorts by other tubes or ducts, ſo as to form a communication from the retorts to the receivers, or vermicular tubes. The apparatus being thus pepared, vegetable bodies, either wood, bark, or other vegetable ſubſtances, are to be placed in the retorts, and fire applied thereto, of ſufficient heat to expel or evaporate the volatile matter or humidity from ſuch vegetable ſubſtances; which volatile matter or humidity, being collected in the

the receivers, (whether through a vermicular tube or otherwiſe,) produces the aſtringent acid liquid mentioned in the ſaid recited letters patent. Beſides which, ſmoke and a groſs black burnt oil or bitumen are alſo produced therefrom, leaving in the retorts a firm ſtrong charcoal; and, by admitting air into the retorts, ſo as to conſume the charcoal to aſhes, they will, by diſſolution in water, produce a fixt ſalt, and leave an earthy ſubſtance. In order to produce the liquid in larger quantities, and of greater ſtrength than can be procured by placing the wood, bark, and other vegetable bodies, in their natural ſtate, in the retorts, the ſame will be effected by firſt ſaturating ſuch wood, bark, and other vegetable bodies, in a liquor impregnated with aluminous, nitrous, and vitriolous earths, either in their natural form, or in a putrified ſtate. In witneſs whereof, &c.

XXVII. *Specification of the Patent granted to Mr.* JAMES JORDAN, *of Oak-Hill, in the Pariſh of Shepton Mallet, in the County of Somerſet; for his new Invention in the Art of conſtructing Bridges, Aqueducts, &c.*

WITH TWO PLATES.

Dated May 24, 1796.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, and in purſuance of the ſaid ſtatute, I the ſaid James Jordan do hereby declare, that my invention conſiſts in ſuſpending to an arch or arches, in manner herein-after deſcribed, bridges, (with or without draw-bridges therein,) aqueducts, the tops or coverings of buildings and other erections, inſtead of the methods heretofore adopted for conſtructing and ſupporting them; whereby the weight or weights thereof will be *ſuſ-pended,*

pended, ſo as to leave the parts under the ſame, between the buttreſſes or other end ſupports of bridges and aqueducts, and between the walls or other encloſures of buildings and other erections, nearly as free as if no ſuch bridge, aqueduct, top or covering, were placed over the ſame; by which means, intermediate piers will be avoided, the navigation of rivers be improved, many cauſes of obſtruction and damage be removed, and bridges be conſtructed and placed in a way likely to preſerve them from decay, a much greater length of time than when they have a connection with the river under them. The materials for ſuch arch or arches, to which bridges and other works are to be ſuſpended, on the principles of my invention, may be of the different kinds herein after ſpecified, or any other whatſoever, capable of being uſed in the conſtruction of the ſame; and the form and ſtrength of the ſeveral parts may vary, according to the nature, extent, and other circumſtances belonging to and dependent upon them. It will likewiſe appear, from the explanations herein after given of *ſome* of the methods in which my invention may be applied,

that

that moſt of the works erected on the principles hereof will not have a *lateral*, but only a *perpendicular* preſſure on the buttreſſes, walls, or other end ſupports; which in many caſes will be of great advantage. To explain more fully the nature of my invention, and the manner in which the *principles* of it may be applied in ſeveral caſes, although with *many* variations in the form and ſtrength of the parts, (the *principle* being ſtill retained,) I have annexed drawings, which the following particulars are intended to elucidate. Fig. 1. (Plate XII.) repreſents the elevation, and Fig. 2. half the tranſverſe-ſection, of a bridge, without a draw-bridge, and with one of the buttreſſes unfiniſhed. It may be formed, and erected, in the following manner: A, ſhews the horizontal rib of the bridgeway, compoſed of well-ſeaſoned timber, in different lengths, ſo as to break the heading joints, and in three thickneſſes, (but it may be in more,) with caſt iron plates, ſolid or hollow, cloſe or open, as wide as the thickneſs of the ribs; the timbers and the iron to be bolted together (ſee A, Fig. 2.) by ſtrong wrought-iron bolts, with large heads and nuts. Theſe ribs may be put together

on

on land, and be conveyed to their place on the buttresses, by means of floating-rafts or vessels, with proper mechanical or other supports thereon, and by such other powers on the land as the nature of the case may require. These ribs are to be completely fixed in their place, and are to be stayed and supported in the middle, from the heads of two, or more, temporary piles, previously driven into the river to receive them. When both the ribs are thus placed, they will form the main parts for the scaffolding, by which much expence will be saved. B, is one of the circular suspending ribs, composed in this bridge (see B, Fig. 2.) of eight ribs of well-seasoned timber, (but may be of such number, and scantling, as strength and convenience may require,) and two ribs of cast iron, in long lengths; (one or both of which may be omitted in small bridges;) the whole bound together by strong wrought-iron bolts, large nuts, and heads. The timbers are to be of different lengths, calculated to give strength and unity to the whole, and to break the heading joints, betweeen which may be placed thin plates of copper, or any other metal. The points of the

circular

circular ribs are to be bound, and connected to the horizontal ribs, by different iron ſtraps and bolts, as ſhewn at C, Fig. 1. Theſe ribs may be erected by beginning at the ends, and uniting them ſucceſſively and progreſſively towards the crown, ſcaffolding and ſupporting the works from the horizontal ribs. D D, Figs. 1 and 2, ſhew the ſuſpending bars of wrought iron, or other metallic ſubſtances, with large heads, plates, and nuts. Preparation is to be made in the different ribs, to admit theſe bars to be paſſed through from the top of the circular ribs, after which the plates and nuts are to be applied, to connect the circular with the lower ribs. E, Fig. 2, is one of the girders or bearers, lying croſswiſe, about ſix feet from each other. Theſe girders are to be received in a box-mortiſe at one end, and a pulley-mortiſe at the other, ſo that they may be fixed, or diſplaced, without affecting the ribs: they are to be ſecured to the ribs by iron ſtrap-bolts, paſſing through the ſides, and faſtened by ſmall ſcrew-bolts to the girders, which will likewiſe prevent the ribs ſpreading from each other. F F, Fig. 2, are bearers laid on the gir-

ders,

ders, longitudinally with the ribs, to be of different lengths, to give ſtrength, and to be ſecured to the girders by ſtrap-bolts paſſing through the bearers; to admit the removal of the latter, they are to be ſtapled to one ſide only of the girders. G, Fig. 2, ſhews the planks lying over the bearers, and ſecured to them by croſs iron plates. The plates to be let into the ſurface of the planks next the joints, that one half the width of the plate may be on one plank, and the other half on the other, with bolts paſſing through the ſame, to ſecure the planks to the bearers: on theſe planks, gravel and ballaſt may or may not be laid. H, Fig. 2, repreſents one of the croſs timbers in the crown of the ſuſpending ribs. Theſe are to be continued down as low as the headway for waggons will admit, and are to have croſs and diagonal timbers framed in between them, to prevent any lateral preſſure from injuring the ribs: they are to be connected to the ribs by proper bearings, bolts, &c. I, Fig. 2, ſhews a footway, which may or may not be affixed to the bridge at its building, or which may be affixed at any future time. It conſiſts, according to this ſection, of of wrought-iron bottom bars, ſide bars, and large and ſmall brace-bars: one of each is to be affixod to every ſuſpending bar, by the bottom bar paſſing on the top of the horizontal rib, and turning up to receive a wrought-iron bar, which is to ſecure it to the ſuſpending bar, as ſhewn at K. When a footway is intended to be erected, the caſt-iron plate of the horizontal rib ſhould be wider than the timbers, to leave a ſufficiency of it for the ſide and brace-bars to bear thereon; the ſide bars may be ſecured to the rib by ſtaples. Four or more timber-bearers are to lie longitudinally over, and are to be notched on to the bottom bars: on theſe bearers are to be laid planks, which are to croſs the bearers, and to form the floor; and on or againſt the front of the outermoſt bearer, are to be fixed poſts, ſecured by the iron braces, and alſo at the bottom to the bars: to theſe poſts proper rails, and pannels filled in, may be affixed. The top of the buttreſſes may be formed into a double parapet, for a footway between, or the paſſengers may turn off into the carriage-way. Fig. 3. (Plate XIII.) repreſents part of a bridge on the before-deſcribed conſtruction, in which a

draw-

draw-bridge is introduced. A A, are the parts of the bridge to be drawn up. BB, is an iron frame, secured to the circular rib, and to two suspending bars, for the purpose of distributing the weight to, and preserving the form of, the arch. The chains here shewn are of the kind generally used, but such as are more proper are on the principle of those for which the Society for the Encouragement of Arts and Manufactures have given a premium, and which act in the same manner as a rope *. CC, are iron rolling-wheels, on which the chains for raising the bridge are to pass, (other rollers being on the inside,) and are so placed as to cause the bridge, in rising, to clear the suspending-chains out of the way of the masts. The chains may either be passed through the rib at D, to wind up the bridge by a perpendicular direction, (in which case proper machinery will be affixed on the bridgeway for that purpose,) or the draw-bridge may be taken up by means of weights moving on the surface of the lower parts

* The chain here recommended by Mr. Jordan is described in our present Number, page 241.

of the circular rib, and on ſuch parts as may tend rather to benefit than to injure them; and, as the weight of the draw-bridge will be progreſſively leſs on the chains, as it riſes, the increaſed velocity and power of the weights may be corrected by the application of ſprings and inclined planes. Various methods may be adopted for taking up and returning the draw-bridges with eaſe and facility, and, by a connection of the chains, render the manual force neceſſary to be employed, not more than that of *one* perſon. As a counter-balance for the ſeparation of the bridgeway, (if only of one arch,) the ends of it are to go the farther on the buttreſſes, and are to be faſtened to iron bars, brought up a conſiderable way in the buttreſſes, and connected with chain-bars laid horizontally in them, for the purpoſe of forming additional binders to the horizontal ribs of the bridgeway. Where, from the great width of the river, more than one arch may be proper, this precaution will not be neceſſary, as the horizontal rib will be continued to receive other additional ſuſpending-ribs, as deſcribed hereafter in the conſtruction of continued aqueducts.

Fig.

Fig. 4. represents the transverse section, and Fig. 5. the elevation, of a continued aqueduct, to which the principles of my invention are applied. A, Fig. 4 and 5, shews the horizontal rib, which is to be put together in a similar manner to that described for the bridge; but, not being liable to so much agitation, nor the support of so great bearings, it may be of smaller scantlings. B B, Fig. 4, are the circular suspending ribs, composed of cast iron, formed in the following manner: each rib-piece is to be cast of a proper length to break the heading-joints, and may appear solid on the face, or may be cast of an open pattern, to give elegance to the appearance of the whole. One rib-piece is to be laid, and secured to the other, so that the rib may be of two, three, or more pieces in width, on one side of the suspending-iron, and of the same number on the other side; and, when combined by bolts and straps, to connect them to each other, and for receiving the hanging-irons, will form a double circular suspending-rib. This mode may be also applied to bridges, and that described for bridges may be applied

applied to aqueducts. C C, Fig. 4, are the ſuſpending-irons, with heads of a ſize ſufficient to cover the rib, and ſecured at bottom in the ſame manner as deſcribed for the bridgeway, Figs. 1 and 2. The heads are to be ſecured to receſſes in the top of the circular ribs, by proper bolts. D, Fig. 4, is one of the girders, which may be put up and united as in the method propoſed for the bridgeway, Fig. 2. E, Fig. 4, ſhews one of the croſs-ſtays, which in this aqueduct, to give it a light appearance, is propoſed to be of caſt or wrought iron. Croſs and diagonal irons are to be added, to anſwer the purpoſe mentioned in the deſcription of the crown of the bridgeway, Fig. 2. F, Fig. 4, repreſents the horſe and foot path; but, as the method of conſtructing this path is nearly the ſame as that deſcribed in the explanation of the footway to the bridge, (ſee I, Fig. 2,) no more need be obſerved than that, this being affixed higher, the bottom and brace bars may be connected to the ſuſpending irons by mortiſes and ſmall bolts, and the floor conſiſt of only one thickneſs of bearers, laid longitudinally on the

iron

iron bottom bar. The bottom and sides of this aqueduct may be of wood, stone, cast or wrought iron, wood lined with sheet-lead, copper, or of other materials, having the upper parts filled in by planks, to give them a bearing against the suspending-irons; by which means, they will be prevented from any accident that a lateral pressure might otherwise occasion. For passing boats and other vessels, an endless rope or chain is to be provided, and vertical and other rollers are to be fixed clear of the ends of the aqueducts: this rope or chain is to lie on the inside and outside of the suspending-irons, and round the rollers. When boats, &c. are brought up to the aqueduct, they are to be made fast to that part of the rope or chain next them, and the force employed to draw them being taken to the other end of the path, and fastened to that part of the rope or chain on the outside of the irons, by drawing towards the boats, &c. the first of them will pass the aqueduct (the rest following) in the time the force applied is passing the pathway. This method of passing boats, &c. may be avoided, by erecting the pathway

way on the inſide of the bars, which may be high enough to permit the boats, &c. to paſs under it, ſo that no extra-width in the aqueduct will be neceſſary on their account. Fig. 5. repreſents part of an aqueduct, which may, on the ſame principle, be continued to any extent; the diſtance of the piers or ſupports being increaſed or decreaſed, regular or irregular, as circumſtances and utility may require. Being conſtructed agreeable to the ſection, Fig. 4, it needs no explanation, only this may be obſerved, that as the points of the ſegments abut on each other, much of the precaution to be obſerved in the conſtruction of a ſingle arch, to prevent a longitudinal expanſion of the rib, will be rendered unneceſſary, and the piers or ſupports will not be liable to a lateral, but only to a perpendicular preſſure; conſequently they may be built much ſmaller than if liable to a lateral preſſure, and may be a frame-work of iron, or other materials, if thought proper. It will appear, from what has been explained, that bridges and aqueducts may be continued to any length, and extended to any width; they

they may be continued, by placing ſuch a number of ribs longitudinally as may be neceſſary; and they may be extended, by adding, at ſuch diſtances as the weight and bearings may require, one, two, or more ranges of ribs between the outer ones. The principles of my invention, as they are to be applied to covering in of large buildings, may be underſtood without any drawings to explain them; as ſimilar methods to thoſe propoſed for the ſuſpending of bridges and aqueducts may be applied, with ſuch variations as the nature of the buildings may require. The cieling-floor may be ſupended by timbers, inſtead of irons, connected to the tie-beams and ſuſpending-ribs, by iron ſtirrups and bolts; the ribs may vary ſomewhat from a curve, and the roof over may be of a common form. The principles of my invention being thus explained and illuſtrated, by *ſome* of the modes which may be adopted, I obſerve that, as the invention itſelf is not ſubject to any preciſe form, ſize, or ſcantling, it muſt always vary according to the nature, extent, and intended ſervice of the works, as well as the kind of materials to be uſed, which the judicious architect or engineer will accommodate to local and exiſting circumſtances. I have conſidered it moſt proper not to perplex the explanation with dimenſions of the various parts, thinking it quite ſufficient to deſcribe the nature and utility of my invention, and the manner in which it may be applied. Neither have I explained the good effects and advantages that will ariſe from it, by ſpeedy erection, by a ſaving in expence, by durability, by the certain and eaſy mode of repairing, and various other advantages, becauſe ſuch explanations would not properly form a part of the ſpecification. It witneſs whereof, &c.

XXVIII.

Fig. 1

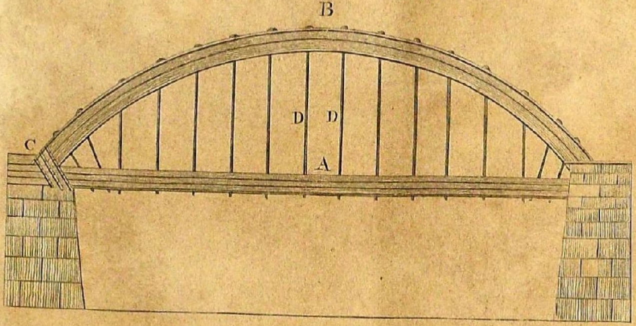


Fig. 2

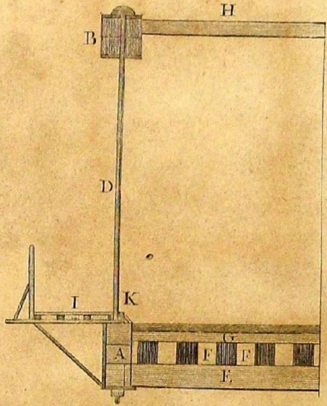


Fig. 3

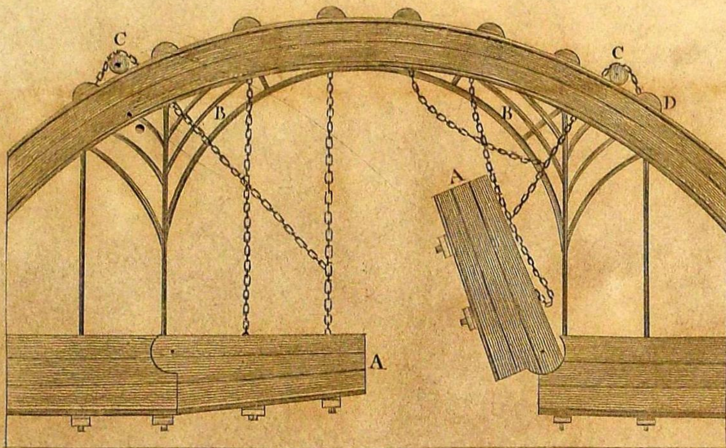


Fig. 4

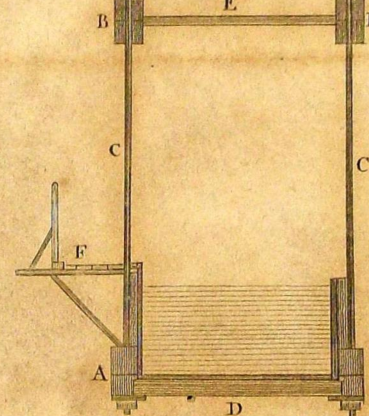
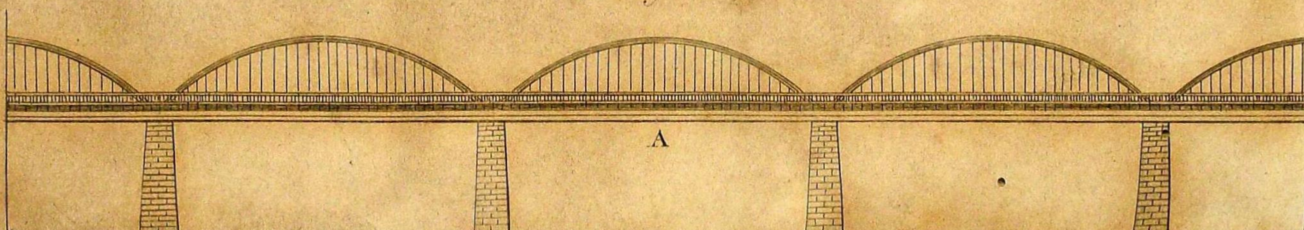


Fig. 5



XXVIII. *Specification of the Patent granted to Mr.* John Bigg, *of Iping, in the County of Suſſex, Papermaker; for his Invention of an entire new Mode of bleaching Paper, by a cheap and expeditious Proceſs, in Conſequence of which the Colour of ſuch Paper will be ſo effectually fixed as not to be affected by Heat or any Length of Time.*

Dated Feb. 28, 1795.

To all to whom theſe preſents ſhall come, &c. Now know ye that, in compliance with the ſaid proviſo, I the ſaid John Bigg do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, take of manganeſe eight pounds, of common ſea-ſalt twelve pounds, or any other quantity in the ſame proportion, which being mixed together muſt be well beaten in a mortar, ſo as to be thoroughly incorporated, having a wooden box or receiver made of the dimenſions moſt convenient to the ſize of the papers to be

bleached;

bleached; in which box or receiver may be contained ten, twelve, or more wooden racks, which are to be made to ſlide in grooves juſt clear of each other, on which lay your paper flat; if a thick paper, about ſix or ſeven ſheets thick; if a thin paper, nine or ten ſheets thick. If it is to be bleached in the firſt ſtate, as made from the vat, it muſt be preſſed as hard as is uſual to preſs the packs of fine papers the laſt time after being parted in the pack. Then take it in the quantities as above, and lay it on the racks, taking care it does not lie one quantity in the leaſt over the other; then cloſe up the door of the receiver, and, having a ſand-bath, or other method of conveying heat, conveniently affixed at the back of the box or receiver, place therein a glaſs, lead, or other proper retort, being tubulated; in which firſt put eight ounces of the above mixture of mangeneſe and ſalt, to which add ten ounces of vitriolic or ſulphuric acid (the retort being previouſly fixed with its neck admitted through a hole made as near the centre in the back of the box as may be) immediately into the retort, with ſome pipe or other ſoft clay, and the bleaching

will

will immediately commence, and in the courſe of two hours will be effectually completed. Then open the door of the box or receiver, and take out the paper, and furniſh the racks with freſh paper; after which, add the ſame charge again to the retort, and proceed as before. The paper, after being bleached, muſt be laid even together, and preſſed juſt ſufficient to make moiſture appear at the edges in drops; after which, hang up the paper to dry in lofts, in the common way. After it is dry, previous to its being ſized, it muſt be wetted out in the following liquor, which will effectually fix the colour: take of alum eight pounds, diſſolve it in a gallon or two of warm water, letting it ſtand till quite cold; mix it with one hundred gallons of cold ſpring-water; then take the paper and wet it out in the common way in the above liquor, and, be it either thick or thin paper, it muſt be preſſed very hard, and after being again dried it may be ſized in the uſual way. Particular care ſhould be taken that you do not uſe any of the above liquor after being preſſed out of the paper; or it may be done in the dry water-leaf ſtate. To do it after it is ſized, the paper may be done dry, or wetted out in cold water, and preſſed very hard; after which, you are to proceed in every reſpect as above; but, to ſucceed in this way, it requires the paper to be peculiarly well ſized. By this proceſs, paper that has become mildewed, or loſt its colour, will be completely reſtored, and fine papers rendered much ſuperior, both in quality and colour. Another method is; take a tub or other receiver, fill it with cold water, leaving a vacancy of about one tenth of the quantity it will contain, into which introduce the neck of a retort, the retort charged with a proportion of the aforeſaid mixture of the manganeſe and ſalt; then add thereto the ſame proportion of vitriolic or ſulphuric acid as before: the quantity in each retort, and the number of retorts to be uſed, muſt be ruled by the quantity of liquor wanted; in which liquor the paper is to be wetted out, and ſoaked in it till it is properly bleached, which will depend on the quality of the paper to be bleached; after which, let the paper be well preſſed and dried; when dry, wet it out in alumed water, as in the other proceſs. In witneſs whereof, &c.

XXIX.

XXIX. *Specification of the Patent granted to Mr.* JOHN AITKEN, *Fellow of the Royal College of Surgeons in the City of Edinburgh; for his Invention of a new Method of loading Tubes, Barrels, Calibers, or Bores, commonly called Guns or Fire-Arms, &c. whether the ſame be mounted or unmounted, of every Form, Dimenſion, and Denomination, with two or more Charges of Gunpowder and Shot, or Balls, (the ſaid Charges placed before one another in one Tube,) and of diſcharging them from the ſaid Tube, in Succeſſion, by Fire communicated through correſpondent Perforations or Touch-holes.*

Dated Dec. 5, 1780.—Term expired.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid John Aitken do hereby declare, that my ſaid invention of a new method of loading tubes, barrels, calibers, or bores, commonly

commonly called guns or fire-arms, is performed in the following manner; that is to ſay, into a tube, barrel, &c. cylindrical, conical, chambered, or not, its poſterior extremity (ſituation ſuppoſed horizontal) ſecurely cloſed, named breech, its anterior one open, named muzzle, I lodge a plurality of charges of powder and ſhot. The extenſion of the fire, in a poſterior direction from the charge next the muzzle, which is firſt inflamed, is intercepted by intermedia betwixt the ſeveral charges, about or above the ſhot firmly rammed. Theſe I form of any ſubſtance ſufficiently reſiſtent, compact, and incombuſtible, properly proportioned and ſhaped. In the ſmaller tube (the muſket, blunderbuſs, piſtol, &c.) I chiefly employ the thicker ſtuffs, or leather. In the larger one (the cannon, ſwivel, &c.) various ſtuffs, paſtes, &c. as being commodious and procurable. The charges are ignited, in ſucceſſion, through touch-holes, by the lock, or match, as occaſion demands, according to the ſize and condition of the tube. In witneſs whereof, &c.

XXX. *Description of a metal Rope or Chain, intended to answer the Purpose of a hempen Rope, in large Manufactories; invented by* Mr. WILLIAM HANCOCK, *of Birmingham.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Premium of Fifty Guineas was given to Mr. HANCOCK for this Invention.

THESE chains are designed as a substitute for ropes, and are applicable to all the purposes to which ropes are adapted, particularly in the working of coal and other mines; also for cranes, wells, &c. From the mode of making the common chains, they are very uncertain, and are known to break in the welded parts, when over-strained; which objection is, in these chains, removed,

removed, by the manner in which they are made; (see Plate XIV. Fig 1.) being woven together, while cold, out of the stoutest iron drawn into wire, and so managed that it is next to impossible there should be a bad link.

With the above account of Mr. Hancock's chain are given letters from Mr. J. Miles, Mr. W. Whitmore, and Mr. W. Bingley, of Birmingham, also from Mr. W. Johnson, of Bradley, from which the following are extracts.

Extract from Mr. Miles's letter.

I have seen a chain or iron rope, invented by William Hancock, used by Mr. William Bingley, in his plated-wire manufactory, for the very powerful purpose of drawing large wire. I observed that it runs as flexible on the pulley as a hempen rope, and I believe that it is much stronger, and will wear much longer, than a rope of two inches diameter, made of the best hemp; I do also believe, that its strength may be more safely relied on, as the wire of which it is made has, in every part of it, first borne an equal pur-

chase,

chaſe, in being cold-drawn, for the purpoſe of making the ſaid chain or iron rope.

Extract from Mr. Whitmore's letter.

I have frequently ſeen, and admired, an iron chain uſed in Mr. Bingley's manufactory for drawing wire, made on Mr. Hancock's principle; and which, I have no doubt, will anſwer the purpoſe of drawing coals much better than a rope; it having the advantage of being as ſtrong where it coils round a ſmall barrel as where it is ſtraight. A rope is weakened by being bent, and takes more power to open and ſhut than the chain: bad iron cannot be uſed in it, nor can a faulty place eſcape being found in the operation of cold-drawing.

Extract from Mr. Bingley's letter.

I have made uſe of the metallic rope or chain made by William Hancock, for about four years: it works over a nine-inch pulley, and anſwers admirably well; and as, from Hancock's ſituation in life, he is not able to make them for ſale, I have executed many orders, &c.

Extract from Mr. Johnſon's letter.

A chain of Hancock's making is now in uſe at our foundry here; and has been, for five or ſix years paſt, uſed inſtead of a rope at the large triangles, for loading caſtings, breaking old guns, metal, &c. The iron or wire of which it is made, is about three-eighths of an inch in diameter, and occaſionally lifts two or three tons.

We had, ſome time ſince, a chain of that kind worked in a pit about fifty yards deep, and a hempen rope to work againſt it; but, the colliers taking a prejudice againſt it, we employed it otherwiſe.

We have now, at moſt of our engines where ropes are required, adopted thoſe chains for drawing up piſtons from the cylinders, &c, and, where ropes are ſubject to ſteam and wet ſituations, they are far preferable to ropes, as they work perfectly pliable and eaſy over either pulleys or rollers.

We have had ſome of thoſe chains made from Engliſh and foreign iron, but they have ſometimes failed, through the iron being faulty.

The only iron to be depended upon is thick wire, as the drawing of it detects any fault in the quality. Chains made from this wire would come into more general uſe, inſtead of ropes, if it were not for the ſcarcity, as well as high price, of this kind of iron.

We have had a chain from Hancock, a few weeks ſince, ſeventy-one yards long, bare three-eighths wire, weight two hundred and ſixteen pounds, or about three pounds *per* yard; it will work two tons. If the obſtacles before mentioned were not in the way, we ſhould have thoſe chains in more general uſe than they are; but this objection ſhould not deprive the claimant of the merit due to his invention.

XXXI. *Description of a Method of using, to the best Advantage, the Power applied to the Cross-Bar Lever, for raising large Weights.* By *Mrs.* ELIZABETH WYNDHAM, *of Petworth.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

The Silver Medal of the Society was presented to Mrs. WYNDHAM for her ingenious Contrivance, a Description of which is given in the following Letter from her.

I HAVE sent you a model of a mechanical invention of my own, which you will laugh at, as every one here did at first; but, I assure you that

that the workmen all approve of it very much, and agree that it is of great service to them. Since you left Petworth, a great work has been begun, of moving earth in which there are great quantities of stones: I observed that the men made use of the lever in a very ineffectual manner, by standing three or four at a time on the bar of the lever, by which means some of them were placed so near the fulcrum, that their power was in a great degree lost; besides, they were obliged to steady themselves upon sticks, for fear of falling, which took off their weight upon the lever.

A, (Plate XIV. Fig. 2.) is the lever.

B, is an upright piece of wood to be fixed to the lever, taking care that the side marked with the letter B be placed opposite the letter A, on the lever, as by that means it inclines backwards, which increases the power.

C, is a cross-bar for the workmen to hold by.

D, is a cross-bar to be placed at bottom, behind the upright piece of wood, for the men to stand upon, and the end of the lever passes,

through

through it. Theſe additions are made to take on and off, and are only to be uſed when the ſtrength of the rocks requires an increaſe of power.

If the rock to be moved ſhould be, as I have often ſeen it, placed ſo high above the ground as to put the men in danger of being hurt by falling, on the diſplacing of the rock, in ſuch caſe the lever may be reverſed, ſo that the men will then ſtand upon the bar on which, in common caſes, their hands are placed; and thus they will not be in danger of falling.

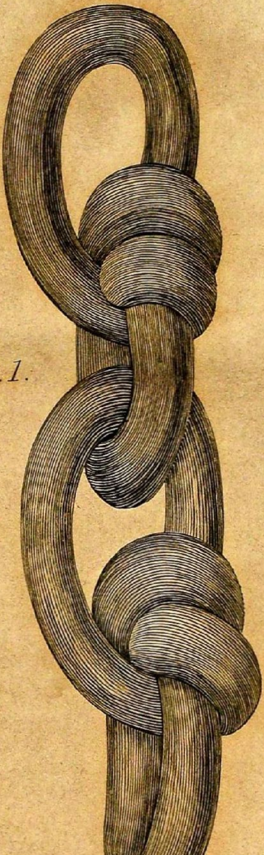
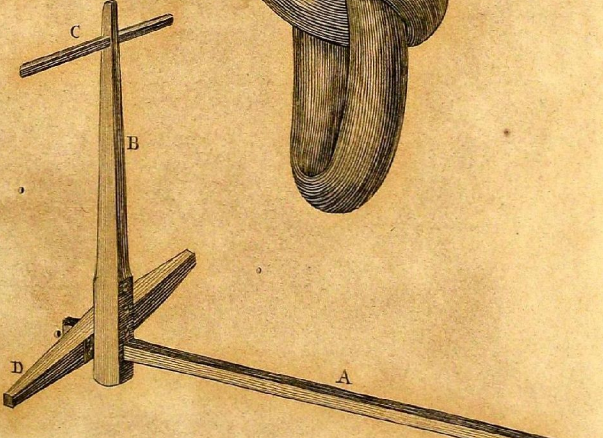


Fig. 1.

Fig. 2.



XXXII. *Description of an improved Pedometer.* *By Mr.* LEWIN TUGWELL, *of Beverstone.*

WITH A PLATE.

From the Letters and Papers of the Bath and West of England Society for the Encouragement of Agriculture, &c.

IN the Cyclopædia of Chambers, under the article *Perambulator*, it is said, that the proper application of that machine is, for surveying of roads and large distances, where great expedition, and not much accuracy, is required. This want of accuracy, as will be obvious enough to every inspector, arises from the too small dimensions of its measuring-wheel, which, in its application, too readily adapts itself to the casual inequalities of the surface; and hence the desideratum of some contrivance for admitting a larger wheel, to obviate that defect. This, some years since, was attempted by Mr. Edgeworth, whose machine for the

the purpoſe ſeems the moſt ſimple that can be conceived; he however, ſimplicity being in mechanics a criterion of excellence, (and probably from conſidering, in addition to the above-mentioned defect in the old machine, its too great complexity,) ſeems to have gone into the oppoſite extreme, and, almoſt through the whole of his machine, to have ſacrificed utility to an unneceſſary degree of ſimplicity.

In mechanics, the previous aſcertaining a defect is as neceſſary to improvement as, in phyſic, the determining on the exiſtence of a diſeaſe to its cure; I have therefore ventured to ſubmit the annexed ſpecimen to the inſpection of the committee, hoping ſome one will point out improvements which I do not ſee, and, purſuing the ſame to effect, render it ſtill more deſerving the regard of the community.

Mr. Edgeworth, in conformity to the above-mentioned ſimplicity of his pedometer, found it neceſſary to attempt nothing more in its operations than the meaſuring of roads, diſtances, &c. and, even for this, unleſs where the ſtones had previouſly been broken, and the roads worn ſmooth,

ſmooth, (inſtances, for any conſiderable length, rarely to be met with,) I found it, on trial, very inadequate.

In the ſpecimen I have now ſent, nothing has been omitted to render it capable of meaſuring roads in general, with greater facility, accuracy, and expedition, than can be done by any other mode I have ſeen or heard of; while it alſo equally excels in ſurveying or meaſuring of lands. By the common mode of meaſuring theſe, by Gunter's or any other chain, the progreſs (comparatively, in reſpect to that made by the pedometer) is uſually ſlow; and, while it ingroſſes the conſtant attention of two or more perſons in company, the reſult is ſometimes erroneous. A perſon uſing the pedometer has not only, when at work, no need of an aſſiſtant; but while, of himſelf, he meaſures with greater accuracy and expedition than is done by the chain, if an unemployed companion caſually attend him, he is at liberty, for the moſt part, while the work goes forward, to take a ſhare in converſation on any indifferent ſubject.

The idea of land-meaſuring by this mode aroſe from an impoſition, which is, perhaps, but too frequently practised. A labourer's task-work being to be measured, no one was at hand to carry the chain (the usual term) but the labourer himself; when the land was measured, and the money paid, he went to the ale-house, got drunk, and boasted of having outwitted his master, in having shortened the chain, by gathering some of the links in his hand at its fore end.

References to the Figure of the Pedometer. (See Plate XV.)

A. The stock of the Pedometer.

B B B, &c. Twelve spokes; one end of each inserted in the stock; the other fastened, with a screw, to the outward ring, or periphery, of the wheel.

C. Periphery, being an iron ring, 16½ feet, or one pole, in circumference, adapted to Gunter's concise method of arithmetic, and divided into 25 equal parts, corresponding to the links of his chain for land-measuring, &c.

D D D, &c. Twelve small plates, denoting the separate spokes, each including two links of the chain above-mentioned.

N.B.

N.B. The twelfth ſpoke is divided at its foot, for taking in the odd or 25th link.

E. An iron axis, being a ſcrew with 320 circumvolutions, ſeparately marked on an engraved index on one of its ſides: in its application, it is ſcrewed faſt into the ſtock of the wheel, and, when at work, revolves with it.

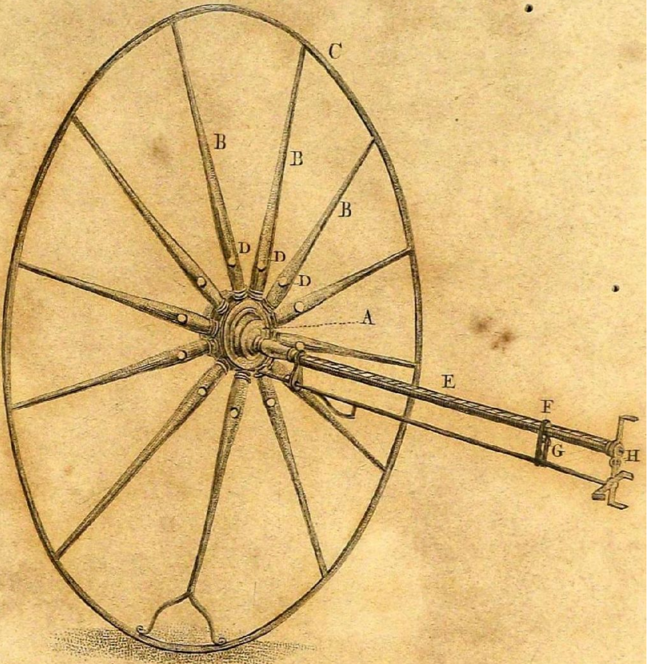
F. A ſtyle or alidade, being an expanding ſcrew-nut, embracing the axis, and ſcrewing along it, as the latter revolves with the wheel; and, as each revolution of the wheel, when rolling on the ſurface, deſcribes an exact longitudinal pole, (and conſequently four of them a chain,) the ſtyle, being pendent, and moving to its proper figure, denotes the length of ground paſſed over, as divided into chains and poles, on the index of the axis E, and into links on the periphery C.

G. A ſmall adjuſting-ſcrew, by turning of which the ſtyle may be inſtantaneouſly moved back to the beginning of the index, when, in land-meaſuring, the given line has been aſcertained in chains, poles, &c.

H. A croſs or ſquare, with ſights for determining, in land-meaſuring, the perpendiculars; ſuſpended

pended at its ends on the axis, and occaſionally to be detached therefrom, when uſed, with a touch only of the finger and thumb. It farthermore acts (by the lower end of the ſtyle F embracing alſo its ſtandard) in preventing the ſaid ſtyle from being carried round, by any poſſible accident, with the axis as it revolves, which, before it was uſed, had ſometimes taken place, and greatly embarraſſed the account; and, as the 320 diviſions, marked poles on the index of the axis, are calculated for deſcribing an exact mile, the ſtyle F, having paſſed over them, will then ſcrew no farther; but, moving round with the axis, takes with it the ſtandard, and, ſtriking it on the wriſt of the operator, prevents the poſſibility of his proceeding farther, till he has drawn his hand from between the ſaid ſtandard and the axis; having received the neceſſary hint, he turns the ſcrew G, puts back the ſtyle F to the bottom of the index, and goes on as before.

N.B. The ſtandard of the croſs, being divided into five lengths, occaſionally ſubſtitutes the ten-link rod, which is uſed for meaſuring off-ſets, &c. and is alſo uſed for ſmall diſtances inacceſſible to the wheel.


C
B
B
B
D
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D
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E
F
G
H

XXXIII. *An Attempt to make a Thermometer for measuring the higher Degrees of Heat, from a red Heat up to the ſtrongeſt that Veſſels made of Clay can ſupport. By* Mr. JOSIAH WEDGWOOD, *of Greek-ſtreet, Soho.*

From the TRANSACTIONS of the ROYAL SOCIETY OF LONDON.

A MEASURE for the higher degrees of heat, ſuch as the common thermometers afford for the lower ones, would be an important acquiſition, both to the philoſopher and the practical artiſt. The latter muſt feel the want of ſuch a meaſure on many occaſions, particularly when he attempts to follow, or apply to uſe, the curious experiments of Mr. Pott, related in his Lithogeognoſia, and other modern writers upon ſimilar ſubjects. When we are told, for inſtance, that ſuch and ſuch materials were changed, by fire, into a fine white, yellow, green, or other coloured glaſs, and

and find that these effects do not happen, unless a particular degree of fire has fortunately been hit upon, which degree we cannot be sure of succeeding in again; when we are disappointed, by having the result at some times an unvitrified mass, and at others an over-vitrified scoria, from a little deficiency or excess of heat; when we see colours altered, not only in shade but in kind, and in many cases destroyed, by a small augmentation of the heat which had produced them, insomuch that, in the gradual increase of the fire, a precise moment of time must be happily seized, in order to catch them in perfection; and when inconveniences similar to these arise in operations by fire upon metals and other substances; how much is it to be wished, that the authors had been able to convey to us a measure of the heat made use of in their valuable processes!

In a long course of experiments for the improvement of the manufacture I am engaged in, some of my greatest difficulties and perplexities have arisen from not being able to ascertain the heat to which the experiment-pieces had been exposed. A *red*, *bright red*, and *white heat*, are

indeter-

indeterminate expreſſions; and, even though the three ſtages were ſufficiently diſtinct from each other, they are of too great latitude; as the brightneſs or luminouſneſs of fire increaſes with its force, through numerous gradations, which can neither be expreſſed in words nor diſcriminated by the eye. Having no other reſource, I have been obliged to content myſelf with ſuch meaſures as my own kilns, and the different parts of them, afforded. Thus, the kiln in which our glazed ware is fired furniſhes three meaſures; the bottom being of one heat, the middle of a greater, and the top ſtill greater. The kiln in which the biſcuit-ware is fired furniſhes three or four others, of higher degrees of heat; and by theſe I have marked my regiſtered experiments. But, though theſe meaſures had been fully adequate to my own views, which they were not, it is plain that they could not be communicated to others; that their uſe is confined to a particular ſtructure of furnaces, and mode of firing; and that, upon any alteration in theſe, they would become uſeleſs and unintelligible, even where now they are beſt known. And indeed, as this part of the

 operation

operation is performed by workmen of the loweſt claſs, we cannot depend upon any great accuracy, even in one and the ſame furnace. It has accordingly often happened, that the pieces fired in the top of the kiln, in one experiment, have been made no hotter than thoſe fired in the middle, in another, and *vice verſa.*

The force of fire, in its higher as well as lower ſtages, can no otherwiſe be juſtly aſcertained, than by its effects upon ſome known body. Its effect in changing colours has already been hinted at; and I have obſerved compoſitions of calces of iron with clay to aſſume, from different degrees of fire, ſuch a number of diſtinct colours and ſhades, as promiſed to afford uſeful criteria of the reſpective degrees.

With this idea, I prepared a quantity of ſuch a compoſition, and formed it into circular pieces, about an inch in diameter, and a quarter of an inch thick. A number of theſe was placed in a kiln, in which the fire was gradually augmented, with as much uniformity and regularity as poſſible, for near ſixty hours. The pieces taken out at equal intervals of time, during this ſucceſſive

increaſe

increafe of heat, and piled in their order, one upon another, in a glafs tube, exhibited a regular and pretty extenfive feries of colours; from a flefh-colour to a deep brownifh-red, thence to a chocolate, and fo on to nearly black, with all the intermediate tints between thefe colours. A back being fixed to the tube, like the fcale of a thermometer, and the numbers of the pieces marked upon it, refpectively oppofite to them, it is obvious that thefe numbers may be confidered as fo many thermometric divifions or degrees; and that, if another piece of the fame compofition be fired in any other kiln or furnace, not exceeding the utmoft heat of the firft, it will acquire a colour correfponding to fome of the pieces in the tube, and thus point out the degree of heat which that piece, and confequently fuch other matters as were in the fire along with it, have undergone.

It muft however be confeffed, that for general ufe, a thermometer on this principle is liable to objection; as ideas of colours are not perfectly communicable by words; nor are all eyes, or all lights, equally adapted for diftinguifhing them,

 efpecially

eſpecially the ſhades which approach near to one another; and the effects of phlogiſtic vapours, in altering the colour, may not in all caſes be eaſily guarded againſt.

In conſidering this ſubject attentively, another property of argillaceous bodies occurred to me; a property which obtains, in a greater or leſs degree, in every kind of them that has come under my examination, ſo that it may be deemed a diſtinguiſhing character of this order of earths; I mean, *the diminution of their bulk by fire.* I have the ſatisfaction to find, in a courſe of experiments made with this view, that it is a more accurate and extenſive meaſure of heat than the different ſhades of colour.

I have found that this diminution begins to take place in a low red heat, and that it proceeds regularly, as the heat increaſes, till the clay becomes vitrified, and conſequently to the utmoſt degree that crucibles, or other veſſels made of this material, can ſupport. The total contraction of ſome good clays which I have examined, in the ſtrongeſt of my own fires, is conſiderably more than one-fourth part in every dimenſion.

If,

If, therefore, we can procure at all times a clay ſufficiently apyrous or unvitreſcible, and always of the ſame quality in regard to contraction by heat, and if we can find means of meaſuring this contraction with eaſe and minute accuracy, I flatter myſelf that we ſhall be furniſhed with a meaſure of fire, ſufficient for every purpoſe of experiment or buſineſs.

We have, in different parts of England, immenſe beds of clay; each of which, at equal depths, is pretty uniform in quality throughout its whole extent. Of all the ſorts I have hitherto tried, ſome of the pureſt Corniſh porcelain-clays ſeem the beſt adapted, both for ſupporting the intenſity, and meaſuring the degrees of fire.

For preparing and applying this material to thermometric purpoſes, the following method is propoſed.

The clay is firſt to be waſhed over, and, whilſt in a dilute ſtate, paſſed through a fine lawn: let it then be made dry, and put it up in boxes *.

The

* While the clay is thus kept dry in boxes, as well as while it continues in its natural bed, it is ſecure from altera-

tions

The dry clay is to be ſoftened for uſe, with about two-fifths of its weight of water; and formed into ſmall pieces, in little moulds of metal, ſix-tenths of an inch in breadth, with the ſides pretty exactly parallel, (this being the dimenſion intended to be meaſured,) about four-tenths of an inch deep, and one inch long. To make the clay deliver eaſily, it will be neceſſary to oil the mould, and make it warm.

Theſe pieces, when perfectly dry, are put into another iron mould or gage, conſiſting only of a bottom, with two ſides, five-tenths of an inch wide, to the dimenſions of which ſides the breadth of the pieces is to be pared down.

For meaſuring the diminution which they are to ſuffer from the action of fire, another gage is made, of two pieces of braſs, twenty-four inches long, with the ſides exactly ſtraight, divided into inches and tenths, fixed five-tenths of an inch aſunder, at one end, and three-tenths at the other, upon a

tions in quality; which clays in general are ſubject to undergo, when expoſed, for a long courſe of years, to the joint actions of air and moiſture. In the lawns I made uſe of, the interſtices were each leſs than the 100,000 part of an inch.

braſs

braſs plate; ſo that one of the thermometric pieces, when pared down in the iron gage, will juſt fit to the wider end. Let us ſuppoſe this piece to have diminiſhed in the fire one-fifth of its bulk, it will then paſs on to half the length of the gage; if diminiſhed two-fifths it will go on to the narroweſt end; and, in any intermediate degree of contraction, if the piece be ſlid along till it reſts againſt the converging ſides, the degree at which it ſtops will be the meaſure of its contraction, and conſequently of the degreee of heat it has undergone.

Theſe are the outlines of what appears to me neceſſary for the making and uſing of this thermometer; and it is hoped, that the whole proceſs will be found ſufficiently ſimple, and eaſy of execution. It may, nevertheleſs, be proper to take notice of a few minuter circumſtances, and to mention ſome obſervations which occurred in the progreſs of the enquiry.

I. There ought to be a certainty of the clay being eaſily, and at all times, procurable in ſufficient quantity, and on moderate terms. That this is the caſe, with the clay here made choice of, of, will be evident to every one acquainted with the natural hiſtory of Cornwall, where there are beds of this clay, inexhauſtible, and in too many hands to be monopolized. If this ſhould not prove ſatisfactory, the author offers to this illuſtrious ſociety, and will think himſelf honoured by their acceptance of, a ſufficient ſpace in a bed of this clay to ſupply the world with thermometer-pieces for numerous ages; and he does not apprehend that any greater inconveniences can ariſe to foreign artiſts or philoſophers, from their being ſupplied with clay for theſe thermometers from this ſpot only, than what we now feel from being ſupplied with mercury, for the common thermometers, from the Spaniſh or Hungarian mines.

II. We ought to be aſſured alſo, that all the clay made uſe of for theſe thermometers is perfectly ſimilar. For this purpoſe it will be beſt to dig it out of the earth in conſiderable quantity at once, (an extent of ſome ſquare feet or yards in area, and to the depth of ſix or ſeven yards, or more from the ſurface,) and to mix the whole thoroughly together, previous to the farther pre-

paration

paration already mentioned. When the firſt quantity is exhauſted, another perpendicular column may be dug from the ſame bed, cloſe to the firſt, to the ſame depth, and prepared in the ſame manner; by which means we may be aſſured of its ſimilarity with the former parcel, and that it will diminiſh equally in the fire.

III. This clay, dried by the ſummer heat, or in a moderately warm room, or with more heat before a fire, has not been obſerved to differ in degree of dryneſs. After being ſo dried, it loſes about a hundredth part of its weight in the heat of boiling water, about as much more in that of melted lead, and thence to a red-heat ten ſuch parts, in all $\frac{12}{100}$. Each of theſe heats ſoon expels from the clay its determinate quantity of matter, chiefly air; after which, the ſame heat, though continued for many hours, has no farther effect. I had ſome hopes, that the graduation of the common thermometer might be continued, upon this principle, up to the red-heat at which the ſhrinking of the clay commences, ſo as to connect the two thermometers together by one ſeries of numbers;

but the loss of weight appears not to be sufficiently uniform, or proportional to the degree of heat, to answer that purpose; for it was found to go on quicker, and bladders tied to the mouths of the vessels in which the pieces were heated became more rapidly distended, at the commencement of redness than at any other time. From a low red-heat to a strong one, such as copper melts in, the loss of weight was only about two parts in a hundred; though the difference between these two heats appears to be much greater than what the same loss corresponds to in the lower stages. After this period, the decrease of weight entirely ceased.

The vapours expelled from the clay, caught separately in the different degrees of heat, seemed, from the few trials made with them, to consist of common air mixed with fixt air. They all precipated lime-water; that which was first extricated, exceeding weakly; the others, more and more considerably; but the last, not near so strongly as the air expelled from lime-stone in burning: none of them were inflammable.

IV. The

IV. The thermometric pieces may be formed much more expeditiouſly than in the ſingle mould, by means of an inſtrument uſed for ſimilar purpoſes by the potters. It conſiſts of a cylindrical iron veſſel, with holes in the bottom, of the form and dimenſions required. The ſoft clay, put in the veſſel, is forced by a preſs down through theſe apertures, in long rods, which may be cut while moiſt, or broken when dry, into pieces of convenient lengths. It was hoped, that this method would of itſelf have been ſufficient, without the addition of the paring-gage, making proper allowance, in the ſize of the holes, for the ſhrinking of the clay in drying; but it was found, that a variety of little accidents might happen to alter the ſhape and dimenſions of the pieces, in a ſenſible degree, while in their ſoft ſtate. It will therefore be always ſafeſt to have recourſe to the paring-gage, for aſcertaining and adjuſting their breadth when perfectly dry, this being the period at which the pieces are exactly alike with regard to their future diminiſhing; ſo that, if they are now reduced to the ſame breadth, we may be ſure that they will ſuffer equal contractions from equal degrees of heat afterwards, whether they have been made in a mould, or by a preſs, or in any other way: neither is any variation in the length or thickneſs of theſe pieces of the leaſt conſequence, provided one of the dimenſions, that by which they are afterwards to be meaſured, is made accurate to the gage.

TO BE CONCLUDED IN OUR NEXT.

XXXIV.

XXXIV. *Conclusion of M.* Parmentier's *Observations on the Nature and Action of Manures.*

(From Page 216.)

THOSE plants which, for their vegetation, require the most assistance from the soil and manure, are very apt to contract a disagreeable taste, if either the soil or manure are capable of supplying the principles from which it is acquired. The class *Tetradynamia*, particularly all sorts of cabbages, (which contain sulphur ready formed,) contract a bad taste in a soil composed of mud and dung, because these substances, as they are decomposed, furnish a great quantity of hepatic gas, or of sulphurized hydrogen gas; yet plants of another class may grow in the same soil, close by the cabbages, without partaking, even in the smallest degree, of the bad taste of the latter. The plants last mentioned, when growing in hepatic gas, retain only so much of it as is suf-

ficient

ficient for the production of the substances of which they are formed; the overplus, which could not be assimilated, is thrown out by the excretory vessels, after undergoing those modifications which the digestive juices and organization of the plant, and the state of the atmosphere, have produced.

Thus we see that those plants which abound most in oily, saline, and mucilaginous principles, are generally such as require a soil well manured. Tobacco, for instance, gives forty pounds of alkaline salt or potash from every hundred weight of ashes: this plant may, by being buried in the ground, be converted into a very powerful manure; while other plants, which thrive in a middling soil, and appear as vigorous, are, in general, such as have not so great a quantity of principles in their composition, and, when thrown on the dunghill, and left to rot, furnish very little manure. From such observations, it may perhaps not be impossible hereafter to judge, by the analysis of a plant, not only whether it requires a large or a small quantity of manure, but likewise, what kinds of soil and manure are most fit to pro-

mote

mote its vegetation: wild plants alſo may ſerve to ſhew the nature of the ſoil which they ſeem moſt to flouriſh in.

Beſides the phyſical action of manures, of which I have endeavoured to give ſome account, they have a very evident mechanical action. When mixed with earth, in a certain proportion, they not only render it more permeable to water, but the roots of plants can, with greater eaſe, acquire their proper ſize and form in it; in other caſes, manures tend to unite that earth which is too looſe, and, by rendering it more tenacious, they prevent the water from being loſt, and the roots from becoming dry. Thoſe manures which are called *warm* are ſuited to cold lands, not only becauſe they render them leſs compact, but alſo becauſe they take off a part of that moiſture which ſuch lands always have in too great quantity. *Cold* manures, on the other hand, by their viſcid quality, give tenacity to dry and hot ſoils, attracting and retaining, for a longer time, the moiſture which comes in their way. The nature of the ſoil muſt therefore determine what kind of manure it ſtands in need of, and alſo whether cul-

tivating

tivating it by means of oxen, or by horſes, is preferable; for, the manures produced from theſe two animals have thoſe oppoſite qualities which we have above deſcribed. By ſuch obſervations, we ſhall perhaps be able to reſolve a queſtion, reſpecting which the ſentiments of cultivators, in many parts of the kingdom, are much divided.

It cannot however be denied, that the earth is able, of itſelf, to ſerve as a baſis and ſupport to plants, and that it has an action, more or leſs evident, upon air, upon water, and upon dung. There is a well-known method of diſtinguiſhing clay from other earths; by merely breathing upon it, a ſmell is immediately perceived, ſufficiently ſtrong to ſhew that a decompoſition and freſh combination have taken place. In ſummer, after a drought of ſome days continuance, there always ariſes in the fields a particular ſmell during a ſhower of rain; and there is no kind of vegetable manure which, when mixed with earth, does not ſend forth a ſmell. This proves, that the nature of the ſoil muſt have an influence, not only upon air and upon water, but alſo upon the effect of manures; and that, before we ſpeak of their

power,

power, we ſhould always ſpecify what kind of earth they were applied to; becauſe, when manures and earth are mixed together, there enſues an action and re-action, more or leſs favourable to vegetation.

Having examined to what degree air and water enter, in ſubſtance, into the veſſels of plants, and having ſhewn that the principal action of earth, of ſalts, and of manures, conſiſts in preparing, elaborating, and decompoſing theſe two fluids, and in giving to the products of their decompoſition the forms they require, to accompliſh the purpoſe of nature in vegetation, I ſhall now make ſome obſervations upon the particular effects of certain ſubſtances uſed for improving land, ſuch as marl, lime, chalk, and wood-aſhes; which are uſually applied, either to an exhauſted ſoil, in order to reſtore it, or to a drooping plant, with a view to give it ſtrength. Of the efficacy of theſe ſubſtances no one doubts, but it does not appear that we are equally agreed reſpecting their manner of acting; and I ſhall be happy if the obſervations I am about to make, ſhould be of any aſſiſtance to thoſe who may employ themſelves in examining this queſtion.

Marl (a manure whoſe effects are well known, and which is found to be of the greateſt benefit in thoſe diſtricts where it can be procured in ſufficient quantity) is capable of acting in the ſame manner as the moſt fertile ſoil, when the principles of which it is compoſed, namely, clay, ſand, calcareous earth, and magneſian earth, are juſtly proportioned to each other. But it is ſometimes compact and tenacious, becauſe it contains a ſuperabundant portion of clay, and at other times porous and friable, becauſe it contains too much ſand, and therefore is not, in general, fit for vegetation by itſelf. Theſe conſiderations ought always to be our guide, when we mean to employ marl as a manure. The Abbé Rozier was ſenſible of their propriety, and has entered very largely into the ſubject, in his *Cours complet d' Agriculture*, article *Marne*; one of the moſt intereſting of that exellent work.

It has been ſuppoſed that *to marl* was a ſort of technical expreſſion, intended to denote the bringing together, or dividing, the earthy particles, by by means of clay or ſand. It appears to me that neither of the above operations can properly be called *marling*; becauſe, in either caſe, all we do is, to put the ſoil into a ſituation to receive, and to profit by, the influence of the atmoſphere, and that of the manures made uſe of. The peculiar principle of marl is, that part of it which, like lime, acts very powerfully upon the different aëriform fluids, is eaſily reduced to powder, efferveſces with acids, and ſends forth a quantity of air-bubbles, when water is poured upon it. Now this matter, which in a particular manner does the office of manure, reſides neither in clay nor in ſand. Upon the proportion of it depends the duration of the fertility it produces; conſequently it is of importance, when we make uſe of marl, to know which of its conſtituent parts it contains in the greateſt proportion, otherwiſe, in ſome caſes, we ſhould only add one common kind of earth to another.

Let us conſider that part of the department of *La Marne* which we may, with great propriety, call the chalky diſtrict, ſince its ſoil conſiſts merely of chalk. What is the kind of earth we ſhould add to it, to render it proper for cultivation? Clay, without doubt; and, according to ſome experiments made by M. Bayen, there is reaſon to think that the chalk, in that diſtrict, lies upon a bed of clay; if ſo, the inhabitants of that part of the kingdom may conſider themſelves as being in poſſeſſion of what, to them, is as valuable as a gold mine.

Wood-aſhes, as a manure, may be, in ſome reſpects, compared to marl; at leaſt they contain the ſame earths as thoſe which generally enter into the compoſition of marl, but they contain a greater quantity of ſaline ſubſtances, proceeding from the vegetables of which they are the reſidue, and from the proceſs made uſe of in their combuſtion; a proceſs which encreaſes their activity, and ſhould render us careful in what manner, and for what purpoſes, we employ them. Wood-aſhes, when ſcattered over fields, at proper times, and in proper quantities, deſtroy weeds, and encourage the vegetation of good plants. But do the aſhes produce this effect by a ſort of corroſive power? I cannot think it; for, in that caſe, all kinds of plants would

would indiscriminately be acted upon by them, and, to a certain degree, destroyed.

Besides, the ashes of fresh wood are seldom employed until they have been lixiviated, in which state, they are deprived of their caustic principle; those ashes which are most commonly made use of for manure are produced, either from wood that has been floated in water, or from turf, or from pit-coal, and contain little or no alkaline salt.

It appears much more probable that ashes, when laid upon ground, destroy the weeds by a well-known effect, namely, by seizing with eagerness that moisture which served to produce those weeds, and which, in a superabundant quantity, is necessary to their existence and support. Whereas those plants which have a firmer texture and a longer root, which are rendered strong by age and by having withstood the rigour of winter, and which are in fact the plants of which the fields are composed, do not suffer any damage from the application of the ashes; but, on the contrary, by being freed from the superfluous weeds, which stifled them, and robbed

robbed them of a part of their fuftenance, they receive a quantity of nourifhment proportioned to their wants. The ftate of relaxation and langour, to which they were reduced by a fuperabundance of water, leaves them, the foil gets its proper confiftence, and the grafs, corn, &c. acquiring the ftrength and vigour which is natural to them, foon overcome the mofs, rufhes, and other weeds; thus a good crop, of whatever the field confifts, is produced. It is in the above manner that wood-afhes act, whenever, in the fpring, it is neceffary to apply them to meadows, corn-fields, &c. the plants of which are ftifled and weakened by a luxuriant vegetation of weeds, the ufual confequence of mild and wet winters.

When wood-afhes produce an effect different from what is above defcribed, it is either becaufe they happen to contain too much alkaline falt, or that they are laid on the ground in too great quantity, or that the fields to which they are applied were not fufficiently wet to reftrain their action; for when they are fcattered upon cold foils, and buried by the plough, before the time of fowing, they are, like lime, of great fervice. The laft-mentioned ſubſtance is very efficacious in other circumſtances; and there is a well-known method of uſing it, practiſed by the Germans, as follows; a heap of lime is formed by the ſide of a heap of poor earth, and water is poured upon the lime; the earth is then thrown over it, and becomes impregnated with the vapours which eſcape from the lime while it is ſlaked. The earth, after being thus aërated, may be ſeparated; and, although no lime remains mixed with it, is, by the operation juſt deſcribed, rendered capable of giving a luxuriant vegetation to whatever plants may be put into it.

It is poſſible, therefore, to aërate earth as well as fluids; for this purpoſe, by mixing it with certain ſubſtances, during their decompoſition, we muſt attach to it the principles of which thoſe ſubſtances are compoſed; from which there reſults a matter ſo loaded with gas, as to form a more compound ſubſtance, and one which has acquired new properties. The Arabians, for example, who take great pains to improve their land, are accuſtomed to make large pits, which they fill with animals which happen to die: theſe pits they afterwards cover with calcareous or clayey earth; and, after some time, these earths, which of themselves are steril, acquire the properties of the richest manures.

The foregoing observations may, at least, be considered as proving, that those substances which, when employed fresh and in too great quantity, are most prejudicial to vegetation, have, on the contrary, an advantageous effect, when they are previously made to undergo a fermentation; or when they are mixed with earth or water, in a proportion adapted to the end proposed. The grass of fields in which cattle or poultry go to feed, after the first or second crop of hay, appears to be dried by the urine and dung of those animals, as if fire had been applied to it; whereas these same excrementitious substances, when combined with earth, or diluted with water, are capable, without any other preparation, of performing the office of good manure.

But if animal secretions, when applied in substance to plants, were capable of acting upon them, as is affirmed, in such a way as to corrode or burn them, how could seed which has been swallowed,

ſwallowed, and eſcaped the action of the digeſtive powers, be prolific when thrown out by the animal, after having remained ſo long in its dung? yet we often ſee oats, ſo circumſtanced, grow and produce ſeed. Is it not more conſiſtent with experience and obſervation, to ſuppoſe that theſe excrementitious ſubſtances, being ſtill endowed with animal heat, and with an organic motion, diffuſe round plants in vegetation, a deleterious principle, or inflammable gas, which deſtroys them; for, ſoon after their application, the foliage of the plant grows yellow, dries up, and the plant withers, unleſs there happens a ſhower of rain which revives it. When theſe ſubſtances are diluted, by being mixed with water and earth, they loſe that principle which is ſo deſtructive to vegetable life, and an incipient fermentation augments their power as a manure, ſo that they may be immediately made uſe of, without any apprehenſion of injury from their effects.

It appears, therefore, that any operation upon excrementitious ſubſtances, by which they are dried and reduced to powder, cannot be practiſed without depriving thoſe ſubſtances of a great part of ſuch of their principles as are eaſily evaporated, and upon which their fluidity depends; theſe principles, when diluted with water, and confined by being mixed with earth, are capable of increaſing the produce of the ſoil. Such is the way in which the huſbandmen in Flanders made uſe of this kind of manure, in the cultivation of a kind of rape or cole ſeed, which is to them a very important branch of agricultural induſtry and commerce; and they never obſerve that the ſap carries up any of thoſe principles which give ſuch manure its offenſive ſmell; nor do they obſerve that the fodder produced from fields ſo manured, whether eaten freſh or dry, is diſagreeable to their cattle. The excrements of all animals would be injurious to plants, if applied too freſh, or in too great quantity; and a gardener could not commit a greater fault, than to put more than a certain quantity of them into the water he means to make uſe of to water his young plants; in ſhort, this kind of manure is to be uſed in a very ſparing manner, and he that is too prodigal of it will find, to his coſt, that exceſs, even of that which is otherwiſe beneficial, becomes an evil.

It

It muſt certainly be allowed, that excrementitious ſubſtances are a very advantageous manure for cold ſoils, and ſuited to moſt vegetable productions: a long experience of their effects over a large tract of country, and the acknowledged intelligence of the Flemiſh farmers, ought to be conſidered as ſufficient to overcome the prejudice that has been raiſed againſt this ſort of manure. Suppoſing that the bad effects which have been attributed to it, when uſed in the ſtate in which it is taken out of privies, &c. are not the offspring of a prejudiced imagination, they may, I think, have ariſen from its having been made uſe of at an improper time, or in too great quantity; or from its having been applied to a ſoil, and for the cultivation of plants, to which it was not adapted; for we know that the exceſs of any kind of manure changes the ſmell and taſte of plants, and the ſame effect is produced by watering them too frequently. Striking examples of this change are ſeen in the ſtrawberry and in the violet, when ſuch as have grown in the woods are compared to thoſe produced from ſome of our over-manured gardens; alſo in the lettuce, and ſome other

 plants,

plants, when those raised for sale, by the gardeners about Paris, are compared to those of some particular kitchen-gardens. In the markets of some cities, the carrots, turneps, and potatoes of the fields, are preferred to the same kind of roots cultivated by the gardeners; for, though the last are of a larger size, they have not so good a flavour. Some vegetables, therefore, are like certain wild species of the animal kingdom, they resist every kind of culture, as those animals resist every effort to tame them.

Although experience has taught the Flemish farmers that excrementitious substances are more active in their natural state than when dried, yet it cannot be denied that drying them, and reducing them into powder, is sometimes very advantageous, because, in that state, they are much less offensive, are easily transported to any distance, and may be used when most convenient, or most proper. In many cities the inhabitants pay to have their privies emptied; in other places those who empty them pay for their contents; and it would astonish any one to be told how great a revenue is produced in the city of Lisle,

in

in Flanders, by the ſale of this kind of manure. I am, however, far from thinking that it is right, in all caſes, to employ it in the above-mentioned ſtate of concentration; it would be better, in my opinion, to follow the example of the Flemiſh farmers, who uſe it the firſt year for the cultivation of plants for oil, or for hemp, or flax; and the ſecond year for the beſt kinds of grain; thus obtaining two crops, inſtead of one, without any farther preparation of the land. What is ſaid above may be applied alſo to the manures produced from the dung of cattle, poultry, &c. (particularly to pigeons' dung, the moſt powerful manure of its kind,) all which, by being dried and powdered before they are uſed, loſe a great portion of their activity. From theſe obſervations another fact may be deduced, namely, that manure ſhould not be taken from the place where it has been thrown together, until the ſeaſon of the year, and the ſtate of the land, are ſuch that it may be put into the ground as ſoon as it is brought to it. In ſome diſtricts a very injurious cuſtom prevails, of carrying the manure into the fields, and leaving it there, formed into

ſmall

ſmall heaps, expoſed for ſome days to the elements; during which time, either the ſun and wind dry up its natural moiſture, leaving a maſs which is much leſs active; or the rain diſſolves and carries away the extractive part, impregnated with the ſalt. This kind of brine, which is the moſt powerful part of the manure, penetrates the earth to a conſiderable depth, and ſhews (by the thick tufts which ariſe in thoſe places, and which produce more ſtraw than grain) that manure ought to be put into the ground as ſoon as it is brought to it, becauſe it then poſſeſſes its full force and effect, and conſequently would be then uſed to the greateſt advantage.

We have always at hand the means of compoſing, from a great variety of vegetable and animal ſubſtances, ſuch manures as, when brought into a proper ſtate, and mixed with land, contribute to its fertility. Chymiſtry alſo offers to us a number of ſubſtances, which, although when uſed ſeparately they tend to diminiſh the fertilizing quality of the earth, yet are capable, by being combined, of forming excellent manures; ſuch, for inſtance, is that ſaponaceous combi-

nation

nation which is produced from a mixture of pot-aſh, oil, and earth. What an advantage it would be, if, inſtead of being ſparing of manure, the inhabitants of the country would endeavour to increaſe the number of theſe reſources, and to render them more beneficial, by employing them in a more effectual manner. How many years had paſſed before it was known that the refuſe of apples and pears, after they are preſſed, (and which uſed to be thrown away as uſeleſs,) is capable of forming as valuable a manure, in cider and perry countries, as the refuſe of grapes does in wine countries.

I think we may ſafely conclude, from what has been obſerved, that manures act, in many circumſtances, like medicines, and conſequently that the ſame ſort of manure cannot be adapted to every ſituation, and every kind of ſoil; we muſt therefore take care to make proper diſtinctions between them. Whoever ſhall pretend that any particular kind of manure may be uſed, with equal benefit, in graſs-land, corn-fields, vineyards, orchards, kitchen gardens, &c. ought to be claſſed amongſt thoſe quacks who undertake to

cure

cure all perſons with the ſame remedy, without any regard to their age, conſtitution, &c. It is, probably, from not having paid ſufficient attention to the aforementioned diſtinctions, that ſome authors have found fault with particular manures, while others have ſpoken too highly in their favour.

What I have ſaid evidently ſhews, that we are ſtill in want of a courſe of comparative experiments upon the various kinds of manures, conſidered according to their influence with reſpect to different ſoils, ſituations, and productions. If this part of rural œconomy were better underſtood, we ſhould perhaps ſee many places in a ſtate of cultivation, which, on account of the bad quality of their ſoil, have hitherto reſiſted all our endeavours to render them fertile.

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REPERTORY

OF

ARTS AND MANUFACTURES.

NUMBER XXXV.

XXXV. *Specification of the Patent granted to Mr.* JOSEPH BRAMAH, *of Piccadilly, in the County of Middlesex, Engineer; for certain new Methods of producing and applying a more considerable Degree of Power to all Kinds of Mechanical Apparatus, and other Machinery requiring Motion and Force, than by any Means at present practised for that Purpose.*

WITH A PLATE.

Dated March 31, 1796.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I the said Joseph Bramah do hereby

 declare,

declare, that my ſaid invention is deſcribed in the plan and deſcription thereof hereunto annexed, and in manner following; that is to ſay, the merits and particular advantages to be derived from this my ſaid invention, principally depend on a new and peculiar method of applying water, or other denſe fluids, to operate in various engines and mechanical apparatuſſes; ſo as, in ſome inſtances, to cauſe them to act with immenſe accumulated force; in others, to communicate the motion and powers of one part of a machine to ſome other part of the ſame machine; and, in other inſtances, for the purpoſe of communicating the properties of motion and force from one machine to that of another, where their local ſituations preclude the application of all other known methods of connection. There is likewiſe an infinite variety of other inſtances, wherein this new application of fluids will be found of great importance and utility, which cannot here be enumerated; but the figures and drawings annexed will fully explain the nature of my ſaid invention. In witneſs whereof, &c.

Fig. 1. (Plate XVI.) is the ſection of a machine, literally nothing more than two pumps of different dimenſions acting on each other, which will be ſufficient to elucidate and explain the firſt and moſt material part of this invention; namely, that, by the application of water, or other denſe fluids, various engines and other apparatuſſes may be rendered capable of operating with immenſe force, for every purpoſe where accumulated power is neceſſary. A, is a cylinder of iron, or other materials, ſufficiently ſtrong, and bored perfectly ſmooth and cylindrical; into which is fitted the piſton B, which muſt be made perfectly watertight, by leather or other materials, as uſed in pump-making. The bottom of the cylinder muſt alſo be made ſufficiently ſtrong, with the other part of the ſurface, to be capable of reſiſting the greateſt force or ſtrain that may at any time be required. In the bottom of the cylinder is inſerted the end of the tube C; the aperture of which communicates with the inſide of the cylinder, under the piſton B, where it is ſhut with the ſmall valve D, the ſame as the ſuction-pipe of a common pump. The other end of the tube C

communicates with the ſmall forcing-pump or injector E, by means of which, water or other denſe fluids can be forced or injected into the cylinder A, under the piſton B. Now, ſuppoſe the diameter of the cylinder A to be 12 inches, and the diameter of the piſton of the ſmall pump or injector E only one quarter of an inch, the proportion between the two ſurfaces or ends of the ſaid piſtons will be as 1 to 2304; and, ſuppoſing the intermediate ſpace between them to be filled with water, or other denſe fluid capable of ſufficient reſiſtance, the force of one piſton will act on the other juſt in the above proportion, *viz.* as 1 is to 2304. Suppoſe the ſmall piſton in the injector to be forced down, when in the act of pumping or injecting water into the cylinder A, with the power of 20 cwt. which could eaſily be done by the lever H; the piſton B would then be moved up with a force equal to 20 cwt. multiplied by 2304. Thus is conſtructed a hydro-mechanical engine, whereby a weight amounting to 2304 tons can be raiſed by a ſimple lever, through equal ſpace, in much leſs time than could be done by any apparatus conſtructed on the known principles

principles of mechanics; and it may be proper to obſerve, that the effect of all other mechanical combinations is counteracted by an accumulated complication of parts, which renders them incapable of being uſefully extended beyond a certain degree; but, in machines acted upon or conſtructed on this principle, every difficulty of this kind is obviated, and their power ſubject to no finite reſtraint. To prove this, it will be only neceſſary to remark, that the force of any machine acting upon this principle can be increaſed *ad infinitum*, either by extending the proportion between the diameter of the injector and the cylinder A, or by applying greater power to the lever H.

Fig. 2. repreſents the ſection of an engine, by which very wonderful effects may be produced inſtantaneouſly, by means of compreſſed air. A A, is a cylinder, with the piſton B fitting air-tight, in the ſame manner as deſcribed in Fig. 1. C, is a globular veſſel, made of copper, iron, or other ſtrong materials, capable of reſiſting immenſe force, ſimilar to thoſe of air-guns. D, is a ſtrong tube of ſmall bore, in which is the ſtop-

ſtop-cock E: one of the ends of this tube communicates with the cylinder, under the piſton B, and the other with the globe C. Now, ſuppoſe the cylinder A to be the ſame diameter as that in Fig. 1. and the tube D equal to one quarter of an inch diameter, which is the ſame as the injector Fig. 1; then, ſuppoſe that air is injected into the globe C, (by the common method,) till it preſſes againſt the cock E with a force equal to 20 cwt. which can eaſily be done; the conſequence will be, that when the cock E is opened, the piſton B will be moved in the cylinder A A with a power or force equal to 2304 tons; and it is obvious, as in caſe Fig. 1. that any other unlimited degree of force may be acquired by machines or engines thus conſtructed.

Fig. 3. is a ſection, merely to ſhew how the power and motion of one machine may, by means of fluids, be transferred or communicated to another, let their diſtance and local ſituation be what they may. A and B are two ſmall cylinders, ſmooth and cylindrical; in the inſide of each of which is a piſton, made water and air tight, as in Figs. 1 and 2.

CC,

C C, is a tube conveyed under ground, or otherways, from the bottom of one cylinder to the other, to form a communication between them, notwithſtanding their diſtance be ever ſo great; this tube being filled with water, or other fluid, until it touch the bottom of each piſton; then, by depreſſing the piſton A, the piſton B will be raiſed. The ſame effect will be produced *vice verſa*: thus, bells may be rung, wheels turned, or other machinery put inviſibly in motion, by a power being applied to either.

Fig. 4. is a ſection, ſhewing another inſtance of communicating the action and force of one machine to another, and how water may be raiſed out of wells, of any depth, and at any diſtance from the place where the operating power is applied. A, is a cylinder, of any required dimenſions, in which is the working-piſton B, as in the foregoing examples: into the bottom of this cylinder is inſerted the tube C, which may be of leſs bore than the cylinder A. This tube is continued, in any required direction, down to the pump-cylinder D, ſuppoſed to be fixed in the deep well E E, and forms a junction therewith,

therewith, above the piſton F; which piſton has a rod G, working through the ſtuffing-box, as is uſual in a common pump. To this rod G is connected, over a pulley or otherways, a weight H, ſufficient to over-balance the weight of the water in the tube C, and to raiſe the piſton F when the piſton B is lifted: thus, ſuppoſe the piſton B is drawn up by its rod, there will be a vacuum made in the pump-cylinder D, below the piſton F; this vacuum will be filled with water through the ſuction-pipe, by the preſſure of the atmoſphere, as in all pumps fixed in air. The return of the piſton B, by being preſſed downwards in the cylinder A, will make a ſtroke of the piſton in the pump-cylinder D, which may be repeated in the uſual way by the motion of the piſton B, and the action of the water in the tube C. The rod G of the piſton F, and the weight H, are not neceſſary in wells of a depth where the atmoſphere will over-balance the water in the ſuction of the pump-cylinder D, and that in the tube C. The ſmall tube and cock, in the ciſtern I, are for the purpoſe of charging the tube C.

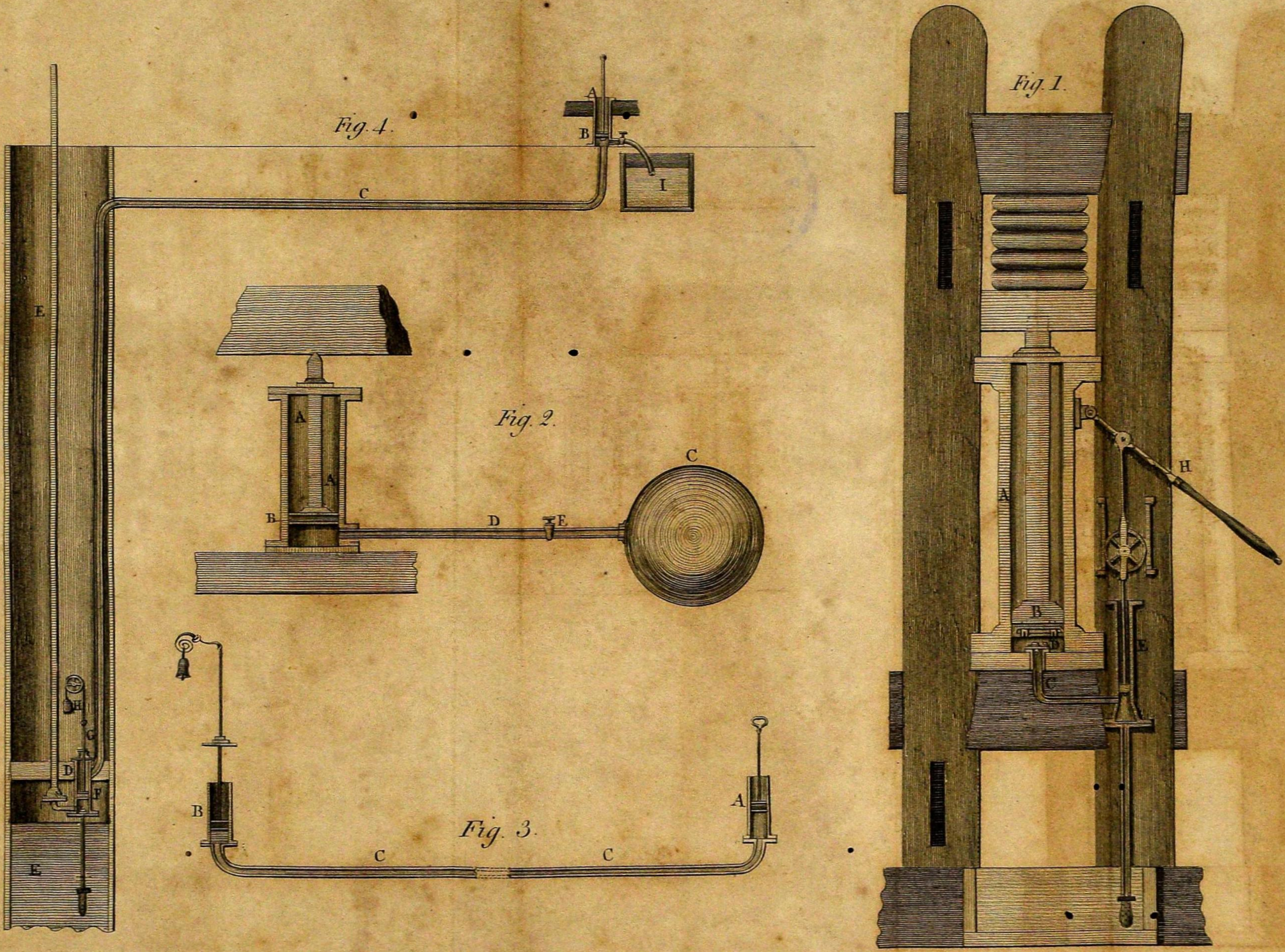


Fig. 1.
A
B
C
D
E
H
Fig. 2.
A
A
B
C
D
E
Fig. 3.
A
B
C
C
Fig. 4.
A
B
C
D
E
E
F
G
H
I

XXXVI. *Specification of the Patent granted to Mr.* JOHN LONG, *of* LONGVILLE, *in the County of* DUBLIN, IRELAND, *Merchant; for his Invention of an entire new Method, in all the eſſential Parts, of brewing good Malt-Liquor, without any Addition to the uſual Quantity of Malt or Hops.*

Dated June 4, 1790.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid John Long do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, for the better extracting from malt, near a maſh-tun, place a ſhallow copper or other veſſel, that will readily heat; the curb of which to be on a level with the tun, and to contain from two to ſix hogſheads, according to the dimenſion of the tun, more or leſs; and, at the lower end of the copper, have a cock from 2 to 5 inches diameter, more or leſs, to conduct the heated liquor from the copper, into a tube which paſſes down the external part of the tun, and enters it through an aperture about 6 inches from the bottom; then forming two revolutions, more or leſs, through the body of the tun, and communicating its heat to the wort, as it paſſes through the tube; and then, at a convenient diſtance from the place it firſt entered, it runs from the tun into a ciſtern or tub, ſituate as near as convenient to the copper or heating veſſel. In the tub or ciſtern is to be placed a pump, for the purpoſe of conveying the cooler liquor back to the copper or heating veſſel again; there to receive the heat of 208 degrees, more or leſs, (which it will require after the firſt half-hour,) and then convey it through the maſhing-tun as before, and in the ſame manner, as long as the working brewer or diſtiller may think neceſſary, to raiſe the maſhing-tun to any degree of heat required. By adhering to the foregoing proceſs, the firſt liquor may, with the greateſt ſafety, be let upon the malt from twenty to thirty degrees lower than the preſent practice; by which means, it operates with gentleneſs, opens and expands the malt and raw corn, and prepares

it

it for the reception of ſharper or warmer liquor, ſo as to extract the whole of the ſaccharine quality from the malt and raw corn. By the foregoing method, the maſhing-tun, inſtead of loſing its firſt heat, (which it does by the preſent practice,) continues to increaſe in heat every moment, by conveying the heated liquor through the tube into the tun; by which means, at the end of two hours, the working brewer or diſtiller can have the tun brought to any degree of heat he ſhall think beſt ſuited to the different qualities of the malt or raw corn. Perſons who would wiſh to ſave expence, may heat their maſhing-tun at the ſide or bottom, by a large piece of metallic ſubſtance made fire-proof, and fixed therein; which, in ſome degree, will anſwer the end propoſed, but with great trouble and delay.

Secondly. To prevent the wort from receiving a diſagreeable flavour while in the under-back, a tube muſt be placed at the cock of the maſhing-tun, to receive the wort as it comes off, and convey it to a great ciſtern or refrigeratory, which is ſupplied with a ſtream of water. The wort, paſſing through that medium in a ſpiral tube, ſoon loſes that heat which ſo often proves prejudicial to the brewer and diſtiller in warm weather: then paſs it from the tube into a veſſel in which pumps are placed, to return the worts into the copper for the purpoſe of boiling off. All veſſels for receiving the cold wort muſt be placed lower than the ſource whence the wort comes.

Thirdly. As the great object of long boiling the wort is remedied, by my invention of taking the extract from the hops in a ſeparate manner from the worts, I boil my worts no longer than from 15 to 20 minutes; and, by purſuing that method, I ſave much time and fuel, and regulate my lengths accordingly.

Fourthly. I ſteep my hops, the preceding day to which they are to be uſed, in a copper or other veſſel, with as much fluid, blood-warm, as will cover the hops, where it is to remain over a ſlow fire at leaſt 14 hours, cloſe covered; the copper at the tenth hour not to be of a greater heat than 175 degrees, continuing ſlow until the laſt hour. Then I bring the copper gradually to a ſimmer or ſlow boil, in which ſtate I let it remain about 10 minutes, and then run

off

off the fluid; and this I do at the ſame time the firſt wort is boiled off, that they may both paſs together through the refrigeratory, into the fermentation or working-tun. After the foregoing operation, I cover the hops again with other liquor, and bring the copper to boil as ſoon as convenient, and let it remain in that ſtate a conſiderable time, until the ſecond worts are boiled off. Then I paſs the hop-fluid with the wort, the ſame as in the firſt inſtance; and, if there is a third wort, I boil my hops a third time, with ſmall worts, and paſs it off as before; by which means, I gradually obtain the whole of the eſſential oil and pleaſing bitter from the hops, which is effectually preſerved in the beer.

Fifthly. To cool worts. When the wort is boiled off, it is conducted from the cock of the copper or boiler, into a tube of a proper dimenſion, which paſſes the wort from the cock to the large ciſtern or refrigeratory, and there performs ſeveral revolutions, in a ſpiral manner, through the ſame tube; which is immerſed in a conſtant ſupply of cold water, where it loſes the greateſt part of its heat in a ſhort time, and thence

thence continues a ſtraight courſe, through the tube, a little elevated and of a ſuitable length, placed in brick-work, until it meets a ſmall refrigeratory ſupplied with colder water, from a reſervoir made for that purpoſe at the head of the works; whence a continual ſtream runs on the ſurface of the tube down to the great refrigeratory, cooling the wort as it paſſes, in order to enable the working-brewer or diſtiller to ſend it into the backs or working-tuns at whatever degree of heat he ſhall think proper. There is no difference between brewer and diſtiller in this proceſs, but that the diſtiller immediately paſſes the ſtrong wort from the maſhing-tun to the back, through the ſame machinery above inſerted, and the tubes may be made of lead, or any other metallic ſubſtance.

Sixthly. To enable me to brew in the warm ſummer months, I ſink my backs or working-tuns at leaſt to a level with the ground, but if deeper the better, and cover them cloſely by an arch made of bricks, or other materials, that will totally exclude the atmoſpheric air from them. I place them as near as poſſible to a

ſpring

ſpring or ſand-drain, as their depth will naturally draw the water thence, which muſt be ſo contrived as to paſs or flow round the backs or tuns. I then introduce a large tube, which paſſes through the tuns, and keeps the wort ſeveral degrees lower than can poſſibly be done by the preſent practice; by which means, I can produce a complete fermentation, even in the dog-days.

Seventhly. In cold or froſty weather, if the tun and backs ſhould loſe the firſt heat, intended to carry it through the proceſs by the foregoing method, you may convey a ſupply of warm or boiling water by the tube, which paſſes through the body of the backs or tun, communicating its heat, which raiſes to any degree the working-brewer ſhall think proper; by purſuing this method, in the coldeſt ſeaſon, I never want a fermentation. In witneſs whereof, &c.

XXXVII. *Specification of the Patent granted to* JAMES WILSON, *of the Pariſh of St. Martin's in the Fields, in the County of Middleſex, Eſquire; for his Invention of a conſiderable Improvement in the Conſtruction of Fire-Arms, whereby the Powder will be much more conveniently protected from the Effects of bad Weather, and at leſs Expence, than by any Method hitherto diſcovered.*

Dated July 5, 1792.

TO all to whom theſe preſents ſhall come, &c. NOW KNOW YE that, in compliance with the ſaid proviſo, I the ſaid James Wilſon do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, the object of my invention is, to protect the powder in the pan of fire-arms from wet, as much as may be, by eaſy means, and at a moderate expence. Firſt, for locks already in uſe, the method I propoſe is, by dovetailing, brazing, or ſcrewing, or altogether,

a piece

a piece of brafs, or iron, into the fide of the lock and the pan next the barrel, which fhall form an arch, about one line in breadth, over the touch-hole, and rife from the fide that joins the barrel with a bevil upwards, in an angle of about fixty degrees; by which, any wet that may infinuate itfelf between the barrel and the hammer or upper pan, where the powder is moft expofed to its effect, is fufpended, and conducted away on either fide of the arch, by the channel which the bevil forms when in contact with the barrel; which bevil conftitutes the whole utility of the arch, the water being thereby prevented from falling into the pan; as it muft naturally rather take the direction of the paffage, which invites it to get down on either fide of the bridge, than force its way up hill over the bevil. Where the old pan demands, I likewife, by a piece that is laid on it, and in that cafe connected with the arch, form a new one, and raife the fides of it about half a line; by which, the fpace on either fide, for the purpofe of paffage for the water, is deepened, and ftill increafed by cutting down the front and back, between the pan and the fence, for that purpoſe, as much as can be afforded without injury to the lock, which frequently admits ſufficient depth for ſecurity, without raiſing the pan. Where the pan is made on a ſkeleton-principle originally, nothing more than the arch and hammer is neceſſary, as the purpoſe of raiſing the pan, or cutting down a channel, is accompliſhed by the immediate evacuation of the water. The hammer or upper pan is excavated or hollowed, as near as poſſible to reſemble the uſual lower pan, of a moderate depth; and is projected entirely over the pan, the ſides of which are to be wrought up nearly to an edge, and to be ſhut over by the upper pan, (but not ſo cloſely as to endanger the clogging from dirt, as in a box-pan,) as well as the arch; over which it is to come nearly down to the bottom of the bevil, cloſe to the barrel, with an edge, but hollowed or chamfered, ſo as not to reſt upwards on the bevil of the arch, in order to prevent the inconvenience that might ariſe by preſſure, and accumulation of foulneſs by repeated firing. It is to be obſerved alſo, that by the ſides of the pan being brought nearly to an edge, and coming into con-

tact

tact with the excavated upper pan, the oppoſing ſurfaces are extremely inconſiderable, and favour the ſeparation of the dirt, rather than the collection of it, as in flat ſurfaces. This has been proved after forty ſeven ſhoots without wiping. Where locks are to be made anew, the ſkeleton-pan is to be preferred, and the arch may be made in the foregoing manner. The bevil-arch may be added to the barrel, inſtead of the lock, by dovetailing or ſcrewing, for thoſe who prefer it, and may be ſaid to have the advantage of preventing any poſſible inſecurity from careleſſneſs in ſcrewing up the lock cloſe to the barrel; and, for thoſe who have any doubt as to the ſufficiency of the joint between the barrel and the arch, it is extended from the lock about half a line, and inſerted into the barrel. In witneſs whereof, &c.

XXXVIII. *Specification of the Patent granted to Mr.* NICOLAS DONITHORNE, *Mr.* ROBERT SHERSON, *and Mr.* EDWARD SMITH, *all of the City of London; for their Invention of a new White Composition, called Marine Metal, which will be found particularly useful for sheathing of Ships, and other valuable Purposes.*

Dated June 12, 1780.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE that, in compliance with the said proviso, I Edward Smith do hereby declare, that our said invention of a new white composition, called *Marine Metal*, which will be found particularly useful for sheathing of ships, and other valuable purposes, is described in manner following; that is to say, take Zinc *quantum placet*, break it into small pieces, put it into an iron

iron pan, on which invert another, then place it on a sand-heat, and give it a roasting; remove it, and suddenly extinguish the heat in very strong lime-water, about four pints to the pound weight of Zinc. This operation must be repeated six times; always taking care to prevent such a point of heat as would sublime, or cause to escape, any part of the flowers of this semi-metal. This operation duly finished, let the matter be taken out of the lime-water, and finely triturated; then put it, thus prepared, into the lime-water it was immersed in before, and evaporate gently over a moderate fire in an iron pot, adding by degrees, of black soap one ounce, of salt of zinc one drachm, (first mixed together), to every pound of zinc as above described; then evaporate until the moisture is nearly exhaled, or rather to the consistence of paste. It must be covered close from the air, and kept in a dry place, or it will spoil. To every hundred weight of melted tin, add ten pounds of the foregoing mixture; let it fuse with a moderate fire, (stirring now and then,) until it has acquired phlogiston enough to deprive

prive the metal, when beaten, of the peculiar characteristical crackling noise which authors describe it has; the ceasing of which denotes a new modification of parts, and that the operation is duly finished. Generally, this last operation is effected in about three hours, more or less, agreeably to the judgement of the operator respecting the management of the fire. As this mixture is liable to stick to the hands in preparing, a little grease will remedy that inconvenience. Zinc is made from all the mineral Cadmias. In witness whereof, &c.

XXXIX. *Defcription of a Harrow upon a new Conftruction. By Mr.* EDWARD KNIGHT, *of Great Bardfield, Effex.*

WITH A PLATE.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

A Bounty of Fifteen Guineas was given to Mr. KNIGHT for this Invention, which is defcribed in the following Letter from him.

FINDING, in the courfe of my bufinefs in hufbandry, many inconveniences attending the common mode of harrowing, and that it fatigued my horfes much more than the work of ploughing, I flattered myfelf that any plan which fhould occur to me for their relief, as well as for obviating every other difficulty, would be an object effentially

tially ſerviceable. It muſt be a remark obvious to every perſon who will pay the leaſt attention, that the common harrow is almoſt a dead weight after the horſes; the irregular and uneven motions cauſe inceſſant checks, which the horſes muſt inevitably feel the unpleaſant effects of, as well from their collars as from the traces. I likewiſe frequently experienced ſome trouble, by the harrow's being clogged up, in conſequence of too great a weight on the fore-teeth.

In order to remedy theſe, as well as many other inconveniences, I was induced to try a pair of wheels with the axle-tree entire: this I found anſwered the purpoſe with reſpect to the horſes, as the harrows worked much eaſier; it prevented the too great ſtreſs on the fore part, which of courſe was not ſo liable to be choaked up by collecting every impediment that might fall in the way; and the workman found little or no difficulty in keeping his harrow clean, a circumſtance difficult to be done with the common harrow. Though I was perfectly ſatisfied that this plan had a material effect, by being much eaſier to the horſes, as I have before obſerved, ſtill I met with great inconvenience from the axle-tree being entire; it required a conſiderable ſcope of ground at every turning. I likewiſe obſerved, that if either of the horſes was more forward than the other, or not perfectly ſteady in his drawing, the wheel left the furrow proportionally, and loſt its ſtraight direction; another objection I made to the axle-tree being entire was, that it greatly incommoded me in paſſing through the gate-ways, when I wiſhed to convey my harrows from one field to another.

In order to remove theſe difficulties, I have contrived two joints, A A, (ſee Plate XVII.) in the axle-tree; one of which, in the plate, is covered, as when the harrows are at work, the other uncovered, to ſhew the conſtruction of the joint; and two joints, *a a*, in the front of the bar; by means of which I find, by repeated trials, that the pliability of the tree, and that of the bar, humours the wheels, and keeps them in their proper directions in the furrow; and, requiring very little ſcope of ground, the turnings are rendered very convenient and eaſy. The objection I ſtarted, with reſpect to removing the harrows as occasion required, I find now perfectly done away.

If, in the course of working the land, a farmer varies in the breadth of his furrows, I have contrived, in order to make the harrow narrower, that part of the bar B, which is fastened by two pins *b b*, may be taken off when requisite; part of the axle-tree, and part of the hind-bar C, both which are fastened by the iron-bolt D, are also to be removed; and the remaining outward parts to be joined and fastened by one of the two pins in the bar, and by a shorter bolt *d*, (shewn separate,) intended for the axle-tree and hind-bar.

If the farmer should work two horses which are unequal in height, the horizontal direction, or evenness of the joints, may be destroyed in some degree: to remedy and supply this deficiency in the horses, I have made a whipple-tree E, to be heightened or lowered by means of notches *e*, (shewn separate,) to which it is connected by a ring. In light barley-lands, when you accommodate your harrow for one horse, by narrowing it as before directed, there are two strings conveyed by two rings from the axle-tree, through two loops

loops *f f*, under the front bar. The wheel F, under the hind-bar, (which is alſo ſhewn enlarged in the plate,) will ſupport the bar; and, by this aſſiſtance, the harrow is conveyed to the field on the axle-tree bar, as a ſubſtitute for a ſledge: there are alſo two wooden pegs *g g*, by which the harrows, when turned upon the carriage, are ſecured.

Should it be objected by ſome, that the harrow will prove expenſive on account of the iron, an axle-tree and joints may be readily conſtructed in wood, upon the ſame principles as ſhewn in the plate at G; though, for my own part, I give great preference to iron. If the wheel under the hind-bars ſhould not be adopted, there is a ſlider H, (ſhewn ſeparate,) which works with a pin, and, when not wanted, is turned and faſtened under the axle-tree.

In a ſubſequent letter, Mr. Knight writes as follows:

At foot is the price (or thereabouts) of a ſet of harrows and carriage, according to the model ſent to the Society: I have uſed them on my farm more than twelve months, and find them particu-

 larly

larly useful this wet seed-time; as two horses do the work of three, and always go in the furrow; otherwise they must go on the middle of what we call the *stech*; others call them *broad lands*. I also find them (that is, the wheels with a short axle-tree) very useful with my crab-harrow; there is more than a horse's draught difference.

Although my harrows answer every purpose, as described before, and represented by my model; yet, I flatter myself, I have discovered an improvement, which I beg leave to lay before the Society. Experience teaches me, that it would be very useful to heighten or lower the harrows occasionally, particularly on broad lands rising in the middle; where of course the middle harrow takes most hold, and generally requires the least. This is easily effected, by fixing irons, with notches, (like those on the fore-bar, by which the whipple-trees are supported,) on the hind-bar, instead of the hooks, and putting the hooks on those irons.

Price

Price of the Harrows, &c.

	£.	s.	d.
The carriage for the harrows, -	1	1	0
Two whipple-trees, - -	0	1	0
56lb. of hammered iron, at *6d.* -	1	8	0
(or 60lb. of cast ditto, at 2*d.* 10*s.*)			
A pair of wheels with iron work,	2	3	0
(or a pair of second-hand ditto, 12*s.*)			
	£. 4	13	0

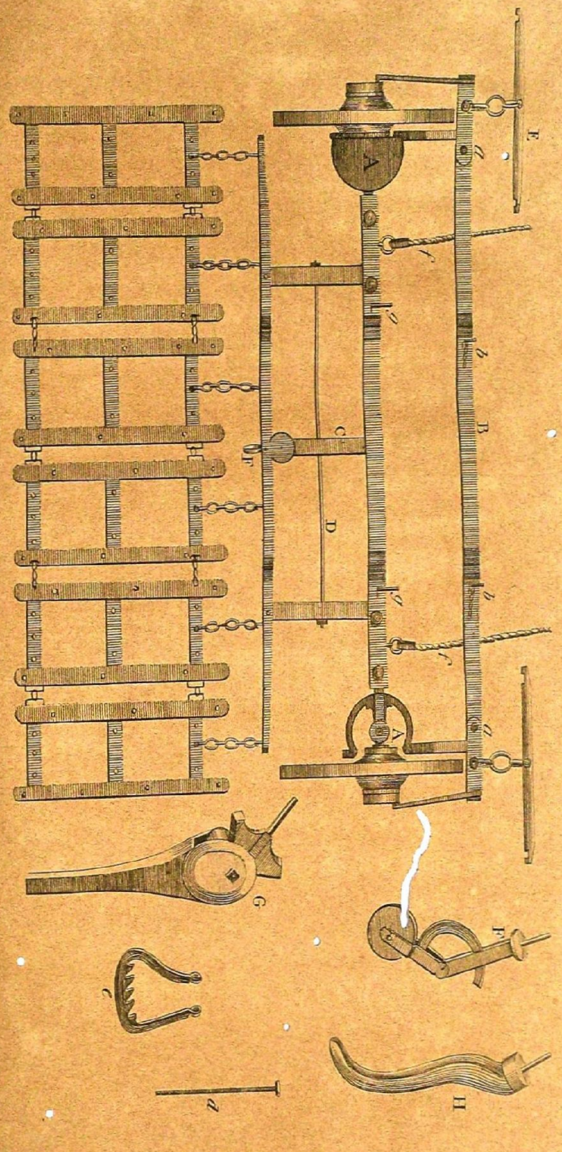
	£.	s.	d.
Or, with second-hand wheels and cast iron, - - -	2	4	0
Three pair of harrows complete,	2	0	0
If the frame is made to take shorter, as represented in the model, 9*s.* extra.			

Annexed to the foregoing account is a certificate, signed by several occupiers of land, and others,

others, in the neighbourhood of Mr. Knight, who ſay,

We have ſeen the harrow at work, as repreſented in the plate, and find it anſwer every expectation; we find it very convenient in the turnings; we are perfectly ſatisfied that it is much eaſier to the horſes; and the additional improvement of the joints gives a ſteadineſs in the furrow, whenever the horſes prove untractable: the wheels are likewiſe the means of the horſes taking an equal ſhare in the draught. We beg farther to expreſs our good opinion of John Knight, Edward Knight's workman, as a perſon well ſkilled in the practical part of huſbandry, and have taken the liberty of encloſing his certificate.

John Knight's certificate ſtates, that he has conſtantly uſed the harrow, and finds it anſwer the intended purpoſe, without exception; and, he is thoroughly convinced that, by this improvement, two horſes will, in moſt reſpects, anſwer the purpoſe of three.



XL. *Deſcription of a Barn upon a new Conſtruction. By Mr.* HENRY DOBSON, *Carpenter, of Norwich.*

WITH A PLATE.

From the Letters and Papers of the Bath and Weſt-of-England Society for the Encouragement of Agriculture, &c.

A Premium was given, by the Society, to Mr. DOBSON, for his Contrivance, of which an Account is given in the following Letter from him.

FROM a deſire of promoting the laudable deſigns of a ſociety eſtabliſhed for ſo important a purpoſe as the improvement of agriculture, I have endeavoured, in compliance with its wiſhes, to conſtruct a barn, on a plan which I believe the model here-with

with ſent, (ſee Plate XVIII.) and the following facts, will prove to be much ſuperior to any now in uſe. I have compared, as well as calculated, the difference, both of ſpace and quantity of timber, of the preſent model, with a common barn, without porches, of the ſame area.

The ties and braces of the barns now in uſe, have always been a juſt cauſe of complaint with the farmer; the form of this renders theſe unneceſſary *, which not only makes the ſpace occupied more commodious, but produces a conſiderable ſaving in the quantity of timber.

I am well aware, that the dimenſions of the threſhing-floors, in this model, will be objected to, as every innovation on common practice is; but, to candid men, (and to ſuch only improvements ought to be intruſted,) they will be found quite ſufficient.

I have obſerved, that the threſher ſeldom uſes a larger ſpace to threſh upon, than that aſſigned

* Yet in a poſtſcript Mr. Dobſon ſays, that the principal braces are to be ſix inches by four, and are ſo accounted in cubing the quantity of timber.

4 for

for this purpose in the present model; and the porches in common use, added to the enormous width of the barn, can serve for very little more than a receptacle for the threshed corn; the bow at the end of each threshing-floor is intended for this purpose, and will contain near two lasts, undressed, or in sacks.

The only objection that remains is, the length not being sufficient to dress the corn upon; the usual method being, to fling it with a shovel, as much spread as possible, to the distance of from 20 to 26 feet; by which means the heavier particles fly farthest, and the unsound corn and husks are of course left in the intermediate space: as this part of the process occupies as little, if not less time than any other, it will not be difficult to find a sufficient time of fine weather, in any season, to place a sail-cloth, or boards prepared for that purpose, to the distance of 12 or 14 feet from the doors, which will effectually answer every purpose of those now in use *.

The

* As threshing is, for the most part, done in the winter-months, when the barn-doors are generally frequented by cattle

The following are the dimenſions of a common barn, 50 feet by 20½, and thoſe of one according to the model.

Common Barn.

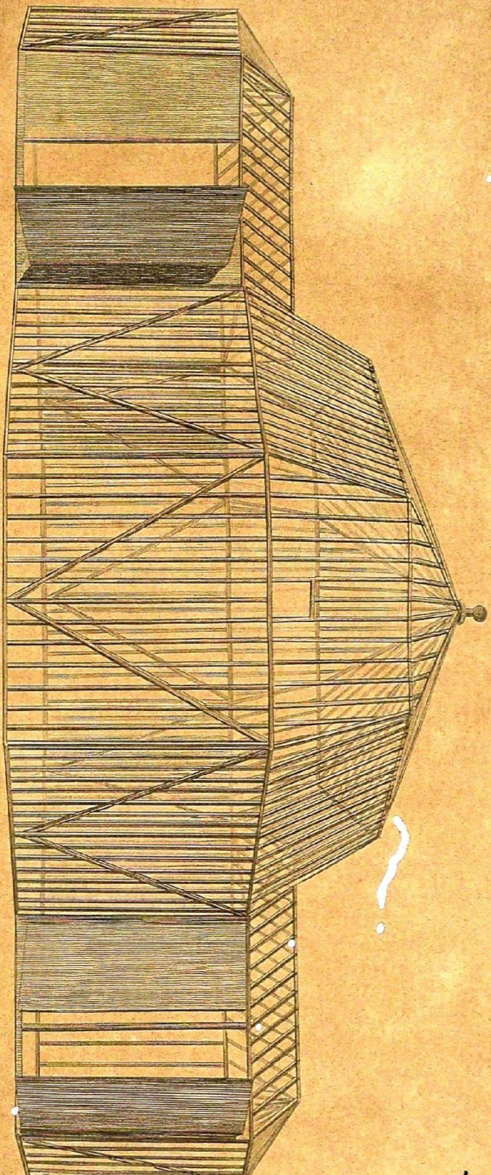
1,475 ſquare feet, the area.
24,426 cubic feet, for corn only.
702 cubic feet of timber.

Barn according to the Model.

1,472 ſquare feet, the area.
30,900 cubic feet, for corn only.*
445 cubic feet of timber.

By which calculation it appears, that a barn built on the model I have propoſed gains, on one

cattle, poultry, and birds, great inconvenience would be found in lengthening the floor by a ſail-cloth or boards, as Mr. Dodſon propoſes. But, if the corn be dreſſed with a winnowing-engine, (as is frequently practiſed in many counties,) the length of the floor will be quite ſufficient. In every other reſpect, we think this the completeſt model for a barn we have ever ſeen. (Note of the Society.)



in common uſe of the ſame area, 6474 cubic feet of ſpace, and is built with 257 cubic feet of timber leſs; and, as there is nothing in its conſtruction which would increaſe the expence of workmanſhip, the difference between the expence of building a barn on this plan, and that of one in common uſe, of the ſame area, would be as 445 is to 702.

It is needleſs to ſay any thing of its mathematical ſtrength, as it muſt be obvious to any one who is at all acquainted with mechanics, that the method here propoſed is of all others the beſt calculated to anſwer the purpoſe.

XLI. *Conclusion of Mr.* WEDGWOOD'S *Attempt to make a Thermometer for measuring the higher Degrees of Heat.*

(From Page 268.)

V. IT will be proper to bake the pieces, when dry, with a low red-heat, in order to give them some firmness or hardness, that they may, if necessary, be able to bear package and carriage; but more especially to prepare them for being put into an immediate heat, along with the matters they are to serve as measures to, without bursting or flying, as unburnt clay would do. We need not be solicitous about the precise degree of heat employed in this baking, provided only that it does not exceed the lowest degree we shall want to measure in practice; for, a piece that has suffered any inferior degrees of heat, answers as well for measuring higher ones as a piece which has never been exposed to fire at all. In this part of of the preparation of the pieces, it may be proper to inform the operator of a circumſtance, which, though otherwiſe immaterial, might at firſt diſconcert him: if the heat is not in all of them exactly equal, he will probably find, that while ſome have begun to ſhrink, others are rather enlarged in their bulk; for they all ſwell a little, juſt on the approach of redneſs. As this is the period of the moſt rapid produce of air, the extenſion may perhaps be owing to the air having at this moment become elaſtic, to ſuch a degree as to force the particles of the clay a little aſunder, before it obtains its own enlargement.

VI. Each diviſion of the ſcale, though ſo large as the tenth of an inch, anſwers to $\frac{1}{600}$th part of the breadth of the little piece of clay. We might go to much greater nicety, either by making the diviſions ſmaller, or the ſcale longer, but it is not apprehended that any thing of this kind will be found neceſſary; and indeed, in proceeding much farther in either way, we may poſſibly meet with inconveniences ſufficient to counterbalance the apparent additional accuracy of meaſurement.

VII. The

VII. The divisions of this scale, like those of the common thermometers, are unavoidably arbitrary; but the method here proposed appears sufficiently commodious and easy of execution, the divisions being adjusted by measures every where known, and at all times obtainable; for, however the inches used in different countries may differ in length, this cannot affect the accuracy of the scale, provided the proportions between the wider and narrower end of the gage are exactly as five-tenths of those inches to three-tenths, and the length 240 of the same tenths; and that the pieces, in their perfectly dry state, before firing, fit precisely to the wider end. When one gage is accurately adjusted to these proportional measures, two pieces of brass should be made, one fitting exactly into one end, and the other into the other: these will serve as standards, for the ready adjustment of other gages to the dimensions of the original.

By this simple method we may be assured, that thermometers on this principle, though made by different persons and in different countries, will all be equally affected by equal degrees of heat, and all ſpeak the ſame language: the utility of this laſt circumſtance is now too well known to need being inſiſted on.

VIII. If a ſcale two feet in length ſhould be reckoned inconvenient, it may be divided into two, of one foot each, by having three pieces of braſs fixed upon the ſame plate; the firſt and ſecond, five-tenths of an inch apart at one end, and four-tenths at the other; the ſecond and third, four-tenths at one end, and three-tenths at the other; ſo that the firſt reaches to the 120th diviſion, and the ſecond thence to the 240th.

IX. As this thermometer, like all others, can expreſs only the heat felt by itſelf, the operator muſt be careful to expoſe the pieces to an equal action of the fire with the body whoſe heat he wants to meaſure by them. In kilns, ovens, reverberatories, under a muffle, and wherever the heat is pretty ſteady and uniform, the means of doing this are too obvious to need being mentioned; but, in a naked fire, where the heat is neceſſarily more fluctuating and unequal in different parts of the fuel, ſome precaution will be required.

The

The thermometer-piece may generally be put into the crucible, along with the ſubject-matter of the experiment; but, where the matter is of ſuch a kind as to melt and ſtick to it, the piece may be previouſly incloſed in a little caſe made of crucible clay. The ſmallneſs of the pieces will admit of this being done without inconvenience, at leaſt in any but the ſmalleſt crucibles, as the pieces themſelves may be diminiſhed to any ſize that may be found proper, provided only that one of the dimenſions, five-tenths of an inch, be preſerved, as mentioned in Sect. IV.

For the very ſmalleſt ſort of crucibles, the caſe may be put in cloſe to the crucible, ſo as to form as it were an addition to its bulk on the outſide. If it be aſked, why the caſe is not always thus put in by the ſide of the crucible, it is anſwered that, in judging of the heat of *large* crucibles, from a thermometer-piece placed on the outſide of them, we may ſometimes be deceived, as the piece in its little caſe has been found to heat ſooner than the matter in the larger veſſels; but in *ſmall* ones, as the crucible and caſe are nearly alike in bulk, there is little danger of error from this cauſe.

X. Theſe

X. Theſe thermometer-pieces poſſeſs ſome ſingular properties, which we could not have expected to find united in any ſubſtance whatever, and which peculiarly fit them for the purpoſes they are here applied to.

1. When baked by only moderate degrees of fire, though they are, like other clays, of a porous texture, and imbibe water, yet, when ſaturated with the water, their bulk continues exactly the ſame as in a dry ſtate.

2. By very ſtrong fire, they are changed to a porcelain or ſemi-vitreous texture; nevertheleſs, their contraction, on farther augmentations of the heat, proceeds regularly, as before, up to the higheſt degree of fire that I have been able to produce.

3. They bear ſudden alternatives of heat and cold; they may be dropped at once into intenſe fire, and, when they have received its heat, may be plunged as ſuddenly into cold water, without the leaſt injury from either.

4. Even while ſaturated with water in their porous ſtate, they may be thrown immediately

into a white heat, without burſting or ſuffering any injury.

5. Sudden cooling, which alters both the bulk and texture of moſt bodies, does not at all affect theſe, at leaſt not in any quality ſubſervient to their thermometric uſes.

6. Nor are they affected by long *continuance* in but ſolely by, the *degree* of heat they are expoſed to. In three minutes, or leſs, they are perfectly penetrated by the heat which acts upon them, ſo as to receive the full contraction which that degree of heat is capable of producing, equally with thoſe which had undergone its action during a gradual increaſe of its force for many hours. Strong degrees of heat are communicated to them with more celerity than weak ones: perhaps the heat may be more readily tranſmitted, in proportion as the texture becomes more compact.

Theſe facts have been aſcertained by many experiments, the particulars of which are omitted, becauſe they would ſwell this paper much beyond the bulk intended.

XI. The uſe and accuracy of this thermometer, for meaſuring, *after an operation*, the degree of heat

heat which the matter has undergone, will be apparent: the foregoing properties afford means of meaſuring it alſo, eaſily and expeditiouſly, *during the operation*; ſo that we may know when the fire is increaſed to any degree previouſly determined upon. The piece may be taken out of the fire in any period of the proceſs, and dropped immediately into water, ſo as to be fit for meaſuring by the gage in a few ſeconds of time. At the ſame inſtant, another piece may be introduced into the place of the former, to be taken out and meaſured in its turn; and thus alternately, till the deſired degree of heat is obtained. But, as the cold piece will be two or three minutes in receiving the full heat, and correſponding contraction, to avoid this loſs of time, it may be proper, on ſome occaſions, to have two or more pieces, according to convenience, put in together at firſt; that they may be ſucceſſively cooled in water, and the degrees of heat examined at ſhorter intervals. It will be unneceſſary to ſay any thing farther upon precautions or procedures which the very idea of a thermometer muſt ſuggeſt, and in which it is not apprehended that any difficulty can occur, which every experimenter will not readily find means to obviate.

XII. It now only remains, that the language of this new thermometer be underftood, and that it may be known what the heats meant by its degrees really are: for this purpofe, a great number of experiments has been made, from which the following refults are felected.

The fcale commences at a red heat, fully vifible in day-light; and the greateft heat that I have hitherto obtained in my experiments is 160°. This degree I have produced in an air-furnace about eight inches fquare.

Mr. Alchorne has been fo obliging as to try the neceffary experiments with the pure metals at the Tower, to afcertain at what degrees of this thermometer they go into fufion; and, it appears, that Swedifh copper melts at 27, filver at 28, and gold at 32°.

Brafs is in fufion at 21°: neverthelefs, in the brafs and copper founderies, the workmen carry their fires to 140°, and upwards; for what purpofe they fo far exceed the melting-heat, or whether

ther ſo great an additional heat be really neceſſary, I have not learnt.

The welding-heat of iron is from 90 to 95°; and the greateſt heat that could be produced in a common ſmith's forge is 125°.

Caſt-iron was found to melt at 130°, both in a crucible in my own furnace, and at the foundery; but could not be brought into fuſion in the ſmith's forge, though that heat is only 5° lower. The heat by which iron is run down among the fuel, for caſting, is 150°.

As the welding-ſtate of iron is a ſoftening or beginning fuſion of the ſurface, it has been generally thought, that caſt-iron would melt with much leſs heat than what is neceſſary for producing this effect upon forged-iron; whereas, on the contrary, caſt-iron appears to require, for its fuſion, a heat exceeding the welding-heat 35 or 40°, which is much more than the heat of melted copper exceeds the loweſt viſible redneſs.

Thus we find, that though the heat for melting copper is by ſome called a white heat, it is only 27° of this thermometer. The welding-heat of iron, or 90°, is likewiſe a white heat; even 130°,

at

at which caſt-iron is in fuſion, is no more than a white heat, and ſo on to 160°, and upwards, is all a white heat ſtill. This ſhews abundantly how vague ſuch a denomination muſt be, and how inadequate to the purpoſe of giving us any clear ideas of the extent of what we have been accuſtomed to conſider as one of the three diviſions of heat in ignited bodies.

A Heſſian crucible, in the iron-foundery, *viz.* about 150°, melted into a ſlag-like ſubſtance. Soft iron nails, in a Heſſian crucible in my own furnace, melted into one maſs with the bottom of the crucible at 154°; the part of the crucible above the iron was little injured.

The *fonding-heat* of the glaſs furnaces I examined, or that by which the perfect vitrification of the materials is produced, was, at one of them, 114° for flint-glaſs, and 124° degrees for plate-glaſs; at another, it was only 70° for the former; which ſhews the inequality of heat, perhaps unknown to the workmen themſelves, made uſe of for the ſame purpoſe. After complete vitrification, the heat is abated for ſome hours to 28 or 29°, which is called the *ſettling-*

heat;

heat; and this heat is ſufficient for keeping the glaſs in fuſion. The fire is afterwards increaſed, for working the glaſs, to what is called the *working-heat*; and this I found, in plate-glaſs, to be 57°.

Delft ware is fired by a heat of 40 or 41°: cream-coloured or Queen's ware by 86°; and ſtone-ware, called by the French *pots de grés*, by 102°: by this ſtrong heat it is changed to a true porcelain-texture. The thermometer-pieces begin to acquire a porcelain-texture at about 110°.

The above degrees of heat were aſcertained by thermometer-pieces fired along with the ware in the reſpective kilns; but this thermometer affords means of doing much more, and of going farther in theſe meaſures, than I could at firſt even have expected. It will enable us to aſcertain the heats by which many of the porcelains and earthen wares of diſtant nations, and of different ages, have been fired; for, as burnt clay, and compoſitions in which clay is a prevailing ingredient, ſuffer no diminution of their bulk by being re-paſſed through degrees of heat which they have already undergone, but are diminiſhed by any additional heat, (according to Sect. V.) if a fragment of them

be

be made to fit into any part of the gage, and then fired along with a thermometer-piece until it begins to diminiſh, the degree at which this happens points out the heat by which it had been fired before. Of ſeveral pieces of antient Roman and Etruſcan wares which I have examined, none appears to have undergone a greater heat than 32°, and none leſs than 20°; for they all began to diminiſh at thoſe or the intermediate degrees.

By means of this thermometer, ſome intereſting properties of natural bodies may likewiſe be diſcovered, or more accurately determined, and the genus of the bodies aſcertained. Jaſper, for inſtance, is found to diminiſh in the fire, like an artificial mixture of clay and ſiliceous matter. Granite, on the contrary, has its bulk enlarged by fire; whilſt flint and quartzoſe ſtones are neither enlarged nor diminiſhed. Theſe experiments were made in fires of between 78 and 80° of this thermometer. A ſufficient number of facts like theſe, compared with each other, and with the properties of ſuch natural or artificial bodies as we wiſh to find out the compoſition of, may lead to various diſcoveries, of which I have already found ſome promiſing appearances; but many more experiments are wanting, to enable me to ſpeak with that certainty and preciſion on theſe ſubjects which they appear to deſerve.

A piece of an Etruſcan vaſe melted completely at 33°: pieces of ſome other vaſes and Roman ware at about 36°: Worceſter china vitrified at 94°: Mr. Sprimont's Chelſea china at 105°: the Derby at 112°: and Bow at 121°: but Briſtol china ſhewed no appearance of vitrification at 135°. The common ſort of Chineſe porcelain does not perfectly vitrify by any fire I could produce; but began to ſoften at about 120°, and at 156° became ſo ſoft as to ſink down, and apply itſelf cloſe upon a very irregular ſurface underneath. The true ſtone Nankeen, by this ſtrong heat, does not ſoften in the leaſt, nor does it even acquire a porcelain-texture; the unglazed parts continuing in ſuch a ſtate as to imbibe water, and ſtick to the tongue. The Dreſden porcelain is more refractory than the common Chineſe, but not equally ſo with the ſtone Nankeen. The cream-coloured or queen's-ware bears the ſame heat as the

the Dreſden porcelain, and the body is as little affected by this intenſe degree of fire.

Mr. Pott ſays, that to melt a mixture of chalk and clay, in certain proportions, which proportions appear from his tables to be equal parts, is "among the maſter-pieces of art." This mixture melts into a perfect glaſs at 123° degrees of this thermometer.

The whole of Mr. Pott's or any other experiments may, by repeating and accompanying them with theſe thermometric pieces, have their reſpective degrees of heat aſcertained, and thereby be rendered more intelligible and uſeful to the reader, the experimenter, and the working artiſt.

I flatter myſelf that a field is thus opened for a new kind of thermometrical enquiries; and that we ſhall obtain clearer ideas with regard to the differences of the degrees of ſtrong fire, and their correſponding effects upon natural and artificial bodies; thoſe degrees being now rendered accurately meaſurable, and comparable with each other, equally with the lower degrees of heat which are the province of the common mercurial thermometer.

APPEN-

APPENDIX.

Analysis of the Clay of which the Thermometric Pieces are formed.

This clay makes no effervescence with acids. Diluted nitrous and marine acids being boiled upon it, and afterwards saturated with fixed alkali, no precipitation or turbidness appeared. It therefore contains no calcareous earth; as that earth would have been dissolved by the acids, and precipitated from them by the alkali.

Calcined with powdered charcoal, it contracted no sulphureous smell, and the acids had no more action upon it than before. It therefore contains no gypseous matter, or combination of calcareous earth with vitriolic acid; as that acid would have formed sulphur with the inflammable principle of the charcoal, and left the calcareous earth pure, or in a state of solubility by acids.

Some of the clay was calcined with an equal weight of salt of tartar, which, for the greater certainty in regard to its purity, had been run *per deliquium*, and afterwards evaporated to dryness. The calcined mixture was boiled in water; the filtered liquor slowly evaporated, and suffered to cool at intervals. No crystalization was formed: the dry salt appeared merely alkaline, as at first, and deliquiated in the air; a farther proof that this clay contains no gypseous matter; for, the vitriolic acid would have been absorbed by the alkali, and formed vitriolated tartar; a salt which neither liquifies in the air, nor dissolves easily in water, and which therefore would have crystalized long before the alkali became dry, or remained after its deliquiation.

A twentieth part of gypsum, ground with clay, was very distinguishable by both the foregoing processes; producing a sulphureous smell, and calcareous earth, by calcination with charcoal-powder; and crystals of vitriolated tartar, by calcination with the same alkaline salt.

To separate the pure argillaceous part, or that matter which, in all clays, forms alum with the vitriolic acid, 240 grains of this clay were thoroughly moistened with oil of vitriol, boiled to dryness,

dryneſs, and at laſt made nearly red-hot. The mixture was then boiled in water: the earth which remained undiſſolved was treated again in the ſame manner with vitriolic acid, and this operation was repeated five or ſix times. The clay was diminiſhed, in the firſt operation, about 70 grains; but leſs and leſs in the ſucceeding ones, and in the laſt ſcarcely two grains. The filtered liquors yielded cryſtals of true alum; but its quantity was not examined, as the produce of alum from aluminous earth is already ſufficiently known; and the quantity of aluminous earth itſelf, or its proportion to the undiſſoluble earth, was here the object. From the 240 grains of clay there remained, in one experiment 98, and in another 95 grains, of indiſſoluble earth; ſo that five parts of this clay conſiſt of three parts of pure argillaceous or alum earth, and two parts of an earth of a different kind.

With reſpect to the nature of this laſt earth, it is eaſier to determine negatively what it is not, than poſitively what it is; but aſcertaining the former will be a great ſtep towards the diſcovery of the latter.

That

That it is not calcareous, gypſeous, or argillaceous, is manifeſt from the experiments. It is not jaſper; as this conſiſts, in great part, of argillaceous earth, which would have been extracted by the vitriolic acid. It is not fluor; as this, by the ſame acid, would have been decompoſed, its own acid expelled, and a gypſeous earth left. It is not of the micaceous kind; as the peculiar aſpect of theſe earths would readily betray them to the eye. It is not granite; for, ſtrong fire, which granite melts in, has no effect upon this. Nor is there any known kind of earth to which it is in any degree ſimilar, except thoſe of the ſiliceous order, and with theſe it perfectly agrees in all the properties I am acquainted with, that they poſſeſs in a ſtate of powder.

It does not vitrify or ſoften with pure clay, in the ſtrongeſt fire I have been able to produce. Nor is it diſpoſed to melt with the matter of Heſſian crucibles; for, a little of it, rubbed on the inſide of the crucible, and urged with ſtrong fire, continued white, powdery, and unaltered. Thirty grains of this earth were mixed with an equal weight of dry foſſil alkali, and the ſame quantity of a fine white quartzy ſand was mixed with the ſame proportion of the ſame alkali; the two mixtures were put into two ſmall crucibles, which were ſurrounded with ſand in a larger one, that both might be expoſed to an equal heat. They both began to melt at the ſame time; and, at about 80° of the thermometer, they had formed perfectly tranſparent glaſſes.

Though theſe properties may not perhaps be thought ſufficient, of themſelves, for determining with certainty that this ſubſtance is of the ſiliceous kind; yet, when joined to the negative proofs of its not belonging to any other known order of earthy bodies, they afford the fulleſt evidence which the nature of the ſubject can admit of, that the indiſſoluble part of this clay is truly ſiliceous, and conſequently, that the clay conſiſts of two parts of pure ſiliceous earth, to three parts of pure argillaceous or aluminous earth.

XLII. *Experiments on the Means of improving the Colours used in Painting. By M. de* Morveau.

From the Memoirs of the Academy of Dijon.

Nothing is more diſcouraging to a man of genius, who wiſhes to leave upon canvas ſome laſting monuments of the powers of his fancy, than the inſtability of the colours he is obliged to make uſe of in painting. Such however is ſtill the lot of this art, notwithſtanding it has been ſo long cultivated, and in ſpite of the reſearches of many artiſts, who, jealous of their reputation, would not truſt their conceptions to any materials but thoſe which they had themſelves prepared *. This defect,

* It is very certain, that many famous painters prepared their colours themſelves, and ſome of them were probably ſo lucky as to arrive at the art of rendering them more beautiful

defect, therefore, does not arise merely from the artist having neglected to acquire that knowledge of chemistry which ought to guide him in such an enquiry, but rather from the resources of chemistry in that respect having been, till very lately, unknown. As it appeared to me that it was now a proper time to seek whether the numerous discoveries made in that art might not furnish means to create, or at least to fix, those shades which the painter is desirous of producing, I undertook to make some experiments on the subject, and shall proceed to give an account of the result of my first enquiries.

White is the most important of the colours used in painting; not merely because it serves to soften the shades of all others; but white, upon the pallet of the painter, may be compared

beautiful and more lasting, or of making them of materials less subject to change. Those who have most carefully examined ancient and modern pictures, have assured me that there could be no doubt of their having done so, but they kept their processes secret, and they are probably lost: it is the office of chemistry to discover them again, or to find out others which may replace them.

to the matter of light, which he knows how to apply, ſo as either to bring objects nearer, or to give them relief. In ſhort, it is the chief cauſe of the illuſion he produces: in proportion as this light grows weaker, or fades, the appearance of the picture changes, the deception ceaſes, and at laſt the canvas preſents nothing but a flat ſurface, covered with dull colours without expreſſion. I have therefore directed my attention principally to this colour; indeed it is the only one of which I ſhall ſpeak at preſent, as I mean to defer, till another opportunity, an account of thoſe obſervations my experiments have furniſhed me with reſpecting the other colours which artiſts may be in want of.

I. *Examination of the White Colours already known.*

The firſt white colour which was known, and the only one which is yet uſed in painting, is that which is produced from the calx of lead. The mere theory of chemiſtry might have been ſufficient to ſhew how improper it was for that purpoſe, purpofe, becaufe, of all metallic fubftances, (except the perfect metals,) it is that which moft readily recovers its loft phlogifton; befides, that terrible diforder, known by the name of the painter's colic, to which thofe who are in the habit of ufing the calces of lead are expofed, ought, I think, to have engaged us to feek for fome fubftance lefs prejudicial. But it was not even fuppofed poffible that any other fubftance could be ufed in its place; and therefore, paying lefs attention to the danger of the artift than to the perfection of the art, all that we have done has been, to vary the preparation of white-lead, with a view to render it lefs fubject to change. Accordingly we have various kinds of white, which in commerce are diftinguifhed by the names of Krems-white, (fo called from a town in Auftria,) flake-white, and white-lead or cerufe.

It is well known that the bafis of all thefe colours is white-lead, fome of which are more pure, others contain more or lefs chalk, or whiting; confequently they all partake of the effential qualities of this metallic earth: thofe who doubt their doing fo, may be convinced of the fact, by the following experiment.

Experiment to determine and demonſtrate the Changeableneſs of Colours by phlogiſtic Vapour.

Into a wide-mouthed glaſs bottle I put ſome liver of ſulphur; (whether it be made with fixed or volatile alkali is indifferent;) I let fall upon it ſome drops of diſtilled vinegar, and I immediately cover the bottle with a piece of card, cut to the ſhape of its mouth, upon which I have previouſly applied ſpecimens of the ſeveral kinds of white-lead already mentioned, mixed both with oil and with water; over the firſt piece of card I place a ſecond, and tie a piece of bladder over the whole, faſtening it round the neck of the bottle.

It is evident that, in the foregoing operation, I do no more than make uſe of the means which chemiſtry affords me, to diſengage very quickly a great quantity of phlogiſton, ſo as to produce inſtantaneouſly the effects of ſeveral years; that is to ſay, I apply to the ſpecimens made uſe of for trial, the ſame kind of vapour to which the pic-

ture

ture will neceſſarily be expoſed, but in a more accumulated or concentrated ſtate.

That theſe vapours are of the ſame kind, it is hardly neceſſary to prove; every one now knows that the ſmoke from candles, &c. animal exhalations of all kinds, reſpiration, the effluvia of volatile alkali, thoſe of electricity, even light itſelf, furniſh continually a greater or leſs quantity of matter, which is not merely analogous to, but is identically the ſame as, the neutralizing principle of the vitriolic acid in ſulphur.

If therefore it ſhould happen, that any of the colours applied upon the card be ſenſibly changed, by the phlogiſtic vapour diſengaged from the liver of ſulphur by the vinegar, we may ſafely conclude, that the matter of which ſuch colour is compoſed has a great affinity with phlogiſton; and, ſince it is impoſſible to prevent colours from being expoſed to its influence, it is obvious that they muſt, in a courſe of time, ſuffer changes, more or leſs in degree, according to circumſtances.

When the ſpecimens have been for ſome minutes expoſed to the vapour from the liver of ſulphur, fulphur, I take them out to examine them, and I find them all changed. The cerufe is turned quite black, fo alfo is the flake-white mixed with water; that mixed with oil is changed to a lead-colour; and the Krems-white is become of a dark brown. I therefore no longer hefitate to affirm, that thefe colours are unftable, and ought not to be made ufe of. In vain fhould we flatter ourfelves that we may be able to defend them by varnifhes; fuch methods can only delay, for fome time, the contact of the phlogiftic vapour; the fhrinking of thefe varnifhes, in drying, would fooner or later occafion a number of cracks, through which this fubtle vapour would infallibly find accefs; befides, the varnifhes themfelves contain phlogifton, and act upon the colours as they lofe their humidity.

II. *Experiments with various Subftances, to difcover White Colours more durable.*

Having fhewn the inftability of the white colours now in ufe, I am fenfible that it would be

to

to no purpose to make the artists who use them uneasy respecting the duration of their pictures, by furnishing them with means to convince themselves that what I advance is true, if I did not at the same time endeavour to procure them some colours more worthy of their confidence; and I think that it may be of use to give a particular account, even of those trials which did not succeed, as by so doing I may save trouble to others, and help to establish, upon this subject, some theoretic principles not yet sufficiently known.

Three conditions are requisite to constitute a good colour for painting.

The first, that it should mix easily, and incorporate, both with oils and mucilages, or at least with one or the other of these substances. This property depends upon a certain degree of affinity: if that is too strong, a degree of dissolution takes place, the colour is lost in the new composition, and the mass becomes more or less transparent; or else the sudden re-action absorbs the fluids, leaving only a dry body, which cannot be again softened. If the affinity is too weak, the colouring-substance, being hardly suspended in the fluid, is applied upon the canvas in the form of a ſand, not fixed by, nor united to, the fluid made uſe of.

The ſecond condition is, that the matter of which the colour is compoſed ſhould have but a weak affinity with phlogiſton, that it ſhould not be capable of contracting with that ſubſtance (at leaſt without the aid of fire, or ſome other medium) ſuch an union as is capable of altering its manner of reflecting the rays of light. The trial to which I ſubmitted the various kinds of white-lead, as before deſcribed, is an infallible way of determining the exiſtence of this property, in a few minutes, without waiting for the experience of years.

The third condition, equally eſſential, is, that the colouring matter ſhould not be volatile, that it ſhould not be united to a ſubſtance of ſo weak a texture as to be liable to periſh ſpontaneouſly. This circumſtance excludes moſt ſubſtances which have received their colour from vegetable organization, unleſs we ſhould be able to make their colouring-particles enter into a more ſolid combination.

In

In consequence of these reflections, my enquiries were first directed to the five pure earths *; afterwards, to earthy compounds; in the third place, to those earthy salts which are very little soluble; and lastly, to metallic earths, either pure, or precipitated by Prussian alkali.

I. The five pure earths possess, in an eminent degree, the quality of stability, and are, at the same time, very little acted upon by phlogiston; but they are entirely destitute of the first of the above-mentioned conditions; that is to say, they refuse to enter into any union either with oil or mucilage, and their whiteness is lost when they are ground with either of these fluids. I tried the earth precipitated from the liquor of flints, chalcedony rendered opake by means of fire, alumine or earth of alum, Cologn clay, calcareous earth, magnesia, and barytes or heavy spar; the three

* Mr. Wenzel has made known a sixth earth, which I call *Eburne*; having prepared it for various experiments, of which I shall give an account hereafter, I thought I ought also to try it for painting, but I soon found that it had the same defects as lime and barytes; besides which, it could not be procured but at too high a price.

laſt I tried both raw and calcined. None of theſe ſubſtances, ground with oil or mucilage, left upon the canvas any thing more than a clotted ſemi-tranſparent matter; having entirely loſt that fine white colour which they poſſeſſed before being ground.

The earth of alum was the ſubſtance from which I had the greateſt expectations; not becauſe M. Baumé had already recommended its uſe in painting *, or becauſe it enters into the compoſition of the Pruſſian blue of the ſhops, but rather becauſe it forms the baſis of ochres, and ſome other earths uſed in painting. This led me to ſuppoſe that it would unite, to a certain degree, with the fore-mentioned fluids; but, in whatever manner I treated it, I could not produce a white paint. This want of ſucceſs will not

* *Baumé, Chymie experimentale et raiſonnée.* Tome I. p. 337. The *Duc de Chaulnes* alſo recommends the uſe of this earth in painting; (*Journal de Phyſique.* Tome 17, p. 232;) but he uſed it only with gum-water; and, though I indeed found that its whiteneſs was leſs injured by this liquor than by oil, yet it appeared to me to be very far from producing a good white for water-colours.

aſtoniſh

astonish any one, when it is considered that in Prussian blue, ochres, &c. the earth of alum is only the vehicle of the colouring-matter, which matter is of a very different nature; whereas, in my experiments, it was itself the colour. When so circumstanced, a trifling alteration, which would be imperceptible in the first case, completely destroys the effect sought for in the second. To be convinced of the truth of this, it is only necessary to mix together equal parts of earth of alum, or of white clay, with ceruse, or any other kind of white-lead: this mixture may be ground, either with oil or mucilage, without losing its colour; and, such is the effect produced by the colouring-body, will have none of the above-mentioned bad properties of the pure earths.

II. Both nature and art offer to us a sufficient number of earthy compositions, as white as we can wish them; such are, among others, white jasper, white feld-spar, white schorl, marl, Reaumur's porcelain, &c. But all these substances, and all the combinations of earths which I attempted to make by fusion, had the defect I have already ſpoken of, ariſing apparently from the ſame cauſe: there was always wanting a fixed colouring-body, capable of preſerving its colour, when powdered, or ground with oil or water. Ultramarine, which is procured from that ſpecies of blue jaſper known by the name of lapis-lazuli, ſeems, at firſt ſight, to warrant the poſſibility of making uſe, in painting, of all thoſe ſemi-vitreous opake compoſitions which are of the nature of jaſper. Poſſeſſed with this idea, I conceived hopes that I ſhould be able to produce a true white lapis-lazuli; but, on the contrary, I ſoon became ſenſible that ultramarine furniſhed an inſtance of the truth of the principle already mentioned, and deduced from my obſervations on the pure earths; as it is not the real ſubſtance of the jaſper which conſtitutes ultramarine, but that metallic ſubſtance which accidentally colours this particular ſpecies of jaſper. Conſequently, in imitating nature in this reſpect, art ought to have no other end in view than to give a fixed baſis to ſome colour already formed, and to prevent its changing; increaſing, if poſſible, the brightneſs

and

and intensity of the colour, but not seeking to produce one.

III. When, from the earthy and metallic salts, those were deducted whose acid is not completely saturated, and those which are dissolved by the moisture of the air, or at least which attract that moisture, there remained but a small number for me to examine.

Selenite, natural or artificial, produced, when mixed with oil, only a sort of paste which was without colour, and of the consistence of honey: when mixed with gum-water, it kept its whiteness rather better, but it still formed only a semi-transparent mass.

Heavy spar, either native or regenerated, gave me greater hopes, because it is the most insoluble of all earthy salts. After being powdered, it was of a beautiful white colour, but no sooner was it touched by the oil, than it became grey and semi-transparent: it was also changed by mucilage, but in a less degree, and did not recover its whiteness as it grew dry upon the canvas.

The same changes took place in calcareous borax, formed in a solution of borax, by means of lime-water. When mixed with oil, its whiteneſs was entirely loſt: with gum-water, it was dimi-niſhed in a leſs degree; but, with this laſt, it immediately grows hard, in ſuch a manner that it is no longer poſſible to ſoften or ſpread it.

Calcareous tartar, obtained by throwing quick-lime into a boiling ſolution of cream of tartar, when mixed with oil, has the ſame appearance as ſelenite: with gum-water, it produced a pretty good white, but rather dull. It applies very well upon canvas, and is not changed by the action of concentrated phlogiſtic vapour.

I alſo tried the oxalat of lime, but, although very inſoluble, its whiteneſs was loſt, whatever fluid it was mixed with.

TO BE CONCLUDED IN OUR NEXT.

XLIII. *List of Patents for Inventions, &c. granted since the Beginning of the Year 1796 *.*

William Whitmore, of Birmingham; for an improvement in machines for weighing waggons, &c. Dated Jan. 4, 1796.

Gabriel Wright, of Leadenhall-street; for improvements in azimuth compasses. Dated Jan. 19, 1796.

Jasper Augustus Kelly, of the Strand; for improvements in the construction of harnesses, &c. Dated Jan. 19, 1796.

Edward Thomas Jones, of Bristol; for a new method of keeping accounts. Dated Jan. 26, 1796.

James Stuard, of St. Anne's, Limehouse; for an anchor for ships, &c. Dated Feb. 4, 1796.

Joseph Creswell, of St. George's, Hanover square; for an improved pump. Dated Feb. 4, 1796.

* Conceiving that it would be agreeable to our readers to be informed what patents are taken out, we have resolved to add to our work a correct list of them, beginning with the year 1796; which list will be regularly continued.

William Paul, of Manchester; for a new machine for printing and staining callicos, &c. Dated Feb. 4, 1796.

Edward Cook and Richard Eva, of Falmouth; for an apparatus for taking observations and altitudes, &c. Dated Feb. 9, 1796.

William Rudder, of Birmingham; for a method of making metal-cocks, so as to prevent leakage. Dated Feb. 16, 1796.

John Grimshaw, of Strines-Hall, Derbyshire; for the discovery of certain vegetable substances for bleaching, &c. Dated Feb. 17, 1796.

Richard Scantlebury, of Redruth, Cornwall; for a new invented bucket for raising or drawing liquids, &c. Dated Feb. 17, 1796.

Joseph Hately, of Worcester; for a method of making, from vegetable bodies, a new astringent acid liquid. Dated Feb. 19, 1796.

Felton Matthew, of Three Cranes Wharf, London; for a method of separating the beer from yeast, and preserving the yeast. Dated Feb. 22, 1796.

Henry Clay, of Birmingham, Esq.; for a carriage or machine for the conveyance and shooting of coals, lime, &c. Dated Feb. 27, 1796.

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NUMBER XXXVI.

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XLIV. *Specification of the Patent granted to Mr.* JOHN NASH, *of Dover-ſtreet, St. James's, Architect; for his Method of conſtructing Bridges of Plate-Iron, either wrought, caſt, framed, or put together, ſo as to form hollow Bodies, Maſſes, or Cubes, capable of being filled up with Earth, Sand, Stone, Gravel, or other Materials, &c.*

WITH THREE PLATES.

Dated February 7, 1797.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE, that in compliance with the ſaid proviſo, I the ſaid John Naſh do hereby declare, that the nature of my ſaid invention of a new and peculiar art or method of conſtructing bridges of plate-iron, either wrought, caſt, framed, or put together, ſo as to form hollow bodies, maſſes, or cubes, capable of being filled up with earth, ſand, ſtone, gravel, or other materials, to make the ſame ſolid bodies, maſſes, or cubes, or, not being filled, have the ſemblance of ſolid bodies, maſſes, or cubes, and the manner in which the ſame is to be performed, is particularly deſcribed and aſcertained in manner following; that is to ſay, the arch of the bridge is formed by hollow frames or boxes, each box conſiſting of four ſides and a bottom; the ſides form the arch-joints of the bridge, and are diminiſhed ſo as to tend to the centre of the circle which ſtrikes the arch, in ſuch a manner that, when theſe boxes or frames are put together ſide by ſide, they form the arch of the bridge, the joints of which have a ſolid bearing throughout, like thoſe of ſtone bridges. Theſe boxes are afterwards filled with earth, clay, ſand, or gravel, or gravel mixed with lime, or ſand mixed with lime, or rough ſtone, or rough ſtone-maſonry, or bricks, or free-ſtone, or any other ſubſtance; ſo that, when filled, the arch is one ſolid body caſed with

with iron. These boxes may be of cast-iron, or wrought-iron; may be cast, rolled, or hammered in flat plates and frames, and put together. They may be cast without bottoms, and the bottoms put in, as shewn in the section, Fig. 1, in Plate XIX: or they may be cast with bottoms, as in the section, Fig. 2: or they may be used without bottoms, or filling up, and be boarded or plated over at top, and the road filled in, as in the section, Fig. 3; one part of the principle of this patent being the abuttal of plates of iron throughout the breadth of the bridge, in the manner of the arch-joints of a stone-bridge. Or those boxes may be a succession of arches, with flanches forming the arch-joints, as in the section, Fig. 4, and filled up in the spandrils, or not filled up: or they may be formed of hollow cylinders, with flanches, as in the section, Fig. 5. These arch-joints may have sheet-lead or other composition placed between them, to fill up the uneven surfaces of the iron, and to prevent the pressure of iron against iron. The arch-joints or flanchings may be screwed together, as in the section, Fig. 1; or stubb tenants, or fillets, with correspondent holes, mortises, and

 grooves,

grooves, may be caſt in the plates themſelves, and fitted into each other, as in the ſection, Fig. 2. The ſkirting or kirb, which keeps in the ground, may be caſt or framed with the boxes, as in the ſection, Fig. 6; or may be caſt ſeparate and put on; or may be omitted. When two, three, or more arches are put together, the ſpandrils or ſpaces between the arches are formed by hollow ſpandrils of wrought-iron, or caſt-iron, and framed, caſt, or put together, as before mentioned; and may or may not be filled up ſolid, as the boxes of the arches before deſcribed. Theſe hollow ſpandrils may be cylindrical, triangular, quadrangular, or of many ſides, as repreſented by the Figures 1, (at A,) 2, 3, and 4, in Plate XX. The piers of theſe bridges are formed, like the boxes, hollow; and may be filled up ſolid, or otherwiſe; and may be of plate-iron, either wrought or caſt, and framed or put together. Or they may be caſt in one piece; may be in form cylindrical, triangular, quadrangular, or of many ſides, as in the ſections, Figures 1, 2, 3, and 4, in Plate XXI. They may be caſt with the hollow frame forming the piers, or be faſtened to them,

them, as in the Figures 5 and 6, in the same Plate. The dam is also formed hollow by piles of plate-iron, grooved, rebated, and dove-tailed into each other; which, when fixed into each other, form a hollow box; and, when driven or inserted into the bed of the river, form a dam for the pier, as in Fig. 7; and, when the pier is built, are driven home to the bed of the river, make a box of dove-tailed piles, inclosing the ground on which the pier stands, and securing it from being undermined by the water passing through the arch. In witness whereof, &c.

Explanation of the Figures.

(See Plates XIX. XX. and XXI.)

Plate XIX. Fig. 1. Section of one of the arches of the bridge, shewing the boxes or frames cast without bottoms; the bottoms put in separate, and the boxes filled up solid.

A A A. Top of the skirting, to keep in the ground.

B B B. Tops of the boxes or frames.

C C C. Boxes or frames.

D D D. Bottoms of the boxes put in.

E. Ground

E. Ground filled in.

F. Solid masonry.

Fig. 2. Section of one of the arches of the bridge, shewing the boxes or frames stubbed, rebated, or grooved together, and the bottoms cast with the sides.

A A A. Top of the skirting, to keep in the ground.

B B B. Tops of the boxes.

C C C. Bottoms of the boxes, cast with the sides.

D. Ground to form the road.

E. Solid masonry.

Fig. 3. Section of one of the arches of the bridge, shewing the boxes or frames used without bottoms, planked on the top, and covered with the ground.

A A A. Planking over the open boxes, to cover the ground.

B B B. Hollow boxes without bottoms.

Fig. 4. The boxes or frames made of a succession of arches, instead of square boxes.

A A A A. Flanching.

Fig. 5. Succession of cylinders forming an arch, instead of square boxes.

A A. Plates of iron.

B B B B.

B B B B. Flanching.

Fig. 6. Outside view of one of the arches of the bridge.

A A A. Skirting to keep in the ground.

Fig. 7. Manner in which the boxes are screwed together.

Fig. 8. Manner in which the boxes are stubbed, rebated, or grooved together.

Plate XX. Fig. 1. Design shewing, when two or more arches are put together, how the spandrils are formed by hollow cylinders.

A. Hollow cylinder.

B B B. Iron plates.

C C C C C C. Flanching.

D D D D. Iron boxes or frames, forming the rim of the arch.

Fig. 2. Triangular hollow spandril, to be applied instead of the cylinder.

Fig. 3. Quadrangular hollow spandril, to be applied instead of the cylinder.

Fig. 4. Octangular hollow spandril, to be applied instead of the cylinder.

Fig. 5. Section across the bridge, shewing the boxes or frames filled up solid, and the ground forming the road over the bridge.

A A. Iron railing.

B B. Bottoms let in.

Fig. 6. Plan of the boxes or frames, ſhewing their form, and how they are bolted together.

Plate XXI. Fig. 1. Pier formed of cylindrical boxes, filled up ſolid.

Fig. 2. Pier formed of triangular boxes, filled up ſolid.

Fig. 3. Pier formed of ſquare boxes, filled up ſolid.

Fig. 4. Pier formed of octangular boxes, filled up ſolid.

Fig. 5. A. Cylinder made of iron, and filled up ſolid.

B. Maſonry to form the pier.

C C. Water line.

D D Ground-line.

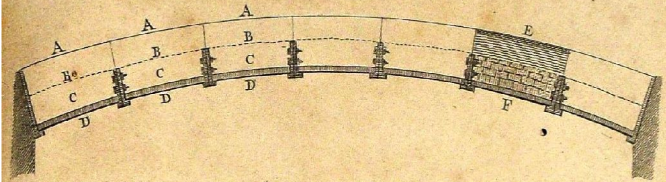
Fig 6. A. Cylinder made of iron, and filled with ſolid maſonry, to form the pier.

B B. Water-line.

C C. Iron piles, driven into the ground to ſecure the foundation.

Fig. 7. Pier of plate-iron, filled up ſolid.

Fig. 1.



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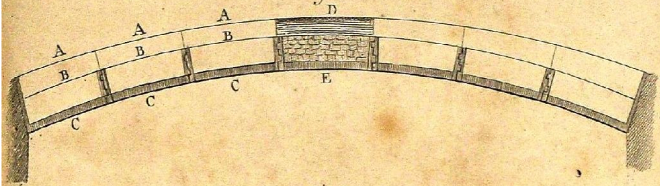

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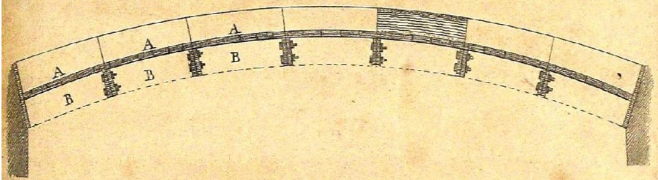

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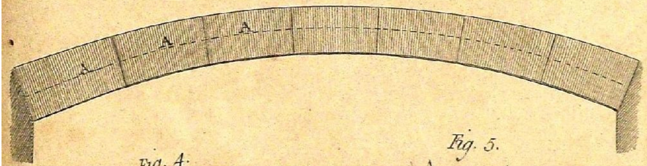

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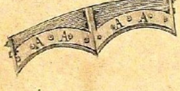

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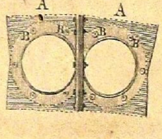
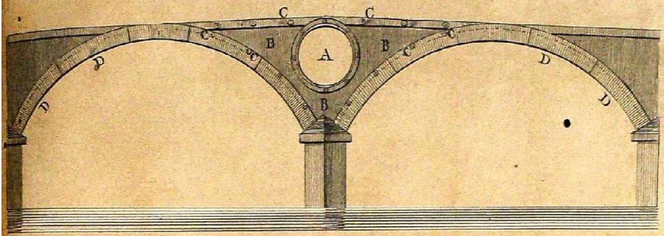


Fig. 7.

Fig. 8.

Fig. 1.



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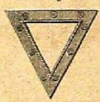

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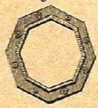

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Fig. 5.

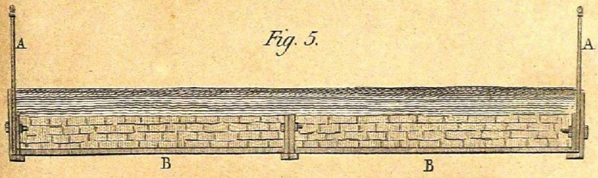


Fig. 6

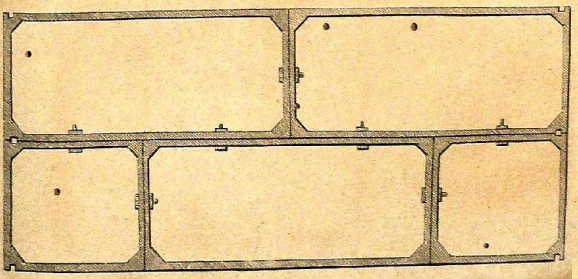


Fig. 1.

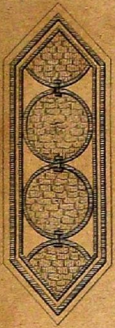
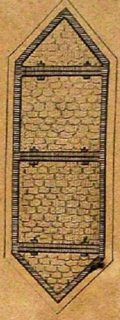


Fig. 2.

Fig. 3.



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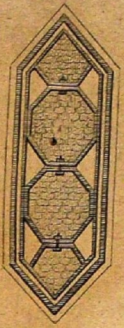

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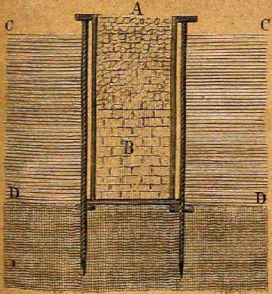

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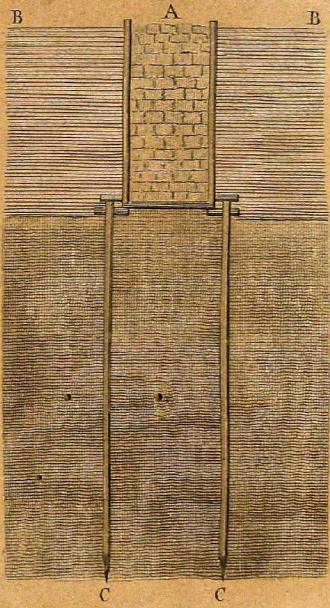


Fig. 7.

XLV. *Specification of the Patent granted to Mr.* Henry Walker, *of Thurmaston, in the County of Leicester; for his Invention of a Method by which Houses and other Buildings, of any Description or Dimensions, might be erected in one entire Mass or Body, at a much easier Expence, especially in the Articles of Timber, Lime, and Workmanship, and which would be equally as durable in themselves, and less liable to Accidents by Fire, than Buildings erected upon the common Construction.*

Dated July 20, 1796.

To all to whom these presents shall come, &c. Now know ye that, in compliance with the said proviso, I the said Henry Walker do describe and ascertain the nature of my said invention, and do declare that the same is to be performed and carried into effect, in the following manner; that is to say, in the first place I take an argillaceous earth or natural clay, which I select, examine, and purify, by the ufual well-known methods, and compound the fame with fand, or broken or pounded pottery, or brick, or coal-afhes, or charcoal, or, in fhort, with any other of thofe fubftances which experience has fhewn to be adapted to form a good, firm, and durable brick, when properly baked; and I vary my compofition according to the nature of the component parts themfelves, and the purpofes which they are intended to anfwer; but, for common conftructions, I ufe the fame proportions as brickmakers in general do. I then proceed to mix, knead, and incorporate the faid materials, until the fame are brought to the requifite firmnefs and tenacity for building; which is nearly fuch that the parts of any lump or mafs of the fame may be readily incorporated with, or joined to, any other fimilar mafs, by moderate blows with a wooden mallet, and the occafional addition of a very fmall portion of water: I call this compofition the prepared material.

Secondly, I conftruct floors, walls, and all other buildings, after my faid new invention, in fuch a manner that I can apply the power of fire, from

from wood, coal, charcoal, coak, or other combuſtible matters, not only to the external ſurfaces of the ſaid floors, walls, and other parts, but alſo to the interior parts of ſuch floors, walls, and other parts, by means of fires maintained in certain cavities left within the ſame: I call theſe cavities by the name of furnaces.

Thirdly, with regard to the particular forms, dimenſions, and relative poſitions of the ſaid floors, walls, and other parts of buildings, and the furnaces left or formed within the ſame, together with the apertures or communications, for the purpoſes of ventilating the fires therein, of ſuffering the volatile matters to eſcape, and of converting the whole into one entire maſs of brick by a due communication and continuance of heat, I do here proceed to explain the general principles and practice relating thereto, by deſcribing the particular operations of conſtructing and baking a portion of a ſtraight perpendicular wall, as follows; that is to ſay, the ground muſt be rendered ſolid, and the foundation laid in the uſual manner; after which, I lay thereon a quantity of my prepared material herein before deſcribed, and do beat, ram, or otherwiſe preſs down the ſame to the thickneſs of about ſix inches; and in width correſponding with the intended dimenſions of the wall, regulated by boards, or framing, or other ſuitable application to the outer ſurfaces. I then plant upright, at the diſtance of about thirty inches aſunder, in the ſaid layer or bed of prepared material, a number of cylindrical pieces of wood, of about nine inches in diameter each, and eighteen or more inches in length, to ſerve as moulds for the cavities of the furnaces; and between each of the ſaid moulds I place, in the longitudinal direction of the wall, and parallel to the horizon, a number of pipes, of wood, or other materials, or rods, or other proper maſſes, of combuſtible or incombuſtible matter, for the purpoſe of forming communications between all the ſeveral furnaces, or as many of them as I think proper. In the next place, I proceed to form another layer or bed of the material to the ſame height, namely, about ſix inches, and diſpoſe a number of pipes, of wood, or other materials, or rods, or other proper maſſes, of combuſtible or incombuſtible matter, for the purpoſe of

forming

forming communications between the furnaces as before. In this manner I conſtruct the whole, or ſo much of the wall as I apprehend at the time may be conveniently formed, in the raw or unburned ſtate; taking care, as the work advances, to raiſe the wooden cylinders or moulds of the cavities or furnaces, in order that a ſufficient portion thereof ſhall remain above the ſurface of the work, to admit of the reception and proper faſhioning of each ſubſequent bed or layer. Or otherwiſe, I form the communications between the furnaces by perforating the wooden moulds, in various places, at right angles to their reſpective axes; and through the ſaid perforations I paſs a bar of iron, or other material, which ſerves to connect three or more of the ſaid furnace-moulds together, and, being afterwards withdrawn as the work proceeds, doth leave a cavity or cavities of communication, ſimilar to thoſe formed in the methods herein before deſcribed, by pipes, or rods, or other maſſes. And moreover I do, with a carpenter's augre, or other fit boring-tools, open ſuch a number of horizontal or oblique apertures or flues into all the furnaces, and alſo into all the

the communication-pipes, or rods, or maſſes, or cavities, as aforeſaid, as may be requiſite for admitting a good communication on all ſides with the open air. Or otherwiſe, in ſome inſtances, I form the ſaid horizontal or oblique apertures or flues, by diſpoſing a ſuitable number of taper rods in the work, along with the pipes, which rods I afterwards draw out.

Fourthly, when the ſaid wall, or ſo much thereof as may conveniently be conſtructed at one time in the raw material, is builded, I ſuffer the ſame to dry ſpontaneouſly. Or otherwiſe, I dry the ſame by moderate fires in the furnaces, which draw in the air by the lower apertures, and emit the heated air, vapour, flame, and other volatile matters, through the upper apertures; and afterwards, by ſtronger fires in the ſaid furnaces, or by ſuitable applications of fire externally, or by both at the ſame time, I convert the whole into one entire maſs of brick; and I muſt alſo obſerve, that, by occaſional cloſing of the furnaces at top, or any of the other apertures, or by opening of the ſame or others of the ſaid furnaces or apertures, in various parts, according to circumſtances

which

which the intelligent operator will readily apprehen'd, I do in ſuch manner regulate the progreſs, communication, and effect of the heat, that the converſion into brick is regularly and uniformly made through the entire maſs.

Fifthly, I do farther ſtate and declare, that the dimenſions of the furnaces, the poſitions and relative diſtances of the pipes of communication and lateral apertures, and the thickneſs of the layers of the prepared material, are each and all ſuſceptible of great variations, according to the nature of the ſaid material, the activity of the fuel, the propoſed ſolidity or figure of the work, and numerous other obvious circumſtances; and that, accordingly, I do by no means confine myſelf to the dimenſions here given by way of elucidation.

Sixthly, I proceed to form the remaining or ſubſequent part or parts of ſuch wall or other edifice, to be conſtructed as aforeſaid, by applying additional portions of the prepared material in contact with that which hath been already baked; and, in this and every other part of my work, I place and diſpoſe proper and ſuitable external and internal moulds, ſupports, frames, and other occaſional contrivances, well known to builders, for ſuſtaining works, or forming arches, or determining the figure and poſitions of ſoft plaſtic ſubſtances. The explanation hereby given is ſufficient to enable any builder, of moderate ſkill, to carry my ſaid invention into full effect, as far as relates to walls, buttreſſes, arches, and other perpendicular or oblique parts of edifices; I therefore do proceed to deſcribe the methods of forming floors and roofs, in the ſame ſtrong, durable, and uniformly conſiſtent material, forming one maſs with the reſt of the building, as follows; that is to ſay,

Seventhly, I form the ground-floor of the prepared material, leaving hollow ſpaces between the ſupports beneath, for making fires to burn the ſame: theſe fires are ventilated by ſide apertures, and the flame and volatile products iſſue therefrom through numerous holes, previouſly made in the ſaid floor, or otherwiſe. When the ſaid floor is of conſiderable thickneſs, I make furnaces therein, as before deſcribed with regard to walls conſtructed in this my new method, together with pipes

pipes of communication, and horizontal apertures and flues, as aforeſaid.

Eighthly, I form the firſt floor above the ground-floor, in ſuch a manner, upon ſuitable temporary framing, that the upper ſurface ſhall be plane, and the lower ſurface thereof ſhall be concave; that is to ſay, either cylindrical, ſpherical, elliptical, or otherwiſe curved, with regard to the lower bounding-line of one or more of its vertical ſections, that it may, when baked, ſupport itſelf upon the principle of a low arch; and I do convert the ſaid floor into brick, by means of fire in the apartments beneath, of which the flame and volatile products iſſue through numerous ſmall apertures, deſignedly made in the ſaid floor. Ninthly, I do conſtruct and bake or burn the other floors above the firſt floor, and alſo the roof, in the ſame manner as the ſaid firſt-floor; and, in all and every caſe and caſes of floors, roofs, platforms, ſtaircaſes, and other horizontal or oblique parts of edifices, I do occaſionally make uſe of, and diſpoſe upon the ſurface, or within the maſs of the prepared materials of which the ſame are made, ſuch and ſo many bars of wood, or

 metal,

metal, or maſſes of ſtone, or baked earth, duly figured and diſpoſed, as may be needful, either for preſerving and ſuſtaining the ſame in their proper figures reſpectively, until perfectly baked, or for giving ſtability and permanency to the ſame afterwards.

Tenthly, and laſtly, I do cloſe the apertures, fill up the furnaces, amend the deficiencies or imperfections, adorn the walls, floors, cielings, or other parts, internally and externally, by requiſite applications of my prepared material, or otherwiſe, according to the taſte and direction of the proprietor of ſuch building or buildings as I may conſtruct according to this my ſaid new invention. In witneſs whereof, &c.

XLVI.

XLVI. *Specification of the Patent granted to M.* NICOLAS DUBOIS DE CHEMANT, *of the City of Paris, in the Kingdom of France, (now of Frith-ſtreet, Soho,) Surgeon-Dentiſt; for his Invention of a Compoſition for the Purpoſe of making artificial Teeth.*

Dated May 11, 1791.

TO all to whom theſe preſents ſhall come, &c. Now KNOW YE that, in compliance with the ſaid proviſo, I the ſaid Nicolas Dubois de Chemant do hereby declare, that my ſaid invention is deſcribed in manner following; that is to ſay, to make the mineral paſte, or compoſition of which the teeth are to be formed, take thirty pounds of fine white ſand, like that of Fontainebleau or Aumont, waſh it well three or four times, until the water runs off very clear; dry the ſand; then take ten pounds of Alicant barilla,

 pounded

pounded and sifted through a coarse sieve; mix both ingredients well together, and place them under an oven or furnace, (similar to that in which the tender or soft French porcelain or china is baked,) until they are properly purified. Take seven pounds of this composition, pound and sift it, then mix with it two pounds of the whitest and cleanest well-dried marl; moisten it in very clear water, and grind it in a mill, (such as mustard-grinders make use of,) until it becomes fine; then take it out, and place it on plates of plaster to dry, and the paste is complete. To make other pastes, but of a quality inferior to the above, take about half an ounce of English earth, such as earthen-ware is made of; add to it six grains of earth of Dombes, calcined, three grains of Naples yellow, and one drachm of Prussian blue; mix the whole together, as above, beginning with the blue, then the yellow, &c. Or, take half an ounce of Kaolin of Limoges, thirty-six grains of saffron of Mars, thirty-six grains of Naples yelow, one drachm of Prussian blue; mix the whole together, as before. Or, take half an ounce of the

the duſt of French porcelain, ſix grains of ſaffron of Mars, ſix grains of earth of Dombes, calcined, ſix grains of Naples yellow, one drachm of blue, made of Cobalt; mix and pound the whole, as before. Theſe paſtes (the firſt excepted) have their colour in their formation: but, in order to give a colour to the paſte firſt deſcribed, take four pounds and a quarter of it, to which add one quarter of a pound of ſaffron of Mars, and one grain of Pruſſian blue, finely pounded; mix them well together. Or, take twenty-four ounces of the ſame paſte, one ounce of ſaffron of Mars, one grain of Pruſſian blue; pound and mix them as before. Or, to thirty ounces of the ſame paſte, add one ounce of ſaffron of Mars, one grain of Pruſſian blue; pound and mix them as before. Any of theſe compoſitions, for different colours, according to the particular ſhade required, are to be mixed and worked up with this paſte at the time of its being made.

To make the teeth ſo as accurately to ſupply and fit the interval in the gums, take a quantity of ſoftened wax and place it in the mouth, which, being

being then ſhut, will give the exact impreſſion of the cavity required to be filled up: in this wax is poured a compoſition formed of plaſter of Paris, ſuch as is mixed for cornice-moulds, which when dry gives a true and ſolid model of the mouth. Either of the above paſtes, which you chuſe to uſe, is then well kneaded, ſo as to make it flexible and compact, and is preſſed into the plaſter-mould. The paſte, having now acquired its proper ſhape, is taken out of the mould, and laid on any flat and hard ſurface, and is dried either in the Sun or before the fire. When it is ſo far dried as not eaſily to be put out of ſhape, carve out the teeth, with a pen-knife, or other ſharp inſtrument, to the form you wiſh; after which, you place it in the oven, on plates made of earth, ſuch as are made uſe of for the French porcelain. As the paſte, in drying, loſes ſomewhat of its thickneſs, ſpread or widen the wax-mould, when taken out of the mouth, to an increaſe in extent of about one-ſeventh; which is done by preſſing on the middle of it with the thumb and middle finger, and determine the ſpace

ſpace by compaſſes. Obſerve to bore ſuch holes as may be neceſſary for the faſtenings, before the teeth are perfectly dry.

To make an enamel, take ten pounds of the beſt lead, and ſix pounds of pewter; calcine them together, reduce the whole into powder, and paſs it through a hair-ſieve: then take ten pounds of ſand, ſuch as that of Fontainebleau, and four pounds of barilla of Alicant: mix them well together; ſift them through a hair-ſieve; put them into a crucible of a proper ſize, and place it under the oven or furnace, to be baked. Take ten pounds of this mixture, clean it well and pound it very fine, add to it one pound of ſpermaceti, and one pound of the beſt lead, then four pounds of borax; mix the whole together, and put them into a good crucible under the oven. Afterwards you clean and pound it well, and add to it as many ounces of red-lead as there are pounds of enamel; moiſten it with water, and paſs it through the mill. This enamel, mixed with clean water, is now to be applied to the teeth with a hair-pencil; after which, the teeth are again put

under

under the oven or furnace, till the enamel is hardened; obſerving that the degree of heat muſt be milder than is neceſſary to purify the paſte as firſt mentioned. Obſerve alſo, that the enamel muſt be laid on the paſte formed of Kaolin of Limoges, in the ſame manner as is uſual in common hard porcelain. That part of the teeth which is intended to repreſent the gums is coloured with a quantity of carmine, according to the ſhade required, mixed with ſpirit of turpentine, and laid on with a hair-pencil; after which, they are again placed in the oven, but in a ſtill milder degree of heat; and, when the colour is dry, the teeth are fully complete.

To make the ſprings and faſtenings for whole ſets, take any quantity you like of gold, at the ſtandard of twenty carats; convert it into wire of the thickneſs of a ſmall pin; but, before it is ſo reduced, that is, about three holes before the laſt of the machine through which it is paſſed, make it red in the fire, which will make it fit for the intended ſprings. After paſſing it through a mixture of three-fourths of common water and one of aqua-fortis,

fortis, you twiſt it hard round a mandrel, of the thickneſs of which you wiſh to make the ſpring, that is, in proportion to the hinges in which it is to be put. The hinges muſt alſo be made of gold, of the ſame ſtandard: they are ſoldered on a plate of gold, which is placed on the ſide of the ſet of teeth. The flat part of the hinge muſt be bored with a hole, large enough for a ſtrong pin; through which hole you paſs the pin which is to join the ſpring to the hinge; taking care to ſolder a plate of gold to the bottom of the hinge, which ſhould be about one-eighth of an inch in length, and one-tenth in thickneſs within. Single, double, treble, &c. teeth are faſtened in the uſual known manner. In witneſs whereof, &c.

XLVII. *Specification of the Patent granted to* WILLIAM ROE, *of Liverpool, in the County of Lancaster, Copper-Refiner; for his Invention of a new Process for calcining, or extracting the Sulphur from, poor Copper and Lead Ores, and rendering such poor Ores as were before unsaleable as valuable and saleable as any Ores.*

Dated March 27, 1779.—Term expired.

TO all to whom these presents shall come, &c. NOW KNOW YE, that I the said William Roe, in pursuance of, and compliance with, the said proviso, and the purport and true meaning of the said letters patent, and of his Majesty's most gracious intentions, do, by this instrument in writing, under my hand and seal duly executed, declare that my said new process or invention, for calcining or burning of poor copper and lead ores, is performed by means of kilns or buildings made of stone or brick, either in a circular, quadrangular, or oblong form, and proportionable in magnitude to the quantity of ore that is required to be calcined or burnt, ſay from 5 tons to 2000 tons in one kiln. At the ſides, ends, or round the ſaid kilns or buildings, under the ore, at convenient diſtances, are to be fixed fire-places; at the roofs of which are placed bars of iron, at ſuch diſtances from each other as to admit a free communication of the flame, or heat, to the ore, and, at the ſame time, to prevent the ore from falling into the fire-places. From one ſide, or one end of the kiln, to the other, muſt be left pipes or draught-holes, to admit a current of air through, ſufficient to keep a ſteady and regular heat, and to promote the burning of the ore, and the evaporation of the fumes that aſcend therefrom. The ore, before being put into the kilns or buildings, is to have all the ſmall ſeparated from the round, and the round or large ore put into the kilns or buildings firſt; which may be calcined or burnt by itſelf, or covered with the ſmall ore; leaving open, at proper places, upon the top or ſides of the kiln, ſufficient ſpaces to admit the ſmoke or ſulphur through, which may either evaporate into the air, or be conveyed into perpendicular or horizontal recipients. The top or ſurface of the

 ore

ore may alſo be covered with ſtone, brick, ſlate, ſods of earth, or ſoil, leaving apertures, as before mentionod, to admit the ſmoke through. And as there are, in different parts of the kingdom of Great Britain called England, and the dominion of Wales, particularly upon the Iſle of Angleſey, large quantities of pyrites, marcaſites, ſulphureous ores, earths, and minerals, which abound with ſilver, copper, and lead; but which, by reaſon of the earth, ſulphur, ſtone, and other heterogeneous particles being combined with them, have never yet been rendered uſeful or merchantable; this, my new invention of calcination, will diſunite the component particles thereof, and, by the method I make uſe of for waſhing or puddling of copper and lead ores, the copper and lead ores will be ſeparated from all the dead or uſeleſs matter, and make ſuch pyrites, or marcaſites, merchantable, and of great value. And laſtly, the pyrites and marcaſites, which abound with ſulphur, arſenic, copper and lead ores, may be rendered uſeful and valuable by means of eliquation. In witneſs whereof, &c.

XLVIII. *On the Cause of the additional Weight which Metals acquire by being calcined.* By George Fordyce, *M. D. F. R. S.*

WITH A PLATE.

From the Transactions of the Royal Society of London.

ALTHOUGH many chemiſts are at preſent ſatisfied of the non-entity of what was formerly ſuppoſed to be a body, called phlogiſton, and conſidered as an element contained in metals, when in their metallic form, yet this ſuppoſition has interwoven itſelf ſo much into chemiſtry in general, and has been ſo univerſally received, that it may not be ſuperfluous to relate the following experiments.

It has been a great deſideratum among chemiſts, to determine the cauſe of the additional weight which metals acquire when they are calcined;

cined; and there is great difficulty in chuſing the metal on which enquiry ſhould be inſtituted, on account of the differences of their calces. After a number of trials, I choſe zinc, as that whoſe calces appeared to differ the leaſt from one another; in other reſpects there are great objections to it likewiſe, but which may be got over.

I took a portion of the zinc I employed, and diſſolved it in vitriolic acid, with which it made a clear ſolution, without any of that black matter which commonly ſeparates during its ſolution, when we employ zinc imported from abroad. After precipitating it by an alkali, and expoſing the calx to the air, it remained of a pure white; ſo that it could contain no iron. This zinc was reduced to its perfect metallic form, by breaking it into ſmall particles, and melting it with black flux, taking that part of it only which was at the bottom of the crucible.

I reduced this metal to a calx, by diſſolving it in vitriolic acid diluted with water, and precipitated it by *kali purum* diſſolved in water.

In doing this, the acid ſhould be diluted with four or five times its weight of water, and the

zinc

zinc ſhould be diſſolved very ſlowly, avoiding heat as much as poſſible during the ſolution. If this precaution is not taken, a quantity of volatile vitriolic acid will be produced, and ſpoil the experiment.

In the precipitation, the alkali is apt to re-diſſolve the calx, if care be not taken to uſe it in ſolution in water, and that the ſolution be diluted with a large quantity of water: the proportion in which the water is in *aqua kali puri*, of the London Diſpenſatory, is a convenient ſolution of the alkali.

Care muſt likewiſe be taken, in the precipitation, that the ſolution of the kali be poured into the ſolution of the *zincum vitriolatum* in water, by a little at a time; and that the whole be perfectly mixed together before a freſh quantity is poured in, otherwiſe part of the calx will be re-diſſolved. It is farther neceſſary, that the exact quantity of *kali purum* be uſed: if too little is uſed, the whole calx will not be ſeparated; if too much, part of the calx will be re-diſſolved. It is alſo neceſſary, that the alkali be perfectly pure, eſpe-

cially

cially free from fixed air *, as that would be transferred to the calx; and, as it flies off when the kali is ſimply united with vitriolic acid, the accuracy of the experiment would be thus deſtroyed.

The weight of the calx, by which it exceeds the weight of the metal, ſhews that there is a ſubſtance added to the whole metal; or that, while ſome ſubſtance is driven off, another is added in greater quantity; ſince it is clear, from various well-known experiments, that all matter gravitates, and that all the ſubſtances found in this earth, which have been tried, gravitate equally. This additional matter muſt be added to the metal, either from the acid, the alkali, the water uſed in the ſolution, the air lying on the ſurface of the materials during the operation, or it muſt come through the veſſels in which the operation is performed: to aſcertain this, I made the following experiment.

* I uſe the name of fixed air, although certainly not proper, in order to avoid running into confuſion by employing thoſe names which have been given to this ſubſtance, until the plurality of voices ſhall fix an appropriate name to it.

I took

I took a large quantity of vitriolic acid, purified by diſtillation; (about two pounds, it not being material what quantity was taken exactly.) I diluted it with diſtilled water, about four or five times its weight, by gueſs; (the exact proportion being alſo immaterial.) I applied to 1000 grains of this diluted acid, a ſufficient quantity for ſaturation of *aqua kali puri*, of the London Diſpenſatory, rendered pure from fixed air, as is preſcribed in the proceſs of the college. I poured in the *aqua kali puri* to the diluted acid, by a little at a time, until it was nearly ſaturated; and then poured in ſome juice of violets, which gave the whole a red colour. I continued to add *aqua kali puri*, by a little at a time, until the red colour juſt diſappeared. I added the *aqua kali puri* to the acid, rather than the acid to the alkali, becauſe the loſs of the red colour, at the point of ſaturation, can be diſcerned much better than the loſs of the yellow colour, which the alkali intermixes with the natural blue.

I aſcertained the weight of the *aqua kali puri*, by weighing the bottle containing it, before any was poured into the acid, and after the ſaturation took place; the deficiency of weight afterwards being the weight of the *aqua kali puri* applied to the acid for the ſaturation: this was 10147 grains. I alſo weighed the veſſel with the acid, before the *aqua kali puri* was poured in, and afterwards; and found the increaſe of weight to be exactly the ſame as the weight of the *aqua kali puri* and juice of violets, ſo that nothing was loſt during the operation.

This experiment was three times repeated, taking the point of ſaturation from the eye. The quantities of *aqua kali puri* employed were found to be 10147 grains, 10145 grains, 10150 grains.

I took 10148 grains, being the mean of the three experiments, and applied it to 1000 grains of the ſame vitriolic acid; evaporated the water to dryneſs, and heated it to a red-heat, to drive off the whole of the water; and found 978 grains of *kali vitriolatum* remaining. By this means, I aſcertained the quantity of *kali vitriolatum* produced from 1000 grains of the diluted vitriolic acid, when ſaturated with kali.

I took

I took 1000 grains of the diluted vitriolic acid, and put it into a veſſel, of the form in the figure annexed. (See Plate XXII.) I added zinc to it, until it would diſſolve no more; I caught, during the ſolution, the inflammable air, which weighed 9 grains, and whoſe ſpecific quantity was, to atmoſpheric air, as ſomewhat leſs than 1 to 12. The veſſel contained the whole of the acid, and the zinc, in the globular part marked A; the acid being introduced by a funnel.

The ſolution was terminated in five days, when, part of the tube D being broken off, it was left to ſtand for four-and-twenty hours, to allow the inflammable air remaining in the veſſel to fly off, and give place to the air of the atmoſphere; which happened ſpontaneouſly, from the different ſpecific gravities of the two vapours.

The veſſel containing the ſolution of the zinc was now laid upon its ſide, and 10148 grains of *aqua kali puri* were introduced, by a crooked funnel, into the globe B; being the quantity ſufficient to ſaturate 1000 grains of vitriolic acid, as before determined: then the tube D was hermetically ſealed, and the whole weighed. The veſſel was then raiſed, ſo that the globe A was undermoſt: this was done very gradually, ſo that the *aqua kali puri* was gradually added to the ſolution of the zinc. When a little was poured in, the veſſel was brought into a horizontal poſition again, and ſhaken a little: this was repeated until the whole of the *aqua kali puri* was poured in. The zinc was thus precipitated in the form of a calx: it was ſuffered to ſtand for forty-eight hours. No alteration of the gravity took place; therefore nothing had entered through the glaſs, to give additional weight to the zinc in order to calcine it.

The next ſtep was to open the tube, which was done under water, and in an atmoſphere of the ſame heat in which it was ſealed, to wit, 57° of Fahrenheit's thermometer. The air was neither diminiſhed nor increaſed, none of the water being driven into the apparatus by the weight of the atmoſphere, and none being thrown out. On heating the globe B, ſo as to drive out ſome of the air, it was found to be of the ſame purity, nearly, as that of the atmoſphere; being tried by the application of nitrous air, produced from ſolution of mercury.

The

The weight, therefore, which the calx had gained, aroſe neither from any ſubſtance paſſing through the glaſs, nor from the ſuper-incumbent air during the precipitation. It muſt, therefore, be either from the acid, the alkali, or the water.

To determine whether the acid or the alkali gave the weight to the calx of the zinc, I waſhed out the *kali vitriolatum*, formed by the combination of the vitriolic acid and the kali, with pure water, repeatedly applied, until it came away as pure as when applied, to all ſenſible trials: the quantity of water uſed was above four pounds. I evaporated this water to dryneſs, and heated the maſs red hot, to expel the whole of the water: it weighed ſeven grains more than the *kali vitriolatum* procured by applying the acid and alkali as above. After evaporating the water, I diſſolved the maſs again in 40 ounces, Troy weight, of pure water: a yellowiſh powder ſeparated. The ſolution of the *kali vitriolatum*, cleared of this powder, was again evaporated to dryneſs, and the water of cryſtalization driven off. It now weighed $976\frac{1}{16}$ grains; which is, nearly two grains leſs than the *kali vitriolatum* I obtained from the acid

acid and alkali applied ſimply together, without the intervention of the zinc.

The *kali vitriolatum*, now obtained, was free from any mixture. The additional weight of the calx of the zinc did not ariſe, therefore, from either the acid or the alkali; it remains, therefore, that it aroſe from the water.

The weight of the calx of the zinc was aſcertained by drying it, after waſhing out the *kali vitriolatum*, heating it to a red-heat, and afterwards weighing it. The weight of the zinc diſſolved, in ſaturating the acid, was 164 grains; the weight of the calx, 220 grains. The additional weight was, therefore, 56 grains.

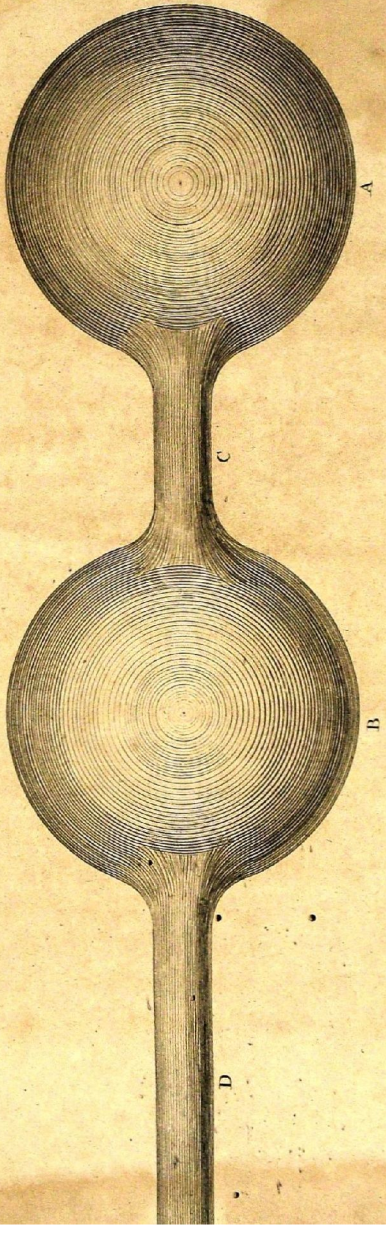
If it aroſe from the water, then a quantity of water, equal to the weight by which the calx exceeds the metal, muſt be loſt in the operation. To determine this, I performed a diſtillation in the following manner.

I put 1000 grains of the ſame diluted vitriolic acid into the globe A, of the ſame apparatus, then introduced the quantity of *aqua kali puri* found neceſſary to ſaturate it. The tube D was then bent downwards about the middle, and the apparatus

ratus brought to a horizontal poſition; ſo that the bent part of the tube was in a perpendicular direction downwards: to this I affixed a ſmall phial, and weighed the whole.

I then put the globe B in a box filled with ice, and applied heat to the globe A, ſo as to diſtil over the water into the globe B; the liquor never being brought to the boiling-point. When the matter in the globe A became dry, the heat was increaſed to a red one, to diſtil over likewiſe the water of cryſtalization. The whole apparatus was now weighed, and found not to have loſt a grain; nor was there any water in the phial. I then cracked the tube C, by applying a red-hot iron to it, and letting a drop of cold water fall upon it. I next weighed the globe B with the water in it, then poured out the water, and let the glaſs dry. I weighed the glaſs: the deficient weight from the former weighing, being the weight of the water, was 10098 grains.

I repeated the experiment, with this difference; I put 1000 grains of the ſame vitriolic acid into the globe A, then introduced the quantity of zinc ſufficient to ſaturate it. I took the weight of the inflammable air, as before, and found it nearly the ſame in weight and quality. The ſame quantity of *aqua kali puri* was then introduced through a funnel, as in the former experiment; then the tube was bent downwards, and a phial applied to it, as before. The whole apparatus was weighed after the diſtillation, and found not to have loſt any ſenſible quantity of weight; nor was there any water in the phial. The phial being detached, the tube broken as before, and the globe weighed again when dry, the deficiency was leſs than in the former experiment, by 63 grains; which is, two grains leſs than the additional weight of the calx, above that of the metal, and that of the inflammable air, taken together: therefore, the matter occaſioning the additional weight of the calx, above that of the metal, and the inflammable air, are both produced from the water.


A
C
B
D

XLIX. *Account of the Method of preparing Opium from Poppies grown in England.* By Mr. John Ball, *of Williton, Somersetshire.*

From the Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Fifty Guineas were given to Mr. Ball for the Difcovery of his Method of preparing Opium.

NOTHING can be more fimple, or attended with lefs expence, than the making or extracting the pure and genuine opium from the large poppies, commonly called, or known by the name of, garden-poppies; the feeds of which I would advife to be fown the latter end of February, and again about the fecond week in March, in beds three feet and a half wide, (well prepared with good rotten dung, and often turned or ploughed, in order to mix it well and have it fine,) either in ſmall drills, three in each bed, in the manner ſallads are ſown, and, when about two inches high, to thin them one foot apart: or otherwiſe, to ſow them in beds, in the broad-caſt way, and thin them to the ſame diſtance. If the weather ſhould prove wet at that time, thoſe that are taken up may be tranſplanted: but I do not ſuppoſe the tranſplanted ones will anſwer, having but one ſpill-root, and will require frequent watering. Keep them free from weeds, they will grow well, and will produce from four to ten heads, ſhewing large and different-coloured flowers; and when their leaves die away and drop off, the pods then being in a green ſtate, is the proper time for extracting the opium, by making four or five longitudinal inciſions, (with a ſharp-pointed knife,) about one inch long, on one ſide only of the head or pod, juſt through the ſcarf-ſkin, taking care not to cut to the ſeeds. Immediately on the inciſion being made, a milky fluid will iſſue out, which is the opium, and which, being of a glutinous nature, will adhere to the bottom of the inciſion; but ſome poppies are ſo productive that it will drop from the pod on the

leaves

leaves underneath. The next day, if the weather ſhould be fine, and a good deal of ſun-ſhine, the opium will be found a greyiſh ſubſtance, and ſome almoſt turning black: it is then to be ſcraped from the pods, and (if any there) from the leaves, with the edge of the knife, or other inſtrument for that purpoſe, into pans or pots; and, in a day or two, it will be of a proper conſiſtence to make into a maſs, and to be potted.

As ſoon as you have taken away all the opium from one ſide of the pod, make inciſions on the oppoſite ſide, and proceed in the ſame manner. The reaſon of not making the inciſions all round at the firſt is, that you cannot ſo conveniently take away the opium; but every perſon, upon trial, will beſt judge of that. Children may with eaſe be ſoon taught to make the inciſions, and take off the opium, ſo that the expence will be found exceedingly trifling.

The ſmall white ſeeds, in that ſtate, will be found very ſweet and pleaſant, and may be eaten without the leaſt danger: it is the cuſtom in the Eaſt to carry a plate of them to the table, after dinner, with other fruits.

I intend this year to keep apart a ſmall quantity of opium from each coloured poppy, to find out if any one more than another produces the greateſt quantity, or of the greateſt ſtrength; and ſhall ſave ſeeds of each, to ſow ſeparately the next ſpring.

I am of opinion, that numbers of incloſures taken from hills in a ſouth aſpect, may with a very little expence be brought into a proper ſtate for the growth of poppies.

I ſhould alſo think, that an inſtrument may be made, of a concave form, with four or five pointed lances, the twelfth or fourteenth part of an inch in length, to make the inciſions at once; and likewiſe ſomething of the rake-kind, ſo that the three drills, which I have directed to be made in each bed, may be performed at the ſame time.

By a calculation which I have made, ſuppoſing one poppy to grow in one ſquare foot of earth, and to produce only one grain of opium, more than fifty pounds will be collected from one ſtatute-acre of land; but, if we conſider that one poppy produces from three or four to ten heads, that in each head from ſix to ten inciſions may be made,

made, and that from many of them (I mean from one incifion) I laft year took away two or three grains of opium, what muft then be the produce? Opium is now twenty-two fhillings the pound.

Some farther obfervations are given by Mr. Ball in two fubfequent letters, from which the following are extracts.

Extract from the firft Letter.

I was fearful that the tranfplanted poppies would not anfwer, and am now convinced of it: having a large quantity which had fown themfelves, when of a proper fize, I tranfplanted about four thoufand in beds, but not one fingle plant came to perfection; therefore I fhall never tranfplant any more; and, not having faved any feed the laft year, owing to my not being at home at the proper time, I could not fow any. The bed where the poppies had fown themfelves was five hundred and feventy-fix feet fquare, from which I collected

collected about four ounces of opium, notwithſtanding the plants were very thick; and (which ſhews the advantage of giving them ſufficient room) ſome few plants, which were detached, produced from fifteen to thirty-four grains each: theſe plants had ſown themſelves on ground that had been well manured with rotten dung, which points out the utility of good cultivation. The ſemi-double, and thoſe of a dark colour, produced the moſt opium: the pods ſhould be about the ſize of a walnut before you make the inciſions.

Extract from the ſecond Letter.

I find you have extracted ſome opium from ſingle poppies. In a former letter I ſaid I had collected my opium from double or ſemi-double poppies, which accidentally grew in my garden; and I find that the produce was more than double what you collected from the ſingle. As a proof, I will ſend you ſome opium, which I have collected myſelf this year from one poppy; I ſhould ſuppoſe it more than thirty grains: twenty-

eight

eight heads grew on that poppy, which was of the ſemi-double kind. I ſhall likewiſe ſend you ſome of the heads from which I extracted the opium, being far preferable to thoſe of the ſingle, as appears from the produce of each.

Annexed to the foregoing account are letters from Dr. Latham, of Bedford-row; Dr. Pearſon, of Leiceſter-ſquare; and Mr. Wilſon, of Bedford-ſtreet; ſtating their opinion reſpecting the medical efficacy of Mr. Ball's Engliſh opium. From which it appears, that they think it equal in effect, and ſuperior in purity, to the beſt foreign opium.

L. *Inſtructions for raiſing Potatoes. By Mr.* JOSIAH HAZARD, *of Stony Littleton, Somerſetſhire.*

From the Letters and Papers of the Bath and Weſt-of-England Society for the Encouragement of Agriculture, &c.

A PREMIUM having been offered, by the Bath Agriculture Society, for the cultivation of potatoes by farmers, &c. whoſe rent does not exceed forty pounds *per annum*, and the increaſe of that valuable root being of great conſequence to the poor, I flatter myſelf it will not be thought impertinent in me to give ſome inſtructions for raiſing them to advantage.

As I ſhall point out various methods, it may be right to inform thoſe who have only a ſmall ſpot of ground, how they may obtain a plentiful crop.

First,

First then, the earth ſhould be dug twelve inches deep, if the ſoil will allow of it; after this, a hole ſhould be opened about ſix inches deep, and horſe-dung, or long litter, ſhould be put therein, about three inches thick: this hole ſhould not be more than twelve inches in diameter. Upon this dung or litter, a potatoe ſhould be planted whole, upon which a little more dung ſhould be ſhaken, and then earth muſt be put thereon. In like manner the whole plot of ground muſt be planted, taking care that the potatoes be at leaſt ſixteen inches apart. When the young ſhoots make their appearance, they ſhould have freſh mould drawn round them with a hoe; and if the tender ſhoots are covered, it will prevent the froſt from injuring them: they ſhould again be earthed when the ſhoots make a ſecond appearance, but not covered, as, in all probability, the ſeaſon will then be leſs ſevere.

A plentiful ſupply of mould ſhould be given them, and the perſon who performs this buſineſs ſhould never tread upon the plant, or the hillock that is raiſed round it; as, the lighter the earth is, the more room the potatoe will have to expand.

 I obtained

I obtained the laſt year, from a ſingle root thus planted, very near forty pounds weight of large potatoes; and, from almoſt every other root upon the ſame plot of ground, from fifteen to twenty pounds weight; and I will venture to aſſert, that except the ſoil be ſtony, or gravelly, ten pounds, or half a peck, of potatoes may almoſt always be obtained from each root, by purſuing the forego-ing method. But note, cuttings or ſmall ſets will not do for this purpoſe.

The ſecond method will ſuit the indolent, or thoſe who have not time to dig their ground; and that is, where weeds much abound, and have not been cleared in the winter, a trench may be opened in a ſtraight line, the whole length of the ground, and about ſix inches deep. In this trench the potatoes ſhould be planted, about ten inches apart: cuttings, or ſmall potatoes, will do for this method. When they are laid in the trench, the weeds that are on the ſurface may be pared off on each ſide, about ten inches from it, and be turned upon the plants: another trench ſhould then be dug, and the mould that comes out of it turned carefully on the weeds. It muſt not be forgot,

forgot, that each trench should be regularly dug, and that the potatoes should be, throughout the plot, ten or twelve inches from each other.

This slovenly method will, in general, raise more potatoes than can be produced by digging the ground twice, and dibbling in the plants; and the reason is, that the weeds lighten the soil, and give the roots room to expand: they should be twice hoed, and earthed up in rows. And here note, that if cut potatoes are to be planted, every cutting should have two eyes; for, though fewer sets will be obtained, there will be a greater certainty of a crop, as one eye often fails, or is destroyed by grubs in the earth.

Where a crop of potatoes fails in part, (as will sometimes be the case in a dry season,) amends may still be made, by laying a little dung upon the knots of the straw or haum of those potatoes that do appear, and covering them with mould; each knot or joint, thus ordered, will, if the weather prove wet afterwards, produce more potatoes than the original roots.

I have raised potatoes from the apples that grow on the haum: they were very small the first year, though I found them much increase in size, when they were planted again the second year; but I do not think they will ever answer any good purpose.

I obtained the last year, from the smallest potatoes, planted whole, from four to six pounds at a root, and some of the single potatoes weighed near two pounds. These were dug in, as before mentioned, in trenches, where the ground was covered with weeds, and the soil was a stiff loamy clay. I know these small potatoes are held in contempt for planting, by those whose prejudice will not suffer them to try experiments; but I can assure them, that they will, upon trial, fully answer their expectations. I advise by no means to dibble in potatoes, as the person who uses the dibble treads the ground, and prevents the young fibres from properly expanding.

A good crop may be obtained by laying potatoes upon turf, about twelve or fourteen inches apart, and upon beds of about six feet wide; on each side of which a trench should be opened, about three feet wide, and the turf that comes from it should be laid, with the grassy side downwards,

upon

upon the potatoes: a spit of mould should next be taken from the trenches, and be spread over the turf, and in like manner the whole plot of ground that is designed to be planted must be treated. And remark, that when the young shoots appear, another spit of mould, from the trenches, should be strewed over the beds, so as to cover the shoots. This will prevent the frost from injuring them, encourage them to expand, and totally destroy the young weeds; and, when the potatoes are taken up in the autumn, a careful person may turn the earth again into the trenches, so as to make the surface level: it will be right to remark, that from the same ground, a better crop of potatoes may be obtained the following year.

For field-planting, a good (if not the best) method is, to dung the land, which should be once ploughed previous thereto; and, when it is ploughed a second time, a careful person should drop the potatoe-plants before the plough, in every third furrow, about eight or ten inches apart: plants that are cut with two eyes are best for this purpose. My reason for planting them at so great

a distance

a distance as every third furrow is, that when the shoots appear, a horse-hoe may go upon the two vacant furrows to keep them clean: after they are thus hoed, they should be moulded up in ridges; and, if this crop be taken up about October or November, the land will be in excellent condition to receive a crop of wheat. Lands that are full of quitch or couch-grass may be made clean by this method, as the horse-hoeing is as good as a summer fallow; and if, when the potatoes are taken up, women and children were to pick out such filth, not any traces of it would remain; and by laying it in heaps, and burning it, a quantity of ashes would be produced for manure.

After ploughing, nobody should ever dibble in potatoes, as the persons who dibble, plant, or hoe them, will all tread the ground, by which means it will become so bound, that the young fibres cannot expand; nor did I ever hear that, from the dibbling method, more than fifty or sixty sacks were produced from one acre; whereas, by ploughing them in, as before directed, I have obtained more than one hundred sacks *per* acre.

Indeed,

Indeed, I have known good crops obtained by ploughing the land twice, and dropping the plants in every other furrow, and by hand-hoeing and earthing them up afterwards, as the gardeners do peas; but this method is not equal to the other. Vacant places in hedge-rows might be grubbed, and planted with potatoes, and a good crop might be expected; as the leaves of trees, thorns, &c. are a good manure, and will surprisingly encourage their growth, and gratify the wishes of the planter, who, by cultivating such places, will make the most of his ground, and it will be in fine order to receive a crop of corn the following year.

I shall now conclude by remarking, that gravelly, stony, chalky, or stiff clay lands, will never produce many potatoes, and the few they do produce will be cankered, and only fit for pigs; it is therefore obvious, that such soils are improper.

LI. *Conclusion of M. de* MORVEAU's *Experiments on the Means of improving the Colours used in Painting.*

(From Page 358.)

THE vitriols of lead * and bismuth are still more subject to change than the calces of these metals; therefore, excepting calcareous tartar, which may be of some use in water-colours, even

* According to Weber, in his work intituled *Fabriken und kunste*, printed at Tubingen in the year 1781, Krems-white is nothing more than a vitriol of lead, made by dissolving lead in nitrous acid, and precipitating it by vitriolic acid; which precipitate is afterwards formed into solid heavy cakes, by the addition of a little gum-water. It is very certain that this by no means resembles what is sold in France by the name of Krems-white; at least I have met with none which was not soluble in vinegar. I thought it right, however, to try the vitriol of lead, prepared on purpose, according to Mr. Weber's process, and found that it was, like the other, completely blackened by the phlogistic vapour.

those

those earthy salts which appear the most promising cannot, of themselves, form any colour that will be of use in painting; all they can do is, like the earths, to furnish a basis to some other colour.

IV. Of the fifteen known metallic substances, nine are capable of giving white calces; namely, silver, mercury, lead, tin, antimony, bismuth, zinc, arsenic, and manganese. It is hardly necessary to say, that I speak only of metallic earths, and not of saline metallic precipitates, the acid of which is not even neutralized; nevertheless I shall take notice of the precipitates by the Prussian alkali, most of which resemble the pure calces by their insolubility.

From these nine substances we may, without hesitation, exclude silver and mercury: it is true, that beautiful white precipitates may be obtained from a solution of either of these metals in nitrous acid, by means of crystalized vegetable alkali, provided the solution of mercury be made without heat. But the whiteness of these precipitates soon changes in the air; which will not be wondered at, when the ease with which these metals are

 restored

reſtored (which conſtitutes them perfect metals) is conſidered.

The Pruſſian precipitate of ſilver, which is at firſt of a beautiful white colour, becomes black as it dries on the filter.

The Pruſſian precipitate of mercury is of a lemon colour; but if, after being ground in oil and ſpread upon canvas, it is expoſed for ten minutes to the phlogiſtic vapour, it becomes black, in ſuch a manner as to dirty the fingers, if the ſurface be touched by them.

It is well known that lead furniſhes a very good white colour, which may be ground, and uſed as paint, either with oil or with ſize; but it is extremely ſubject to change, as I have already proved, by an experiment which places the matter beyond the power of contradiction. I ſhall only add, that if there were any mode of preparation that could correct this defect, it certainly would be, precipitating the earth of this metal from its ſolution in vinegar, by means of Pruſſian alkali: but the white precipitate which is obtained by this proceſs becomes evidently browniſh, by being expoſed, only for a few minutes,

minutes, to the phlogiſtic vapour. It is therefore uſeleſs to perſiſt in employing this ſubſtance, or to endeavour to fix it by mixtures, and compoſitions, ſince the changes which it undergoes are abſolutely eſſential to its nature, and ariſe from the immutable order of its affinities.

The calx of tin forms a white colour, very proper for the purpoſes here treated of, and which is not at all changed by the concentrated phlogiſtic vapour. Theſe conſiderations induced me to try various proceſſes, in order to obtain this calx in a ſtate of perfect whiteneſs: the following are the reſults of my experiments.

Malacca tin, calcined under a muffle, produced a tolerably white calx, but it acquired a grey caſt when mixed with any liquid, although I took great care to remove, from the ſurface of the calx, that part to which the violence of the fire always gives more or leſs of a red tinge. Tin, calcined by means of nitre in fuſion, left only a coarſe calx, having a dull yellowiſh tinge, which repeated waſhings did not intirely take away.

Having precipitated, by means of cryſtalized vegetable alkali, a ſolution of Engliſh tin, made with muriatic acid, according to the manner of M. Bayen, in order to ſeparate the arſenic from it, I obtained a calx which was perfectly white, and ſo light and fine that it roſe to the ſurface of the liquor; the greateſt part of it even paſſed through the filter. This proves that the ſalts are got intirely detached from it, which is the reaſon that the part retained by the filter, inſtead of being powdery, is of a glutinous nature, ſemi-tranſparent, and has rather a yellow caſt. In this ſtate, it loſes its colour when mixed with any liquid; it would therefore be neceſſary to edulcorate it with boiling water, and then ſlightly to calcine the ſediment which would afterwards be formed.

I alſo tried calcination in the humid way; making uſe of the pureſt Malacca tin, and a rectified nitrous acid, according to the method of M. Meyer. A calx of a brilliant whiteneſs was produced, which remained upon the filter in the form of a jelly. I obſerved, however, that it had always a yellowiſh caſt, on account of the mixture of a ſmall portion of an earth, which, during

ring the operation, acquired the colour of turbith mineral.

The Pruſſian precipitate, from a ſolution of tin made with marine acid, in the manner before ſpoken of, was at firſt very white; but, to my great ſurpriſe, I found that it acquired a blue tinge as it grew dry on the filter.

A tolerably-beautiful white calx may be obtained from antimony, by calcining it by means of nitre in fuſion; but the earth of this ſemi-metal muſt be placed among thoſe which too eaſily combine with phlogiſton. Diaphoretic antimony, when ground with oil, acquired, in ten minutes, in my phlogiſtic apparatus, the colour of golden ſulphur of antimony. *Materia perlata*, another product of the ſame calcination of antimony, did not ſtand the proof any better: when ground with gum-water, it became of a grey aſh-colour; and, when ground with oil, the grey-colour became darker, and even almoſt black.

Every one knows that it is the property of biſmuth to give a very beautiful white calx, which is called magiſtery of biſmuth, and is uſed for painting the ſkin. It is very eaſily prepared, nothing

thing more being requisite than to dissolve the bismuth in nitrous acid, and to precipitate it by means of pure water. This calx mixes very easily, both with oil and mucilage; but must be rejected from the number of white pigments, being one of those most easily changed by phlogistic vapour: it was completely blackened in ten minutes in my apparatus. This indeed might have been easily foreseen, by considering what happens to those women who make use of it, when they expose themselves to the vapour of sulphur, or to that of garlic, putrid substances, &c.

Zinc, by every process of calcination and precipitation, furnishes a pretty white calx; particularly when it is pure, and perfectly freed from that portion of iron which generally renders turbid and yellow those solutions of vitriol of zinc which are left exposed to the air. I precipitated this semi-metal from its solutions with lime-water, and also with caustic alkalies, and with mild ones: I likewise calcined it by itself, and with nitre, and, by every one of these operations, I obtained an earthy matter of a white colour, more or less pure, which, after having been edulcorated and dried,

dried, might be mixed with oil or mucilage without losing its whiteness, and which did not suffer any sensible change upon being exposed to the phlogistic vapour.

This very valuable property, and which was the principal object of my enquiries, induced me to make a great number of experiments, in order to determine which was the most œconomical, the most advantageous, and the most certain way of preparing this semi-metal. These experiments convinced me that the simple calcination of it, in a crucible placed horizontally in the cavity made for retorts in a reverberatory furnace*, (as is done for making flowers of zinc,) produces the finest and the whitest calx; and that, in order to form an excellent colour for painting, nothing more is necessary than to pass it through water, in order to separate those parts which are not

* Some trials, on a large scale, having shewn me that the process here described is imperfect, troublesome, and even dangerous for the workmen, I have thought of an apparatus entirely different, constructed upon new principles, and which has been executed with the greatest success: I shall give a description of it hereafter.

sufficiently

ſufficiently calcined, and to add to it, when ground, a little earth of alum, or chalk, to give it body.

Specimens of this colour, ground both with oil and with mucilage, were expoſed to the phlogiſtic vapour; ſome of them were encloſed in my apparatus for the ſpace of eight days. The card on which they were applied was turned yellow, and, in ſome places, even blackiſh, yet the colours themſelves had not ſuffered any alteration; this I was convinced of, by comparing them with ſome of the ſame which had not been expoſed to the phlogiſtic vapour.

Zinc, precipitated by Pruſſian alkali, even from diſtilled vinegar, has always a yellow caſt; nor does it unite well with oil, but acquires a curdled conſiſtence, which appears ſemi-tranſparent.

White arſenic loſes its colour leſs, when mixed with fluids, than might have been expected from its ſaline nature. It preſerves its colour particularly well with gum-water; and it is remarkable that, inſtead of growing black by expoſition to phlogiſtic vapour, it acquires a very ſtriking tinge of of a lemon colour *. This alteration of colour would of course lead us to reject its use in painting, even if its deleterious qualities did not, of themselves, furnish a sufficient reason against it.

The semi-metal known by the name of manganese, and which we have lately discovered how to extract from a mineral which is well known, and has been long employed in the arts, gives also a white calx. I had supposed that I should obtain from it a very perfect white colour, because (owing to a property which is different from, and even contrary to, all other metallic earths) the earth of this semi-metal is white, even when it contains a sufficient quantity of phlogiston to be soluble in acids, and becomes black only by losing this principle; consequently I had reason to suppose, that the whiteness of this colour would be strengthened by the very substance which serves to destroy that of others.

There remained only one difficulty to conquer, namely, to separate from the manganese, that por-

* This property of arsenic is sufficiently singular and constant to furnish a new method of analysis, by which this substance may be readily known.

tion of iron which it commonly contains, and which would infallibly have given the calx a yellow tinge. I ſucceeded in doing this, even without bringing the calx into the ſtate of regulus, which would have been very expenſive, and hardly practicable in the great way. All I did was to make the black ore of manganeſe undergo a long calcination, to render the iron it contained inſoluble. I then treated it with vinegar, according to the manner of M. de la Peirouſe *, and, by precipitating it from the vinegar with mild alkali, I obtained a very beautiful white precipitate.

But I ſoon diſcovered that it is no leſs inconvenient that a colouring-body ſhould loſe its phlogiſton with great facility, than that it ſhould too readily attract that ſubſtance, and that both produce exactly the ſame changes. The white colour obtained from manganeſe very quickly grows yellow in the air; and, in my trials, this effect could not be attributed to any mixture of iron, becauſe neither galls nor Pruſſian alkali diſcovered any in the ſolution.

* See *Journal de Phyſique*. Tom. 16, page 157.

I could

I could not succeed in rendering this colour more fixed, by precipitating the solution with Prussian alkali. The precipitate, which at first was very white, acquired a purple or reddish cast, even in drying upon the filter: consequently, this substance can be of no use as a white pigment.

It appears, however, that I can offer to artists three new white colours *, particularly that which is obtained from zinc; thepreparation of it is subject to less variation than that of the others, its colour is more lively and more uniform, it is fit for every kind of purpose, and will probably be also the most œconomical.

I wish it were in my power to affirm, that it would be sufficiently cheap to take the place of white-lead, wherever that is now employed, even

* At a meeting of the Academy of Dijon, at which the Prince of Condé, Protector of the said Academy, presided, the three colours here mentioned, namely, that prepared from calcareous tartar, that from tin, and that from zinc, were, at the beginning of the meeting, placed in the phlogistic apparatus already described; the first being ground in gum-water, the two last both in that fluid and in oil. At the end of the meeting, which lasted near an hour, they were taken out and examined, when it appeared that they had not suffered the smallest alteration.

lume. Were it otherwiſe, a ſmall difference of price, in colours made uſe of for pictures, would not be worth regarding. Thoſe painters who truly eſteem their art would not ſcruple to prepare their colours from gold itſelf, provided ſuch colours were as fixed and immutable as that metal; immortality cannot be purchaſed at too high a price.

very evident, namely, that both theſe ſubſtances have the ſame baſis. It is, however, neceſſary to deprive the white-vitriol of a portion of iron it contains, which always tends to give the colour a yellow caſt: this is eaſily done, by digeſting a ſolution of it, even without heat, upon filings of zinc. After that, the ſalt may, without any farther preparation, be mixed with the colour upon the pallet; a very ſmall quantity of it produces a very powerful effect.

LII. *List of Patents for Inventions, &c.*

(Continued from Page 359.)

MICHAEL BOWMAN, of Titchfield-street, St. Mary le bone; for a truss for the prevention and cure of ruptures. Dated March 1, 1796.

Lord WILLIAM MURRAY; for the invention and discovery of extracting starch from horse-chesnuts. Dated March 8, 1796.

JOHN ATKINSON, of Harrington, near Liverpool; for the application of certain materials to make white paint. Dated March 8, 1796.

ROBERTSON BUCHANAN, of Rothsay, in the Isle of Bute, Scotland; for a pump for raising water in various situations. Dated March 8, 1796.

ROBERT SALMON, of Woburn; for an improvement in certain machines for weighing goods, &c. Dated March 8, 1796.

MAJOR PRATT, of Running Waters, Durham; for a certain composition to answer the purpose of mill-stones. Dated March 11, 1796.

WILLIAM WOODS, of Greenwich; for a hand-pump for raising water out of ships, and other places;

places; by which a greater quantity of water can be raised in less time than by any other pump now in use. Dated March 17, 1796.

RICHARD VARLEY, of Bolton le Moors, Lancashire; for an improved method of carding, roving, and spinning cotton, wool, &c. Dated March 17, 1796.

JOHN GREGORY HANCOCK, of Birmingham; for paper ornamented by embossing and enchasing. Dated April 6, 1796.

SAMUEL GODFREY, of Southwark; for a machine to relieve the labour of animals, in draft or burden. Dated April 6, 1796.

WILLIAM MOORCROFT, of St. Mary le bone; for an improved and expeditious method of making horse-shoes, &c. Dated April 16, 1796.

PATRICK MILLER, of Dalswinton, North Britain, Esquire; for the invention of a vessel on a new construction, which draws less water than any other vessel of the same dimensions, which cannot founder at sea, and which is put in motion, in calms and light winds, by a method never before practised. Dated May 3, 1796.

END OF VOL. VI.

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