BLEACHING. The art of bleaching conſiſts in removing the coloured matters intermixed with vegetable and animal ſubſtances in their natural ſtate, or ſuch as they have ſubſequently imbibed by accident, or ſome artificial proceſs. Edward Huſſey Delaval, eſq. F.R.S. has ſhewn, by a number of accurate experiments on the cauſe of the permanent colours of opake bodies, publiſhed in the ſecond volume of the ſecond edition of the Memoirs of the Literary and Philoſophical Society of Mancheſter, "that when the colouring matter of plants is extracted from them, the ſolid fibrous parts, thus diveſted of their covering, diſplay that whiteneſs which is their diſtinguiſhing character. White paper and linen are formed of ſuch fibrous vegetable matter, which is bleached by diſſolving and detaching the heterogeneous coloured particles." He further obſerves, "it appears that the earth, which forms the ſolid ſubſtance of plants, is white; that it is ſeparable from the colouring matter by ſeveral means; that whenever it is either pure and unmixed, or diffuſed through tranſparent colourleſs media, it exhibits its whiteneſs, and is the only vegetable matter which is endued with a reflective power; that the colours of vegetables are produced by the light reflected from this white matter, and tranſmitted from thence through the coloured coat or covering, which is formed on its ſurface by the colouring particles; that whenever the colouring matter is either diſcharged or divided by ſolution into particles, too minute to exhibit any colour, the ſolid earthy ſubſtance is expoſed to view, and diſplays that whiteneſs, which, as before noticed, is its diſtinguiſhing character."

He ſtates that in all thoſe animal matters which do exhibit colours, the colouring particles are endued with the ſame properties, and are regulated by the ſame laws, which prevail in vegetable ſubſtances.

A reference to the original paper can only do juſtice to the obſervations of this excellent philoſopher, confirmed by numberleſs experiments; but what is already ſaid will be ſufficient to give an idea of the nature of the proceſs of bleaching, and that it depends on the removal of the matter interpoſed betwixt the air and this white ſubſtance.

The national importance of bleaching is ſo great, that it comprehends nearly the whole of the cotton and linen manufacture, and goes to an extent beyond moſt other arts.

Its operation in theſe branches may be conſidered under two points; viz. 1ſt, the ſeparation of extraneous ſubſtances from linen and cotton, which is effected by ſteeping, fermentation, or weak alkaline leys; 2d, the ſeparation of the conſtituent or inherent colouring matters of thoſe ſubſtances, which is effected by different modes, and by various modifications of each method, as expoſure to the air, light, the uſe of alkaline leys, ſoap, oxygenated muriatic acid, combinations of oxygenated muriatic acid with other matters, ſulphuric acid, hepar ſulphuris, &c.

To impreſs upon the mind the nature of the bleaching buſineſs, it will be proper firſt to deſcribe the veſſels uſed in the ſundry operations of ſteeping, boiling, bucking, waſhing, ſouring, &c. then proceed to ſhew the management of each proceſs, with ſome obſervations on its effects; and, laſtly, how to make or procure the articles neceſſarily employed in this art, and the method of aſcertaining the qualities of each, adding ſome obſervations on the theory of the operations.

BLEACHING of goods, particularly cotton manufactures.

1ſt, *On Steeping.*

The veſſels generally uſed in bleaching are made of ſuch wood as will not communicate any colour to the liquors they are to contain, and therefore deal or fir wood is preferable to moſt others. The veſſels employed for ſteeping the goods when received from the loom are uſually of the form A, *fig.* 1. *Plate* I. *Bleaching.* The goods when received from the weaver contain not only the natural colouring matter of the cotton, which is of an oily nature, and which prevents the cloth from eaſily imbibing water, but alſo a ſubſtance called ſowins, being a paſte made of flour and water, uſed during the weaving, and applied with bruſhes upon the warp, in order to give a firmneſs to the threads by glueing

or paſting together the looſe fibres of the threads, and thus allowing them to paſs more freely through the reed and harneſs. To remove this ſubſtance, and to open the fibres of the cotton, ſo as to give full effect to the ſubſequent operations, it is proper to ſteep the goods in a veſſel of the above form in lukewarm water, till a gentle fermentation takes place, which will uſually be effected in 24 hours. The cloth ſhould then be taken out, and well waſhed in a current of clear water, which will thus ſeparate a conſiderable quantity of filth without the expence of uſing alkaline leys; and the cloth is then ready to be boiled or bucked as may be preferred by the bleacher.

2d, *On Boiling.*

For boiling, a copper veſſel is to be preferred, and the goods prepared, as above mentioned, by ſteeping and waſhing, are put into the veſſel containing hot water only, or warm alkaline ley; a winch is placed over the veſſel, and the piece goods attached to the ends of each other, are, when put in motion by the handle of the winch, dragged or rolled over it till the whole are paſſed; the winch is then turned with a retrograde motion, and the cloth gradually thus returned back, in order that every part of each piece may be thoroughly impregnated with the liquor, which is raiſed to and kept at a boiling heat, as long as it appears to extract any colouring matter from the cloth; the goods are then taken out and well waſhed in water.

Fig. 1. *Plate* IV. ſhews a ſection of the boiling pan A, of copper, ſet in brickwork B; the winch C, with its handle D; E, uprights of wood, on which the winch turns; F, a cock to empty the pan; G, the fire-place; H, the aſh-hole.

The uſe of this proceſs depends upon the properties which alkaline ſalts have of uniting with the oily and reſinous matters which are either attached to or are a conſtituent part of vegetable fibres, and which contain their colouring particles, forming with them a ſaponaceous matter, ſoluble in water, and by that means eaſily extricated from the cloth.

3d, *On Bucking.*

As this is one of the moſt general operations in bleaching, it will be neceſſary to deſcribe it more particularly. *Fig.* 1. *Plate* I. under the word *bucking*, ſhews at A the form of the bucking tub or kier, in which the goods are to be laid; B is an iron boiler, in which the alkaline ſalts, as pot-aſhes or pearl-aſhes, are to be diſſolved in boiling water; C is the fire-place, in which a fire is conſtantly kept up; D is the aſh-hole; E, a cock through which the boiling ley is let out upon the goods cloſely placed together in the bucking tub, A. A ſufficient quantity of boiling ley is let into the bucking tub, till all the goods in the tub are thoroughly impregnated with it; the ley liquor is then allowed to paſs by a cock at H into an iron veſſel placed in the ground at F, and from thence raiſed by the pump G into the iron boiler B, and thence returned hot again upon the cloth. This operation is continued for ſeveral hours, till the ley, by the ſeparation of the colouring matter in the cloth, acquires a colour almoſt black, a very offenſive ſmell, and nearly the conſiſtence of molaſſes or treacle. The cloth is then taken out, well waſhed from its impurities, and, in the old mode of bleaching, it is then laid upon the ground to be whitened by expoſure to the atmoſphere, but, in the new mode of bleaching, is ſubmitted to the action of the oxygenated muriatic acid, to procure a ſimilar whiteneſs. It may be proper here to notice, that the old and new methods of bleaching are yet much the ſame as formerly, only in the ſubſtitution of the uſe of the oxygenated muriatic acid in thoſe parts of the proceſs, where a long expoſure to the atmoſphere was formerly employed after the alkaline leys.

The operation of bucking acts on a ſimilar principle to that of boiling, but in a much more forcible manner, as a greater quantity of aſhes is added in proportion to the water made uſe of, and more heat is received and retained in the large bulk of cloth placed in the bucking tub, which expands the fibres of the cotton, and admits the more powerful action of the alkali, as is eaſily demonſtrated by obſerving the very dark colour of the alkaline leys which have been uſed in bucking, in compariſon with thoſe which have been employed in boiling goods. To thoſe perſons who wiſh for a full and minute account of the abſorption and power of heat, we recommend a peruſal of count Rumford's intereſting eſſays on the ſubject of heat.

The black alkaline ley which remains after bucking ſhould be preſerved, as it will anſwer, after evaporating and calcining, as hereafter mentioned, to form again freſh alkaline ſalts of good quality. With a view to preſerve as much of the ley as poſſible, it will be adviſeable to wring it out into a tub from the cloth or yarn, after it is bucked, by the method ſhewn in *Plate* IV. *fig.* 3. where R R are two ſtrong poſts, fixed firm in the ground, S T two wringing hooks, upon which the cloth U is twiſted, to force out the liquor, by W, a winch handle, which turns the hook round on the poſt R. The two hooks are kept at a proper diſtance from each other, one by a collar at X, the other by an iron pin at Y, which runs through a hole in the ſquare part belonging to the hook T, which ſquare has ſeveral holes in it to bring this hook nearer to the hook S when required.

4th, *Souring.*

This proceſs conſiſts in immerſing, for the ſpace of twelve hours, or more, the yarn or cotton in a mixture of water and ſulphuric acid (vitriolic acid), well incorporated; the proper ſtrength of which mixture is about the acidity of lemon juice, and is uſually directed by the taſte. The four kettle ſhould be made of lead, of a form which can be heated; the heat of the liquor ſhould not be greater than the hand can bear with eaſe. This four kettle ſhould be half ſunk within the ground, as ſhewn in *Plate* IV. *fig.* 2. where M is a ſection of the ſouring veſſel; N, the level of the ground; O, the brickwork; P, the fire-place, which is a half circle, or arch, without any grate; I I I, a ſpace filled with dry aſhes, betwixt the lower part of the ſour veſſel and the brick-work, in order to preſerve the heat of the liquor in that part of the veſſel below the ſurface of the ground; K, a brick hearth, on which part of the fire is made: L, a caſt iron plate, bending in the form of the ſour kettle, which is intended to prevent the fire placed on the floor at P K, from acting upon the lead of the ſour veſſel; Q, the ſpace betwixt the veſſel and brickwork, through which the ſmoke goes to the chimney.

The conſtruction of this apparatus is upon the ſame principle as the warm vats made uſe of by the blue dyers, the intent not being to make the liquor boil, but to keep it at a degree of heat which the hand can long and eaſily bear. There are no grate or bars neceſſary in this fire-place, as the coals will burn with ſufficient rapidity without them.

The goods may be put into this acid liquor either in a wet or dry ſtate. The beſt plan is to immerſe the goods in the evening in the acid liquor cold, let them remain covered with it all night, then in the morning make a fire and bring the liquor to a blood heat, in which ſtate having a winch over the veſſel, ſimilar to that repreſented at C, *fig.* 1. give the goods a few turns over it, that every part of them may be expoſed to the action of the liquor. The goods may then be lapped round the winch to drain a little, to prevent an unneceſſary waſte of the acid liquor, and afterwards carried to the waſh-wheel, or river, to be well waſhed from

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the acid, ſo that the cloth may be perfectly taſteleſs to the tongue. It is a remarkable circumſtance, that cloth may remain immerſed a very conſiderable time in a ſtrong acid liquor without rotting, but that if expoſed to the air or heat of a ſtove, if a very ſmall portion of acidity remains in the cloth, it becomes ſo concentrated by heat, as to damage the cloth immediately; therefore too much attention cannot be paid to this point.

The uſe of the acid liquor above-mentioned is to diſſolve any earthy or metallic matters inherent in the cloth, or which may have been communicated to it accidentally, or which it may have derived from the impurity of the alkaline ſalts uſed in the bucking or boiling.

A conſiderable quantity of the acid liquor may be preſerved by paſſing the goods which have been ſoured through a tub of clean cold water, previous to waſhing them, and repleniſhing the ſour kettle with this acidulated liquor, rather than water only.

5th, *Waſhing*.

After every operation in which acids or alkaline ſubſtances are uſed in bleaching, it is neceſſary that the goods ſhould be well waſhed in clear water; it is therefore of the greateſt conſequence that the water of a bleach ground ſhould be pure, and in conſiderable quantities, ſuch, for inſtance, as is perfectly tranſparent, will not curdle with ſoap, nor yield any degree of blackneſs with powdered gall nuts, or, which is a more accurate teſt, with a tincture of galls by infuſion in ſpirits of wine.

Various methods have been invented for the purpoſe of waſhing out the impurities of the articles to be bleached; ſuch as cleanſing them in a large current of water by ſhaking them with the hand in the ſtream, beating them on blocks of wood with a flat paddle, or hand bruſh, beating them on a large flat ſtone with long wooden levers, flatted underneath, paſſing them over winches placed above veſſels of water, or rivers, as *fig.* 1. and 3. *Plate* II. paſſing them betwixt plain or fluted rollers, as *fig.* 5. and 6. putting them under fulling mills, or fulling ſtocks, as *fig.* 7. or within waſh-wheels, as *fig.* 1. and 2. and by many other modes, few of which are equal, and perhaps none ſuperior, to thoſe of which engravings are here given, for doing the buſineſs ſimply, effectually, and with eaſe to the workmen; the latter point of which is of conſequence to be attended to, as it will be univerſally found in every mechanical employment, that if the leaſt additional labour or care is required from the workmen, however great the effects produced, prejudice or indolence will prevent their doing juſtice to the invention. Under theſe circumſtances, the waſh-wheel repreſented in *Plate* II. *fig.* 1, 3, 4, is the beſt machine for general uſe, and the leaſt liable to occaſion damage to the goods. The front of the waſh-wheel repreſented at A, *fig.* 1. is ſuppoſed to be eight feet diameter, excluſive of the buckets B, ſhewn by dotted lines on its periphery, which give it motion from the water falling into them. This wheel is divided within into four parts or quarters, by the ſtrong arms projecting from the ſhafts D, to the outer circle; in each of theſe ſeparate quarters or boxes, repreſented by dotted lines, one or more pieces of goods which require waſhing, are put looſely folded together through one of the holes C, of 14 inches diameter.

Fig. 2. ſhews the back part of the ſaid waſh-wheel, which is made of ſolid planks, excepting a grate of ſlender iron bars marked R, which encircles the wheel underneath the ſeparation boards or bottoms of the buckets; the uſe of this grating is to admit within the wheel a current of clear water from the pipe Q. When an equal number of piece goods have been introduced into each of the four diviſions of the wheel by the holes, C, &c. above-mentioned, a current of clear water is permitted to run through a cock from the pipe Q, againſt the grating R, which allows it to flow freely through into the boxes, or thoſe parts of the wheel which contain the goods; a valve is then opened from the trough P, communicating with a large reſervoir or ſtream of water, a ſufficient quantity of which is let into the outſide buckets from the valve, to give the proper motion to the waſh-wheel containing the goods. In every revolution of the wheel, the goods in each quarter of it are thrown twice, by the ſimple motion of the wheel, with great force againſt the arms which form the four diviſions of it; viz. once in going down, and once in riſing up. The ear can diſtinguiſh by the firmneſs of the ſound when the wheel moves with proper velocity; and a greater or leſs quantity of water is allowed to act upon the buckets till that is attained, which uſually is when the wheel makes 15 or 16 revolutions in a minute. During the whole time the wheel is in motion, the ſtream of clear water from the pipe Q flows upon the goods within the wheel in every direction; and the dirty water, produced from thus waſhing the goods, runs out of the wheels from a number of holes bored through the wood-work near the axle, and a few made in the front near the outer circle of the wheel. *Fig.* 4. ſhews an end view of the waſh-wheel, about thirty inches wide, with the manner that the bucket-work is made.

It has been found to anſwer equally well to make uſe of a greater number of waſh-wheels of a ſmaller ſize, as ſix feet diameter and two feet wide, of which ſeveral may be put in motion at once by a large water-wheel, horſes, or a ſteam engine.

The goods, when taken out of the waſh-wheel, are to be unfolded, and taken to the river to be ſtreamed, or may be waſhed from any impurities which may remain in the folds by means of a winch N, *fig.* 1. and 3. *Plate* II. where ſix pieces of cloth are repreſented in the action of waſhing in a large wooden back divided into ſix partitions, to prevent the pieces of goods entangling with each other. *Fig.* 1. is a ſide view of the operation, where the dotted lines repreſent the partitions which ſeparate the goods; I, a trundle wheel, which being put in motion by the cogs, H, of the waſh-wheel, turns the winch on its axle, which winch may, at any time be detached from it by the handle M drawing the catch K from the hook, as is ſhewn in the top view *fig.* 3. where alſo is explained, at the letters OOOOOO, the manner in which each piece of goods is kept in its proper place on the winch, by the partitions above mentioned, and by angular ſlips of wood nailed to the back and partitions.

To aſſiſt the drying of the goods after waſhing, they are uſually paſſed betwixt two ſmall rollers, commonly called ſqueezers, repreſented at *fig.* 5, where G is a ſolid wooden frame, containing two wooden rollers, each from 10 to 16 inches long, on an iron axis, which rollers receive a proper preſſure by means of the two ſcrews T acting on an iron bar V, which reſts on the two ends of the axis of the top roller, as ſhewn by the dotted lines. In proportion as the ſcrews preſs the iron bar upon the axle of the top roller, it brings that roller cloſer in contact with the bottom roller, and occaſions more water to be preſſed out of the cloth, which is paſſed betwixt them looſely drawn together, ſomething like a rope, and the goods therefore require leſs time in the ſubſequent drying. In this plate the ſqueezers are connected with the waſh-wheel above mentioned by a ſquare iron ſocket, which, as is ſhewn at F, ſlides occaſionally upon the ſquares of both axles. *Fig.* 4. ſhews at S the buckets of the waſh-wheel, on which the water falls to give it motion; H, the cogs round its axle, which work the trundle wheel I.

Fig. 6. *Plate* II. ſhews two views of another machine uſed for cleanſing cotton goods, conſiſting of two fluted or grooved

grooved rollers, in the ſection of which *a* repreſents the ſills, or bottom timbers; *b b*, the two ſupports or ſide pieces; *c*, one of the upright pieces in which the axles of the rollers are placed; *d d*, the two croſs pieces to ſecure the frame work below; *e e*, the two rollers with grooved channels which fit to each other; *h*, one of the levers, which, from a point *i*, ſhewn by dotted lines, preſſes on the round end of the axle of the top roller, more or leſs, according as the weight *k* is placed on the lever further from or nearer to the axis of the roller.

In the geometrical elevation of the ſame machine, *ee* ſhews a front view of the two rollers; *fg*, the winch to turn it, with a hollow wood handle upon the iron work; *l*, the axis of the upper roller projecting beyond the ſide timber, ſo as to admit one of the levers *h* above mentioned to preſs upon it.

The wet goods, by being paſſed backwards and forwards through theſe fluted rollers, which are conſtructed at a much leſs expence than waſh-wheels, are conſiderably cleanſed, but not ſo perfectly as by the waſh-wheels above mentioned.

Fig. 7. *Plate* II. explains another mode of cleanſing goods, and is applicable to cotton, linen, or woollen goods, but more generally to the two laſt, as, without great care in its management, it is very apt to tear or damage cotton goods. This machinery is uſually termed falling ſtocks, or falling hammers. N° 1. is the axle of the water-wheel, in which are fixed tappets at 2, to raiſe alternately the levers 3, 4, furniſhed with large wooden mallets or hammer heads 6, 8, channelled at the lower part as at 8. Theſe lever hammers or fallers, work from a pin fixed in the upright at 7; 9 is a ſtrong piece of timber hollowed out at 10, to receive the goods to be cleanſed; 11, a piece of timber fixed a-ſlant to keep the fallers in their proper place, and direct their motion; 12, a chain faſtened to each faller, ſerving by means of the hook 13, to ſuſpend the faller whilſt the goods are put in or taken out of the cavity 10.

When the goods to be cleanſed are placed in a looſe bundle in this cavity, the hammers are let down upon them, and put in motion alternately by the tappets 2, in rotation, which raiſe the levers to a certain height, and then quitting them, the hammer heads by their great weight, fall with great force on the goods in the cavity below them; and a current of clear water being admitted upon the goods from a cock above them, the dirty water runs out at a hole in the bottom of the cavity. The falling of the hammers gives a ſlow circular motion to the goods in the cavity, ſo as to expoſe the ſeveral parts in rotation to the action of the hammers.

Having noticed the veſſels made uſe of in bleaching, and the general nature of the ſeveral operations, we ſhall now proceed to mention the origin of the ſeveral improvements made in this art, and their application to practice.

Under the operation of ſteeping, we have ſhewn the method of removing the colouring matters not natural to the vegetable, but acquired in the manufacture, and which may probably be beſt done by water alone, though ſometimes ſome of the old leys, which have been previouſly uſed to other cloth, are employed to this purpoſe. After the ſteeping, and indeed after every application of bleaching agents, it ſhould be laid down as a general rule, that the cloth or goods be carefully waſhed in cold water.

In the old method of bleaching, alkalies, ſuch as pearl or pot-aſhes, were, after ſteeping, applied by bucking or boiling, with alternate expoſure to the atmoſphere.

Alkalies acting ſo important a part, it is neceſſary to deſcribe the bleachers' mode of uſing them, which conſiſts in diſſolving them in clean water, and thus forming what is termed an aſh-ley. To which the more intelligent bleacher, if he does not make uſe of American pot-aſh, or that of a ſimilar quality, adds ⅓ of quicklime, whereby the aſhes are rendered cauſtic, and their power materially augmented. But in order that no inconvenience may ariſe from cauſticiey, after mixture, the whole is allowed to ſettle, and from the pure liquor thereof the work is afterwards ſupplied; the bleacher, in drawing it off, reducing it by the addition of water to the different ſtrengths which the goods may require.

The ley being prepared, the bleacher proceeds to apply it to the cloth by bucking or by boiling.

In bucking, the alkaline ley is put into the boiler before deſcribed, near to and below which is the wooden veſſel called a kier, in which the goods are looſely and regularly arranged. After this, a fire is put under the boiler, and beginning whilſt the ley is yet cold, it is made to circulate through the cloth in the kier, from which it runs into the iron veſſel placed in the ground, from this it is pumped up into the boiler, and again returned upon the cloth in the kier; and this circulation is maintained, and the heat at the ſame time increaſed, until the ley be ſo far concentrated by evaporation, as at laſt to remain almoſt wholly in the cloth. This is generally the operation of a day, and the cloth is allowed afterwards to remain thus impregnated with the concentrated ley until next morning.

In boiling in alkaline leys, the mode of which has been before deſcribed, the operation is continued from one hour to five or ſix hours, but it is more tedious and leſs effectual than bucking, where much buſineſs is to be done.

After bucking or boiling, the goods were, by the old bleaching proceſs, expoſed for at leaſt a week to the air, before they were again ſubmitted to the action of alkaline leys, and this proceſs alternately repeated many times, till the goods were perfectly white, and the goods at laſt ſoured and waſhed off.

To explain the *old method of bleaching* more particularly, we ſhall add the following proceſs for bleaching linen cloth.

Steep your raw linen cloth in a wood veſſel all night, then change the water, and add freſh till you perceive the water to be no longer diſcoloured by it; rinſe, wring, and lay it on the ground, and water it if you have opportunity. When it has thus lain on the graſs three or four days, and is dry, take hold of each piece one after the other by the ſelvedge, and draw the cloth to you, ſtill holding it in the moſt even manner you can, until you get the further end, with the corners of which further end you tie the cloth very looſely in the middle of the folds, and ſo lay it in the bucking tub, with the two ſelvedges upwards.

Thus proceed till you have placed as much cloth in your tub as will cover the bottom of it, taking care not to pack the cloth ſo cloſe but that your ley may penetrate every part equally. When you have laid the firſt range of cloth in your tub, pour upon it as much milk-warm ley as will ſufficiently ſoak through all parts of your cloth. Then lay another range in the ſame manner upon the firſt, and pour on more ley till that be ſoaked as the other was, and continue ſo to do till your bucking tub be full of cloth.

That done, you muſt begin to buck for twelve hours together, the remainder of your ley having been put in the pan with a ſlow fire underneath. For the firſt five hours the ley ſhould not be of a boiling heat; you muſt from time to time allow ſome of the ley to run out of the pan upon the cloth in the bucking tub; then increaſe your fire gradually and ſlowly, ſo as in four hours more to bring it to a boil, continuing to put on the ley, and draw it off your cloth in ſmall quantities at a time. When your ley begins to boil, you muſt let it boil on for three hours, during the whole

time

time pumping your ley up to the boiler from the reſervoir, into which it runs from the cloth, and returning it boiling hot upon the cloth, ſo that the hot ley may act powerfully and equally upon every part thereof.

After each bucking your cloth muſt be laid upon the graſs in the bleach-field for ſome days. The bucking, and expoſure on the ground, muſt be repeated about ten times ſucceſſively, according to the nature of your cloth; it ſhould then be dried up, ſoured, and waſhed well in clean water; if the water is rather warm, the better.

Your two firſt buckings ought to be from a ſtrong cauſtic ley of pot-aſhes; but afterwatds you ſhould abate of that ſtrength, leſt it ſhould injure your cloth. Mild ley, or pearl-aſh, ſhould be uſed for the latter buckings, as the cloth becomes nearer white.

This was the management during the ſummer months; but for four months in winter bleaching was ſuſpended, the operations being periodically interrupted, and the capital of the manufacturers or proprietors of the goods locked up. Even during the bleaching months, their property was long in preparing for ſale; as cotton goods, which required from four to ſix applications or repetitions of alkaline leys, conſumed ſo many weeks in bleaching, whilſt linens, which could not be bleached by leſs than from twelve to twenty applications, could not be brought in a marketable ſtate to the proprietor hardly in ſix months.

Such was the ſtate of bleaching till Mr. Scheele, a Swede and eminent chemiſt, diſcovered the properties of oxygenated muriatic acid, procured by mixing manganeſe with marine acid, in rendering vegetable matter white; and M. Berthollet, the celebrated French chemiſt, improved this operation, and actually applied its powers in bleaching cotton goods by interpoſing its action between the different alkaline operations inſtead of the tedious expoſure of the goods to an uncertain atmoſphere; the ſame effect being produced by immerſion of the cloth in this acid, as by laying the goods upon the graſs in the bleach-field, expoſed to air and light.

Diſcovery of and Variations in the Mode of procuring the Oxygenated Muriatic Acid.

By the addition of vitriolic acid to common ſalt, an elaſtic aeriform fluid, or muriatic gas, is diſengaged, from which with water a marine acid is produced. The mineral ſubſtance manganeſe, or what the modern chemiſts call oxyd of manganeſe, contains what was formerly denominated vital air, pure air, or dephlogiſticated air, but now named oxygen. Manganeſe yields oxygen, when marine acid is added to it, and ſubmitted to diſtillation; the liquor produced by the contact of this oxygen with water, is the oxygenated marine or muriatic acid diſcovered by Mr. Scheele, about the year 1774, when he obſerved and applied its effects in rendering colourleſs vegetable ſubſtances of various kinds, more as a matter of curioſity than uſe.

M. Berthollet, in the year 1786, improved the proceſs of its preparation, applied its power to bleaching or deſtroying the vegetable colours natural to cloth, the reſult of which experiments he gave to the world in the year 1789; but, without derogating from the merit of this excellent chemiſt, it is juſtice to ſtate, that, previous to any publication by M. Berthollet, Mr. Scheele commuuicated to M. Kirwan the properties of the dephlogiſticated marine acid in whitening vegetable ſubſtances, and Mr. Kirwan, then reſiding in Newman-ſtreet, London, ſuggeſted to Mr. C. Taylor, the preſent ſecretary to the Society of Arts, &c. the probability of its uſe in bleaching; and a whole piece of callico, in the ſtate received from the loom, was, in the ſpring of 1788, actually bleached white, printed in permanent colours, and produced in the Manchester market ready for ſale, having undergone all theſe operations in leſs than 48 hours, by the joint efforts of Mr. Cooper, Mr. Baker, and Mr. Taylor, which is perhaps the firſt entire piece, either in France or England, that fully aſcertained the real merits of the new mode of bleaching, and a certainty that it might be generally uſeful in commerce. This experiment was immediately followed by the eſtabliſhment of a large bleaching concern by Mr. Cooper, Mr. Baker, and Mr. Horridge, at Raikes, near Bolton, in Lancaſhire, and before any conſiderable bleaching work was actually at work in France.

The ingenious Mr. Watt we believe to be the firſt perſon who ſimplified the proceſs of preparing the oxygenated muriatic acid, by means of a mixture of common ſalt and manganeſe, previous to the addition of the vitriolic acid. Soon afterwards the operations of the bleacher were farther facilitated by the ſubſtitution of large and commodious ſtills of lead, inſtead of glaſs veſſels, and both theſe improvements have ſince been in general uſe.

We ſhall now proceed to mark the various treatment of the oxygenated muriatic acid when obtained, and the different means which have been adopted to fit it for application in bleaching.

It having been found in the earlier ſtages of diſtillation, that common marine acid was produced inſtead of the dephlogiſticated or oxygenated muriatic acid; and from the violence of the ebullition, that manganeſe itſelf was ſometimes thrown over from the ſtill, M. Berthollet had recourſe to an intermediate veſſel, containing water, to abſorb the marine acid gas, and ſtop other impurities which might contaminate the oxygenated muriatic gas in its paſſage through this veſſel to the receiver.

It will here be neceſſary to diſcriminate the various modes in which the oxygenated muriatic gas has been treated, after paſſing the intermediate veſſel laſt mentioned.

Mr. Scheele ſeems generally to have operated with the acid in the ſtate of gas; but M. Berthollet ſought to condenſe it in water, with which he filled his receiver, or wooden veſſel, and which water he kept agitated during the diſtillation, to accelerate the ſolution or combination of the gas.

The oxygenated muriatic acid, thus prepared, was drawn from the receiver into kiers, or large wooden veſſels, where its ſtrength was regulated by the addition of water; after which, the goods to be bleached were immerſed therein from ſix to twelve hours, but moſt frequently during the night; and though theſe periods may ſeem ſhort, they were ſufficient to allow the cloth to become more white than could be done by as many days' expoſure to the atmoſphere and a ſummer's ſun, and were then ready for a freſh application of the alkaline leys.

Such was the bleaching liquor of M. Berthollet; but it was found in practice yet defective, as the volatility of the gas occaſioned its ſpeedy ſeparation from the aqueous ſolution; a decompoſition even by light alone in glaſs veſſels took place; a rapid loſs in the ſtrength of the liquor when expoſed; and much danger to the health of the workmen from its ſuffocating quality; at the ſame time, that in extracting the natural colours of the cloth, it alſo tended to diſcharge the colours dyed in the yarn, and were along with the gray cotton an imperfection which precluded its uſe in an infinite variety of Britiſh manufactures.

Similar circumſtances probably led ſome bleachers reſident at Javelle, in France, to add a ſolution of cauſtic alkali to the water in the receiver, and by this means to remedy many of the defects complained of.

But M. Berthollet continued to recommend his proceſs, conſidering ſuch ſubſtance as impairing the bleaching powers;

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an idea that was generally maintained by the chemiſts, but contradicted by the bleachers, whoſe experience taught them, that though the acid thus combined whitened with ſomewhat leſs rapidity, yet it was not eventually in an inferior extent; and the advantages of preſerving the colours dyed in the yarn, compelled them to have recourſe to the expenſive addition of pot-aſhes, in preference to M. Berthollet's mode.

Here we ſhall obſerve, that, according to the doctrine of the modern chemiſts, the oxygenated muriatic acid bleaches in conſequence of yielding to the colouring matter of the cloth that oxygen which, in the diſtillation, the acid abſorbed from the manganeſe; or, in the language of Stahl and Becher, that the dephlogiſticated marine acid abſorbed the colouring matter from the cloth, and was reſtored to its original ſtate of common marine acid, by regaining that phlogiſton which it had, in its preparation, yielded to the manganeſe.

In the mixture of an alkali with the acid, we have noticed that the bad conſequences ariſing from its volatility have been corrected, and the requiſite protection afforded to dyed colours, yet ſtill that its power of whitening cloth was not diminiſhed, nor much more time taken up by the operation; yet, in part from deference to M. Berthollet's opinion, and in part owing to the expence of the alkali, other means to produce the effect were attempted.

One of the firſt of theſe, practiſed by the bleachers of cotton-hoſe, at Nottingham, was to receive the dephlogiſticated muriatic gas into a ſmall air-tight chamber, in the upper part of which the goods were ſuſpended from a frame, whilſt at ſome diſtance below was water, ſometimes impregnated with ley of pot-aſh, and ſometimes with lime-water, or water mixed with lime. The gas was introduced betwixt the fluid and the goods, amongſt which it aſcended and mixed; at the ſame time, by occaſionally immerſing the goods in the fluid below, it was ſought to modify the action of the acid. This was effected by means of a pole, or long lever, connected with the frame on which the goods were ſuſpended, the centre of which pole moved on a ſwivel fixed in a hole in the partition, occaſionally ſtopped with clay, and enabled a perſon to let the goods down into the fluid, not always however without inconvenience, which occaſioned it the name of the *Bedlam Proceſs*.

Reſpecting the above proceſs it muſt be obſerved, that the acid is much more powerful or active in the ſtate of gas than in any other way; and though the occaſional immerſion of the goods into the fluid below, corrected in ſome degree its violent effects, yet the dyed colours diſappeared more rapidly in this than in any other proceſs, and the fabric itſelf was ſometimes injured.

The next proceſs attempted by the bleachers, was to put into the receiver, filled with water, a quantity of pulverized lime, then the goods themſelves, and the whole agitated during the admiſſion of the gas; the conſequence of which was, that the goods thus mixed with lime were partially coated with it; and this coating being unequal, the action of the acid upon it was irregular, leaving at the ſame time the parts uncoated to receive the whole action of the bleaching powers; hence inequality of bleaching enſued, and an inſurmountable difficulty in preſerving the dyed colours of the goods to be bleached.

Having noticed the imperfections of the two laſt proceſſes, we ſhall obſerve that lime-water, or a pure chemical ſolution of lime in water, has been ſometimes ſubſtituted inſtead of a ſolution of alkalies in the receiver, but was not, when uſed in that manner, found to anſwer ſo well as the alkaline ſolution.

That lime-water could produce no valuable effect beyond what was derived from M. Berthollet's mode, or from ſimple water, muſt be evident, when it is conſidered that water can diſſolve no more than $\frac{1}{700}$th part of its weight of lime, a quantity wholly inſignificant in neutralizing the oxygenated muriatic acid for the purpoſe of the bleacher; nor could pulverized lime, merely thrown into the water of the receiver, ſerve a better purpoſe, ſince, from its being ſpecifically heavier than the water, all beyond the quantity in chemical ſolution ſubſided and remained nearly uſeleſs at the bottom of the receiver.

It has been already mentioned, in noticing the application of alkaline leys in bleaching, that the more intelligent bleachers, in preparing their aſh-leys, made uſe of quicklime to augment the power of the alkali, when ſuch alkali was in a mild ſtate, or, in other words, combined with fixed air, or, as it is now termed, carbonic acid; the attraction of cauſtic lime for the carbonic acid being ſtronger than that of aſhes. Hence, on cauſtic lime being thrown into mild aſh-ley, the carbonic acid, by which the aſhes were rendered mild, abandons the alkali to combine with the lime, leaving the aſhes in their cauſtic ſtate.

But, although the attraction of carbonic acid is ſtronger for lime than for alkali, the contrary is the caſe with the oxygenated muriatic acid, as it abandons lime to combine with aſhes, leaving the lime to precipitate.

This obſervation is made in order to guard the ignorant bleacher from miſtakes, who, from having mixed lime with his aſh-ley in the receiver, in the preparation of the oxygenated marine acid, may ſuppoſe it acts in a ſimilar manner; but not a particle of lime is acted upon by the acid, whilſt aſhes remain to combine with it; the only effect of the lime there, being to abſtract from the aſhes any fixed air they may contain, and ſo diſpoſe the alkali to abſorb more of the oxygenated muriatic acid.

Beſides the proceſſes above mentioned, the bleachers attempted to unite the oxygenated muriatic acid with clay; but as the clay has ſcarcely any affinity with it, the liquor thus made was little, if at all, ſuperior to that of M. Berthollet.

Such were the attempts made from the year 1786; and the oxygenated muriatic acid combined with pot-aſh was in general uſe by the bleacher until 1798, when Mr. Tennant, of Glaſgow, by a well conducted ſeries of experiments, formed what may not improperly be called a new era in bleaching.

Mr. Tennant, having ſeen ſo long a period elapſe without any material improvement in bleaching, and the alkali, though an expenſive ingredient, regarded by the bleacher as an indiſpenſible article to unite with the oxygenated muriatic acid in the receiver, made ſome trials with the earths ſtrontites and barytes, and with ſucceſs. Their ſolubility in water enabled him to combine them with a ſufficient quantity of oxygenated muriatic acid to ſerve the purpoſe: but the ſcarcity of ſtrontites, and the difficulty of ſeparating barytes from the vitriolic acid, with which it is uſually found in combination, rendered theſe diſcoveries rather objects of curioſity than uſe.

Mr. Tennant had previouſly made experiments to combine the oxygenated muriatic acid with lime and lime-water, in the modes above-mentioned, but found they were not adequate to the purpoſes intended; the lime in general remaining at the bottom of the receiver uncombined with the gas, which was the neceſſary conſequence of the lime being ſpecifically heavier than the water, and the gas much lighter; the water, by its interpoſition betwixt the two ſubſtances which ought to be combined, namely the oxygenated muriatic gas and the lime, preventing their union. To bring the pulverized lime into contact with the gas as quickly as

it entered the receiver, became then the object of his attention; and for this purpose he found it was necessary to keep the lime floating, or diffused through the fluid, which he succeeded in accomplishing by two different methods; one of which was by increasing the specific gravity of the water in the receiver, by the addition of common salt, and thus retarding the lime from subsiding; the other mode was by constant agitation of the lime in the water in the receiver, to keep the lime diffused through the fluid, during the time the oxygenated muriatic gas was introduced; and by this means he succeeded in uniting and retaining a much greater quantity of gas with the mixture, than by any method heretofore used, and without the addition of any ashes or alkaline substances.

A very material advantage was gained by this discovery; namely, that it uniformly afforded security to the dyed colours in a superior degree to the alkaline ley.

It is well known, that in the alkali of commerce, such as pot-ash or pearl-ash, a large and very irregular proportion of neutral salts is intermixed, which are soluble along with the alkali in water, thereby so far contaminating the ley, that the bleacher is always uncertain what quantity of pure and active alkali it contains. In bucking or boiling cotton goods, the detriment from these neutral salts is not so great, as a repetition of the process may compensate for those admixtures in the ley: but in the bleaching liquor formed by the mixture of the oxygenated muriatic gas with such ley, if there is a deficiency of alkali, the uncombined oxymuriatic acid immediately attacks the dyed colours of the goods, and discharges them, and thus considerable damage frequently occurs before the real origin of the evil is ascertained and corrected. The bleacher is kept in a constant state of alarm respecting the quality of the ashes he makes use of, besides the great cost of their purchase. In using lime for the same purpose, the expence is a mere trifle; what is not combined with the oxymuriatic acid precipitates, after the agitation is over, leaving a pure liquor free from all uncombined acid.

Simple as the combination of the lime with the oxygenated muriatic acid may now appear, yet it was a long time attempted in vain; but this, perhaps, will not be such a matter of surprize, when we reflect that the French chemists, whose opinions were regarded generally as law by the common bleachers, and whose treatises on the subject of bleaching were almost the only accounts published, considered lime as no farther useful in bleaching, than in absorbing the carbonic acid or fixed air usually combined with alkalies or ashes; and thus rendering the alkaline ley more disposed to unite with the oxygenated muriatic gas, when exposed to its contact in the receiver, to form, as it is called, the liquor de Javelle; or when intended for use as a mere alkaline ley, to render its action more powerful on the oily particles in the vegetable fibre, on a similar principle to the formation of soap.

An excellent treatise on the subject of bleaching, in the English language, viz. "The Report on Experiments made by order of the right honourable the trustees of the linen and hempen manufactures to ascertain the comparative merits of specimens of oxygenated muriatic bleaching liquids," published at Dublin in the year 1791, in claim of a bounty offered by the trustees, appears to convey no further knowledge of the use of lime in bleaching at that time than in promoting the separation of the carbonic acid from the leys, whether they were afterwards to be used alone, or in the preparation of the oxygenated muriatic acid. Mr. Rose's experiments in this report contain, however, much useful information, which we shall further notice.

The simplicity of Mr. Tennant's invention of retaining a greater quantity of the oxygenated muriatic gas, by agitation of a sufficiency of lime in the water of the receiver, should be no derogation to its real merit. In substituting lime for pot-ash, an article, not only of foreign produce, but expensive, he has benefited this country, to an extent almost beyond conception; it having been proved upon oath, that by the use of Mr. Tennant's process, the consumption of ashes at a single bleaching-green has been reduced three thousand pounds sterling in value in one year. A patent for Mr. Tennant's invention was granted him in the year 1798; but as frequently happens in patent causes, on a late trial of its validity, some circumstances arose from which the jury thought themselves justified in reversing the patent; we have therefore with considerable pains collected for the public benefit an account of his process, and the most approved mode of putting it in practice, either on a small or an extensive scale, as will be seen by a reference to *Plate* I. of *Bleaching* hereafter described.

Mr. Tennant's method of using calcareous earth for neutralizing the muriatic acid gas, and forming the oxy-muriat of lime employed in bleaching is as follows; viz.—In a receiver capable of containing one hundred and forty gallons wine measure, dissolve thirty pounds of common salt, which appear useful only in giving an additional degree of specific gravity to the water, and by that means making it easier to keep the lime to be afterwards added, in suspension; when this salt is dissolved, add sixty pounds of finely powdered quicklime, and into the retort of the apparatus put thirty pounds of powdered manganese, mixed up with thirty pounds of common salt, upon which pour thirty pounds of sulphuric acid (oil of vitriol), previously diluted with its bulk of water, and the usual precaution of luting the vessel being taken, proceed to distillation. When the gas begins to appear, the agitation of the lime and water in the receiver must commence, which should be continued by means of a wooden paddle or rake, or similar contrivance, without intermission, until the materials in the retort, after heat being employed as usual, will not yield any more oxygenated muriatic acid gas. Then the whole should be allowed to remain at rest for two or three hours, when the clear liquor in the receiver, may be drawn off for use, and mixed with water in such proportions as may be found necessary, previous to the immersion of the goods to be bleached.

The principal point of attention in preparing this oxygenated muriat of lime is, to obtain a complete diffusion of the lime through the mixture, or a mechanical suspension of it in the water during the operation, so that every particle of the lime may, by agitation, be exposed to the action of the gas, instead of merely its upper surface, as had been formerly practised. By the present means, the oxygenated muriatic acid gas is absorbed with ease, and meets with a sufficient quantity of lime to produce a strong solution of oxygenated muriat of lime, without any uncombined oxygenated muriatic acid; a thing which could not be otherwise effected. The addition of the common salt in the receiver may even be omitted, without prejudice, if the agitation of the lime be well managed.

Plate I. *fig.* 2. of *Bleaching*, shews a longitudinal section of a method, which has been practised in Ireland for distillation of the oxygenated muriatic acid, and the formation of the oxygenated muriat of lime. *a*, the ash-hole; *b*, the fire under the iron pot or vessel; *c*, the aperture through which it is supplied with coals; *d*, the entrance to the ash-hole, which may be provided with a stopper of burnt clay, or earthen ware, to regulate the draught of the fire, by means of the handle shewn by dotted lines: *e*, a cast-iron pot or vessel,

veſſel, nearly filled with water, in which the leaden retort is placed; *f*, a tripod of iron, on which the retort ſtands; *g g*, the leaden retort, from which the gas is to be diſtilled; *h*, a tunnel of bent lead, though which the oil of vitriol (ſulphuric acid) is to be introduced into the retort; *i*, a leaden cover, fitted and luted to the neck of the retort, having three apertures, viz. for the introduction of the tunnel, the rod of the agitator, and the tube of the condenſer; *k*, the agitator, formed of a rod of iron coated with lead, having ſome arms at its lower end to ſtir the materials within the retort. At the part where the rod paſſes through the cover, a leaden collar or cap is ſoldered, to prevent the agitator from deſcending too low; theſe two parts are made in a conical form, to fit exactly, and thus prevent the eſcape of the gas; *l*, a leaden tube or pipe, of three inches bore, to conduct the gas into the tubulated reſervoir; *m*, the leaden reſervoir, formed upon the principle of Wolfe's apparatus; the tube, *l*, deſcends by the firſt aperture, *m*, to the bottom of the reſervoir, which is about two thirds full of water. The ſmall portion of ſulphuric acid, which riſes in diſtillation, unites with this water; the oxygenated muriatic acid, which traverſes this water, paſſes by the pipe, *n*, into the receiver or condenſer, *o o*, which is a wooden veſſel, in the midſt of which is placed an agitator, *p*, the arms of which raking up the lime cauſe it to combine with the gas, in proportion as it ariſes in bubbles from the lower extremity of the leaden pipe, *n*.

The projections of wood, *q q q q*, fixed to the ſtaves within the tub, counteract the rotatory motion of the arms of the agitator, and thus aſſiſt the combination of the gas with the lime and water. The cover of this tub is fixed cloſe upon the edge of it at *r*; the cover having a groove in it to unite them tighter together; *s*, a cock to draw off the liquor, when ſufficiently impregnated for uſe; *t*, a wooden handle to give motion to the agitator. The joints may be luted with clay, to prevent the eſcape of the gas.

Fig. 3, and 4, ſhew Mr. Tennant's improved machinery for preparing the oxy-muriat of lime. The outline, A, (*fig.* 3.) is the ſtill, made of lead, of a circular form, having a double flange at the top, which is filled with water, to prevent the gas from eſcaping in that direction. B, the leaden cover of the ſtill, having a flange on the under ſide, which goes into the double flange of the ſtill, and having a double flange on the upper ſide, which is filled with water; the inner part of this double flange conſiſts of a ſhort tube, which goes quite through the cover, opening by this means a communication with the ſtill, and allowing the gas to eſcape through the long leaden pipe inſerted into it, and from thence into the receiver, as explained at *fig.* 4, where there is a ſection of the ſtill, furnace, and receiver; *a*, the ſtill; *b*, an iron pan in which the ſtill is placed on an iron ſtand; this pan is then nearly filled with water; *c*, the fire-place; *b*, the furnace door; *e*, the aſh-hole; *f*, double flange filled with water; *g*, the cover, with flanges on the upper ſide filled with water. D, the receiver, made of wood, and lined with lead; *i*, a double flange filled with water, the interior pipe communicating with the inſide of the receiver, and bent horizontally as at *k*, from whence the gas iſſues into the receiver; *l*, *l*, two ſhort pipes inſerted in the top of the receiver, through which the rods of the agitators have a free motion; *m*, *m*, a ſtopper in the top of the receiver, cloſed when the receiver is at work, but ſufficiently large, if removed, to admit a perſon into the inſide to repair or cleanſe it, when neceſſary; *n*, *n*, two paddles, or agitators, generally of a ſquare form, and of a ſimilar conſtruction to the head of a churn ſtaff; *o*, *o*, the rods of the agitators attached by iron pins to the lever, *q*, which lever has ſlits at the place of junction, to allow the rods to riſe and fall perpendicularly; *p*, the fulcrum or ſupport of the lever; *q*, the lever, which, by a proper motion communicated to it, alternately raiſes and depreſſes the agitators in the receiver; *r*, a rod connecting the lever *q*, with the lever *s*, which laſt lever is put in motion by the wheel E; *t*, a balance weight placed at the other end of the lever; the beam ſupporting the fulcrum of the lever being near the letter *s*. E, the wheel to be put in motion by water, or in any other way, having a crank, *u*, communicating by an upright ſhaft with the lever *s*.

It will be found that the flanges, filled with water, preclude the neceſſity of the application of any lute, and occaſion the operation to be conducted in a cleaner, cheaper, and more expeditious mode, than formerly employed.

To deſcribe the proportions of the ſeveral articles uſed in the proceſs of bleaching, would carry us far beyond the bounds which can be allotted in the preſent publication; we ſhall, therefore, give the following ſhort but clear account of the mode we recommend to be practiſed, to procure the moſt perfect and durable white on cotton goods, after their being taken from the weaver; which is, firſt, to wet them thoroughly in cold water; then to allow them to ſteep in cold, or lukewarm water, from 12 to 36 hours, according as they are of a ſtrong or thin fabric; then to waſh them well in clean cold water; afterwards to buck or boil them in a cauſtic alkaline ley; then to waſh the goods well in clean water, and afterwards immerſe them in diluted oxymuriate of lime, and waſh them, repeating the operations of the alkaline leys, and the oxymuriate of lime, till the goods are perfectly white; then to paſs the goods through the diluted ſulphuric acid liquor, waſhing them well afterwards; laſtly, to paſs them through a weak ley of pearl-aſhes, or of ſoap, and again through clean water, before drying and finiſhing them; which finiſhing of the goods conſiſts in ſtarching, blueing, rolling, or callendering them as faſhion directs, or the particular market for which they are intended, may require.

It is to be remarked, that the immerſion of the goods in the vitriolic ſours, and alſo in pearl-aſh, or ſoap liquor, is neceſſary at the end of the proceſs, to prevent a brown hue which the cloths that are bleached white from the oxygenated muriatic acid, without ſuch precaution, are apt to revert to.

By experiments made at Rouen on cotton thread, with a view to aſcertain whether the old or new mode of bleaching was more prejudicial to the fabric, it was proved that the cotton thread bleached in the new mode bore, without breaking, conſiderably more weight than that bleached in the old method, and was leſs injured in texture.

In the report on experiments, made by order of the truſtees of the linen and hempen manufactures at Dublin, in the year 1791, with a view to aſcertain the comparative merits of ſeveral ſpecimens of bleaching liquids ſent for their examination, the following mode of bleaching appeared to be the beſt for linens, and though executed on a ſmall ſcale, will convey the principal neceſſary information.

May 11th, 1791. The linen was ſteeped, in the ſtate received from the loom, into water of a heat ſufficient to bear the hand, and left in the veſſel.

May 16th. The linen was waſhed out of the liquor, in which a pretty ſtrong fermentation was obſerved to have taken place.

May 17th. Finiſhed making a mother-ley, which was made in the following manner: three pounds and a half of lime were ſlaked, and mixed with ten gallons of water; fourteen pounds of Dantzic pearl-aſh were diſſolved in ſome of this water; then mixed the whole; when it had ſettled, it

was filtered through a coarſe cloth, and the reſiduum waſhed repeatedly in four gallons of water, to obtain the whole ſtrength of the alkali; the whole fourteen gallons being then carefully mixed, the ley proved, by very accurate weighing, to contain twelve ounces of cauſtic alkaline ſalt to the gallon. From this, a ley was made from the work, by adding ſix parts of water to one of the mother-ley; thus each gallon of the working ley contained one ounce, five drachms, and forty-three grains of cauſtic alkali.

The boiler being charged with this ley, the linen, which had been ſpittle waſhed, was ſteeped in it cold for one hour; then brought up by a very gentle heat to a ſimmering boil, which was continued for three hours; the cloth was then well waſhed out, and left in ſteep for that night.

May 18th. Waſhed out the above linen in freſh water; hung it on cards in the open air, watering it ſeveral times in the day.

May 19th. Finding the cloth not ſo well cleared as could be wiſhed, the boiler was again charged with one of mother-ley, to four of water, which made the ſtrength two ounces, three drachms, twelve grains of cauſtic alkali to the gallon. In this was boiled another piece of linen which had been ſpittle waſhed as the others; and after it was boiled, it was well waſhed out.

May 20th. Steeped the whole of the linens for ſix hours in the liquid prepared with the oxymuriatic acid of the ſeveral claimants; afterwards waſhed them well out, and left them ſteeping in cold water all night.

May 21ſt. Waſhed out all the above linens, and when dry, boiled the whole parcel as before in one of the mother-leys, to five of water, containing two ounces of cauſtic alkaline ſalt to the gallon; waſhed them well out of the ley, and left them to ſteep in pure water till Monday morning, the 23d inſtant.

May 24th. Steeped the linens for the ſecond time in the oxygenated muriatic acid for ſix hours; then waſhed them out, and left them to ſteep all night in cold water.

May 25th. Having charged the copper with a ley made from one of mother-ley, to ſix of water, containing one ounce, five drachms, and forty-three grains of cauſtic alkaline ſalt to the gallon, the linens were boiled in this for the third time, with a very gentle ſimmering heat for three hours; they were then waſhed out, and left to ſteep.

May 27th. Steeped all the linens for the third time ſix hours in oxygenated muriatic acid as before; waſhed them out, and left them in water all night.

May 28th. Immerſed all the linens which had been ſteeped yeſterday in the oxygenated muriatic acid, in a weak vitriolic acid for four hours; then waſhed them out, and left them ſteeping in cold water.

May 29th. Waſhed and dried the linen cloth which had been ſoured yeſterday.

June 1ſt. Boiled all the linen which had been ſoured in a ſtrong lather of ſoap.

June 2d. Soured and waſhed out all the linen which had been boiled in a ſoap lather yeſterday. This operation finiſhed that experiment, in which the above linens were firſt ſteeped in water; then boiled in cauſtic alkaline ley, and ſteeped in oxygenated muriatic acid alternately four times; then ſoured in vitriolic acid, ſoaped and ſoured again.

The above experiments were made, with various others, by Mr. John Arbuthnot, and Mr. John Clarke; and on the trials of the different ſpecimens of the oxygenated muriatic acid, the preference was given to that prepared by Mr. Robert Roe, of Bing's End, on the principle of the javelle liquor mentioned by Mr. Bartholles, by adding a ſolution of alkali in water in the receiver. Mr. Roe's beſt preparation, of which was made by adding thirty-eight pounds of quicklime to 114lb. of pearl-aſh, which made a cauſtic ley of about nine pounds weight per gallon; he found cauſtic ley more ſuſceptible of imbibing the gas and retaining it, than mild ley of equal ſtrength.

From the different experiments made to bleach various articles at the above time, the following inferences may be deduced, viz. that allowing cotton or linen, when raw from the loom, to ferment, by ſteeping in warm water a conſiderable time before boiling the cloth in an alkaline ley, is of conſiderable ſervice.

That cloth or yarn is not injured by ſteeping for ſix hours together in oxygenated muriatic acid.

That ſtrong alkaline leys anſwer better than weak ones, at the commencement of uſing the leys.

That the white colour of bleached cloth can be better judged of wet than when dry.

That very minute attention in excluding light and air is not abſolutely neceſſary in bleaching with oxygenated muriatic acid.

That purging or clearing yarn or cloth in an alkaline ley, previous to ſteeping in oxygenated muriatic acid, is abſolutely neceſſary.

That the bleaching liquids made from oxygenated muriatic acid, in which alkaline ſalt is blended in the compoſition, require the cloth to be frequently ſteeped in vitriolic acid; and that the oxygenated muriatic acid made with water only, make more frequent boilings of the cloth in alkaline leys neceſſary.

That the loſs of the cloth in weight, when bleached by the new method, is only one fourth, but by the old method one third.

That ſteeping in warm water is infinitely better to extract the ſowen and dirt from the raw cloths, than boiling them with ſoap or ley immediately as they come from the loom.

The liquors of the oxygenated muriatic acid, and alſo thoſe made from the vitriolic acid, may be repeatedly uſed without detriment, till the whole ſtrength is exhauſted.

The cloth or linen, in the acid bleaching liquors, ſhould be moved in the liquor every hour, that every part may be equally cleared.

It is difficult to aſcertain the ſtrength of the leys proper for uſe in bleaching cotton or linen, as the alkalies or aſhes differ ſo greatly in purity, and the admixture generally found in them of neutral ſalts prevents the hydrometer from being a regular teſt. The common allowance for bleaching linens in Ireland, is ſtated by Mr. Higgins, in his ingenious memoir in the Tranſactions of the Dublin Society, to be for ſixty gallons of water, ſix pounds of barilla, or four pounds of pot-aſh at the leaſt, and moſt bleachers uſe more than this.

To diſcover adulterated pot-aſh, Mr. Higgins recommends the following method. The ſpecimen of aſhes being firſt weighed, is digeſted for a few minutes on a ſand-bath, in twice its weight of water, in a heat of about 212 degrees, and inſtantly ſtirred. It is then removed from the ſand-bath, and before it is cooled to the temperature of the atmoſphere, it muſt be filtered through paper. When all the liquor has paſſed through the filter, a ſmall quantity of cold water is gradually poured upon the ſaline reſiduum or the filter, in order to waſh through the whole of the alkali. The undiſſolved ſalt ſulphate of pot-aſh (vitriolated tartar,) remaining on the filter, is afterwards dried and weighed, to aſcertain the quantity.

To determine whether any common ſalt is ſuſpended in the liquor which has been filtered, evaporate the clear ſolution a little on a ſand-bath, and ſet it in a cold place for 24 hours

hours; at the end of which time, any common ſalt it contains will be found cryſtallized in regular cubes at the bottom of the veſſel; pour off the clear liquor, and repeat the proceſs, till no more cubic cryſtals are produced. If it is deſired to be very accurate in the analyſis, before the common ſalt (muriate of ſoda) thus procured is weighed, ſome muriatic acid may be poured upon it, in order to take up any of the pure pot-aſh which may have adhered during its cryſtallization. The muriatic acid, with ſuch of the alkali as it has diſſolved, may be then drained off and thrown away, and the muriate of ſoda dried and weighed.

The ſum of the impurities being then ſubtracted from the weight of the ſpecimen, the quantity of the pure pot-aſh is aſcertained.

To ſhewn what quantity of mere alkali is contained in 100lb. avoirdupois of ſeveral different alkaline ſalts examined by Mr. Kirwan, we ſhall add the following table, publiſhed by him in the Iriſh Tranſactions, in 1789.

One hundred Pounds.		Mineral Alkali.
Cryſtallized ſoda -	yielded -	20lbs.
Sweet Barilla - -	-	24
Mealy's cunnamara kelp -	-	3.437
Do. deſulphurated by fixed air	- -	4.457
Strangford kelp - -	- -	1.25
One hundred Pounds.		**Vegetable Alkali.**
Dantzic pearl-aſh -	yielded -	63.33lbs.
Clarke's refined aſh -	-	26.875
Caſhup - -	-	19.376
Common raw Iriſh weed-aſh -	-	1.666
Do. ſlightly calcined -	-	4.666

It is much to be regretted that, conſidering the immenſe quantities of pure marine alkali which could be procured at a cheap rate from the Eaſt Indies, ſo little attention ſhould be paid by the Eaſt India company to an article which would be ſo profitable a branch of commerce to them, and prevent a conſiderable ſum being paid to other nations. The mineral alkali procured from the Eaſt Indies, is much purer than what is obtained from Barilla; and a preparation exactly ſimilar in appearance and quality to the Alicant Barilla, may be made with great advantage to the manufacturer, from a mixture of the Eaſt India mineral alkali with the common Scotch kelp, for the purpoſes of the bleacher, the ſoap-maker, or the Turkey red dyer. To ſhew the importance of this object, the following table of the imports into Great Britain are annexed for ſeven years.

	Barilla.	Pot-Aſhes.	Pearl-Aſhes.
1796	86.723 cwt.	62.829 cwt.	45.290 cwt.
1797	51 105	57.826	36.674
1798	123.990	81.482	60.691
1799	146.163	77.246	51.792
1800	175.629	135.470	45.161
1801	63.210	90.523	54.835
1802	151.796	48.054	64.288

When it is conſidered that 20 pounds of the mineral alkali brought from India in a powdery ſtate, as it uſually is, will, by mere ſolution in water, yield 100lbs. of the cryſtallized ſoda ſold in the ſhops, it will be ſeen, that the purchaſe of the mineral alkali from the Eaſt India company, will be an object well deſerving the attention of the bleachers and ſoap-boilers; and far preferable to the uſe of Spaniſh kelp or Barilla.

Mr. Kirwan, by means of muriatic acid, precipitated the colouring matter from an alkaline ley, ſaturated with the colouring matter of linen yarn, and found it to poſſeſs the following properties. When ſuffered to dry for ſome time on a filter, it aſſumed a dark green colour, and felt ſomewhat clammy, like moiſt clay. His obſervations in the Iriſh Tranſactions for 1789, are as follow:

"I took, ſays he, a ſmall portion of it, and added to it 60 times its weight of boiling water, but not a particle of it was diſſolved. The remainder I dried in a ſand-heat; it then aſſumed a ſhining black colour; became more brittle, but internally remained of a greeniſh yellow, and weighed one ounce and a half."

"By treating eight quarts more of the ſaturated ley in the ſame manner, I obtained a further quantity of the greeniſh depoſit, on which I made the following experiments:

1ſt. Having digeſted a portion of it in rectified ſpirits of wine, it communicated to it a reddiſh hue, and was, in a great meaſure, diſſolved, but by the effuſion of diſtilled water, the ſolution became milky, and a white depoſit was gradually formed; the black matter diſſolved in the ſame manner.

2d. Neither the green nor the black matter was ſoluble in oil of turpentine or linſeed oil, by a long continued digeſtion.

3d. The black matter being placed on a red-hot iron, burned with a yellow flame and black ſmoke, leaving a coaly reſiduum.

4th. The green matter being put into the vitriolic, marine and nitrous acids, communicated a browniſh tinge to the two former, and a greeniſh to the latter, but did not ſeem at all diminiſhed.

"Hence, it appears, that the matter extracted by alkalies from linen yarn, is a peculiar ſort of reſin, different from pure reſins only by its inſolubility in eſſential oils, and in this reſpect reſembling lacs. I now proceeded to examine the powers of the different alkalies on this ſubſtance, eight grains of it being digeſted in a ſolution of cryſtalized mineral alkali, ſaturated in the temperature of 62°, inſtantly communicated to the ſolution a dark brown colour; two meaſures (each of which would contain eleven pennyweights of water), did not entirely diſſolve this ſubſtance. Two meaſures of the mild vegetable alkali diſſolved the whole."

"One meaſure of cauſtic mineral alkali, whoſe ſpecific gravity was 1.053, diſſolved nearly the whole, leaving only a white reſiduum."

"One meaſure of cauſtic vegetable alkali, whoſe ſpecific gravity was 1.039, diſſolved the whole."

"One meaſure of liver of ſulphur, whoſe ſpecific gravity was 1.170, diſſolved the whole."

"One meaſure of cauſtic volatile alkali diſſolved alſo a portion of this matter."

The colouring matter of cotton is much more ſoluble in alkali, than that of linen: hence the greater facility with which cotton is bleached.

The theory of bleaching vegetable matter, as we have before obſerved to have been deſcribed by Mr. Delaval, depends on removing the colouring matters, whether natural or accidental, which cover their ſolid fibrous parts, which are the only parts endued with a reflective power.

Raw cotton or linen, boiled in a diluted ſolution of cauſtic alkali, gives to the liquor a deep brown colour, and deſtroys its cauſticity; and freſh portions of clear ley applied a ſecond or third time, will produce a ſimilar effect, but in an inferior degree. If the cotton or linen be now plunged into the oxymuriatic acid, and allowed to remain a ſhort time, they will become white; and if they are then plunged into an alkaline ley, the liquor will again become brown, and loſe its cauſticity.

On ſaturating either the firſt or laſt of the alkaline ſolutions with an acid, a ſimilar precipitate is obtained from each, of a dark coloured matter, almoſt inſoluble in water, but ſoluble in cauſtic alkali.

Hence

Hence it appears, that after raw cotton or linen has been acted upon by alkalies for two or three times, they have no further effect upon it, till the cloth comes in contact with oxygen or pure air, either by immerſion in the oxygenated muriatic acid, or by expoſure to the atmoſphere; and it is on account of the ſpeedy action of the acid, in compariſon with that of the atmoſphere, that the new mode of bleaching is now generally adopted.

M. Berthollet, and the modern chemiſts ſuppoſe, that the colouring matter of linen is compoſed principally of carbon and hydrogen; and they conclude, that linen, bleached by the oxymuriatic acid, becomes yellow on this principle, that when the oxymuriatic acid renders linen white, a quantity of oxygen has combined with the colouring particles; but that this oxygen gradually enters into a combination with the hydrogen, and forms water which paſſes off; that then the carbon becomes predominant, and the linen, in conſequence, aſſumes a yellow colour.

The old chemiſts, on the principles of Stahl, would ſay, that a part of the dephlogiſticated marine acid, (oxymuriatic acid,) after the cloth had been acted upon by the alkali, abſorbed ſuch phlogiſtic colouring matter from the cloth, as the alkali had no affinity for; and thus became diluted common marine acid, which has a great attraction to cotton or linen, and, if expoſed to a moderate heat, will act upon the texture of the cloth, and render it of a yellow colour.

We notice this circumſtance in two different points of view, that the bleacher may be aware of the neceſſity of applying, in either caſe, a weak ley of pearl-aſh, ultimately after the uſe of the muriatic acid, to prevent this yellowneſs from occurring; and alſo that the reader may comprehend the reaſoning of Home, and other perſons who have written upon the ſubject of bleaching, previously to Mr. Scheele's diſcovery.

To recover the pure alkali from the black coloured leys, which have been uſed in bleaching, and to render them equally proper for the ſame purpoſe, has been for a conſiderable time a material object in the neighbourhood of Manchester, and practiſed with great ſucceſs.

To effect this, the black or brown ſtrong leys, which have been left after bucking linen, or cotton yarn, or goods, or ſaved after wringing them, is put into an oblong flat ſhallow iron pan, made of plate iron, rivetted together. (See *Plate* IV. *fig.* 4, 5.) Under this pan a fire is made, and the old leys gradually evaporated, till they become of a conſiſtence nearly reſembling tar; the matter is then put into caſks, and carried to the reverberatory furnace, *Plate* IV. *fig.* 6,7. where it is laded or poured into the cavity or bed within the furnace; the fire being then made, acts powerfully on the alkaline maſs; gradually dries the water left amongſt it; then acts on the colouring matter the ley has abſtracted from the cloth, which is partly diſſipated in a black, offenſive ſmoke, and partly deſtroyed by combuſtion; the calcination of the aſhes is aſſiſted from time to time, by raking them up with a long iron rod, in order to expoſe freſh ſurfaces to the flame; the heat is continued and increaſed till the inflammable matter amongſt the alkali is diſſipated, and the aſhes brought to a perfect fluid ſtate; they are then let out by an aperture in the ſide of the furnace, into an old iron pot put into the ground, and when cold, broken into ſmall pieces for uſe, being frequently in a purer ſtate than when firſt imported.

Fig. 4. *Plate* IV. is a ſection of the evaporating pan for the waſte leys, where A repreſents a flat iron pan, of an oblong ſquare form, about ſix inches deep, and of a ſize proportionate to the quantity of leys to be evaporated; B, the fire-place; C, the aſh-hole: D, the flue in which the fire acts under the pan; E. the chimney for the ſmoke; F, the brick work.

Fig. 5. *Plate* IV. is a bird's eye view of the ſame evaporating pan, which is made of plates of beaten iron rivetted together, as ſhewn in the plan; the fire-place underneath it is marked by dotted lines at B, and the chimney flue at E.

Fig. 6. *Plate* IV. repreſents a longitudinal ſection of the reverberatory furnace uſed in the preparation of aſhes, or ſolid alkaline ſalts from the old leys after evaporation, to a proper conſiſtence; *a* the brick work; *b*, the aſh-hole; *c*, a channel, or paſſage under the furnace, to admit a free current of air; *d*, the fire-grate; *e*, the fire-place; *f*, the inner part of the furnace; *g*, the bed of fire proof brick, on which the matter is calcined; *h*, the alkaline ley to be calcined; *i*, a door through which the ley is introduced by an iron ladle into the furnace, and through which door the matter, during calcination, is ſtirred from time to time; *k*, the paſſage for the ſmoke, or chimney, which chimney ſhould be from 20 to 30 feet high; *l*, the upper part of the furnace, arched like an oven; *p*, the ſeparation wall between the fire and matter to be fluxed or calcined.

Fig. 7. *Plate* IV. repreſents the upper plan of the furnace, of which *fig.* 6. is a ſection; *a*, the outer walls; *b*, the aſh-hole and draught-hole; *e*, the iron grate of the fire-place; *g*, the baſon in which the leys are calcined; *m*, the door through which foſſil coal is thrown into the fire-place; *n*, an iron tube through which the aſhes in fuſion flow out of the furnace when ſufficiently calcined; *o*, an iron pot into which the melted aſhes flow, and where they are ſuffered to cool; *p*, a wall of fire-brick between the fire-place and baſon, over which wall the fire paſſes; *r*, the ſteps leading down to the aſh-hole.

It is neceſſary to remark, that all the interior part of the reverberatory furnace ſhould be made of Welſh brick, or ſuch as will withſtand the action of a ſtrong fire; the whole building ſhould be well bound together by iron bars, or cramps. If ſo conſtructed, it will laſt for ſeveral years; and when it then wants repair, the aſhes, which will be found accumulated in the interſtices of the brick-work, will defray the expence of ſuch repairs.

Having ſhewn the methods generally uſed in bleaching linen and cotton, we ſhall notice a proceſs lately diſcovered by Mr. W. Higgins of Dublin, for uſing the ſulphuret of lime, as a ſubſtitute for pot-aſh in bleaching. The ſulphuret is prepared in the manner following, viz. ſulphur or brimſtone in fine powder, four pounds; lime well ſlaked and ſifted, twenty pounds; water ſixteen gallons; theſe are all to be well mixed, and boiled for about half an hour in an iron veſſel, ſtirring them briſkly from time to time. Soon after the agitation of boiling is over, the ſolution of ſulphuret of lime clears, and may be drawn off free from the precipitate, which is conſiderable, and which reſts upon the bottom of the boiler. The liquor, in this ſtate, is nearly of the colour of ſmall beer, but not quite ſo tranſparent.

Sixteen gallons of water are afterwards to be poured upon the remaining precipitate in the boiler, in order to ſeparate the whole of the ſulphuret from it; the matter is then well agitated, and muſt, when ſettled, be drawn off, and mixed with the firſt liquor; to theſe again thirty-three gallons more of water may be added, which reduce the liquor to a proper ſtandard for ſteeping the cloth.

Though either lime or ſulphur, ſeparately, is very little ſoluble in water, yet this ſulphuret of lime is highly ſoluble.

This preparation has been applied, in the following manner, to the bleaching of linen in Ireland.

The linen, as it comes from the loom, is charged with the weaver's paſte or dreſſing, to diſcharge which, the linen muſt be ſteeped in water for about 48 hours, and afterwards taken out and well waſhed; in order to ſeparate the reſinous matter inherent in the vegetable fibre, the linen muſt then be ſteeped in the cold ſolution of ſulphuret of lime (prepared as above), for about 12 or 18 hours; then taken out and well waſhed; when dry, it is to be ſteeped in the oxymuriate of lime, prepared by Mr. Tennant's proceſs, for 12 or 14 hours, and then waſhed and dried. This proceſs is to be repeated by ſix alternate immerſions in each liquor, which are ſufficient to whiten the linen.

Though we muſt confeſs, that we have ſome doubts reſpecting the application of ſulphuret of lime to ſuperſede the uſe of aſhes, in bleaching goods intended to remain perfectly white, yet we think it incumbent upon us to ſtate, that for goods previouſly bleached for dyeing, it poſſeſſes advantages over thoſe where alkalies have been uſed, and which has been actually proved above 30 years ago, by the practice of Mr. Peter Henry Otterſen, communicated by him to the late Mr. John Wilſon, of Ainſworth, near Manchester. Mr. Wilſon's memory deſerves every mark of reſpect from the cotton manufacturers of England, for his numerous improvements in the bleaching, dyeing, and finiſhing of cotton goods.

For the uſe of private families, where the linen is dirtied by perſpiration or greaſe, it will be of great ſervice towards rendering it white, to ſteep it for ſome time in a clear liquor, made by mixing one quart of quicklime in ten gallons of water, letting the mixture ſtand 24 hours, and then uſing the clear water drawn from the lime. After the linen has been ſteeped in this liquor, it ſhould be waſhed as uſual, but will require much leſs ſoap to be uſed.

Cotton goods, after bleaching, were formerly dried in the open air, on frames or tenter-rails, or on rails in covered buildings, or in large rooms or ſtoves heated for the purpoſe, all which modes were attended with great delay and diſadvantages.

Theſe difficulties were removed in 1797 by an apparatus, ſimple in its conſtruction, eaſily managed, and of ſingular uſe in facilitating the proceſs of the bleacher. For this uſeful invention the public are indebted to John Burns, eſq. of Paiſley.

By this diſcovery the bleacher can erect a drying machine, equally uſeful at all ſeaſons, and in all weathers, at leſs than one-tenth of the expence of former conſtructions, for doing buſineſs to the ſame extent. There is no riſk of damage from wind or rain, leſs chance of injury from ſervants, owing to the ſimple manner in which the goods are prepared. They receive a fine gloſs during the proceſs of drying, the colour is as well preſerved as if dried in the open air, and they cannot be injured by the heat.

A contrivance ſo obviouſly beneficial and complete, was ſoon introduced into general practice in the weſt of Scotland; and ſo undoubted were the claims of the above gentleman to the originality of invention, that the bleachers in the neighbourhood preſented him with a handſome donation of ſilver plate, ſuitably inſcribed, in teſtimony of their ſenſe of his merit, and as ſome reward for communicating his plan to the public.

We are more particular in noticing this circumſtance, as ſome other perſons have ſubſequently taken out a patent for the ſame principle, with a little variation in the conſtruction of the machine, but which alteration has not been found to anſwer the purpoſe as expected. We ſhall therefore now more particularly deſcribe Mr. Burns's apparatus for drying.

Fig. 1. *Plate* III. A is the boiler or ſteam veſſel; B, the ſafety valve; C, the hollow leaden pipe which conveys the ſteam from the boiler to the rollers; D, a braſs cock hollowed to receive the pivot of the roller, repreſented in *fig.* 2, one of which cocks is fixed to the pipe under each roller, and by opening which the ſteam is admitted into the roller; E repreſents twelve rollers placed upon the cocks, one of which, next to D, has the cloth upon it in the operation of drying; FFF, the wood frame in which the machinery is placed; GGG, the ſupporters of the leaden ſteam pipe, and of the trough HH, which trough is 15 inches broad at top, to receive the water formed by the condenſed ſteam as it drops from the bottom of the rollers, E, and to conduct it to I, a ſmall pipe extending from the trough, H, to the funnel, K, which funnel has its lower pipe reaching to within eight inches of the bottom of the boiler, to prevent the ſteam from iſſuing out at its mouth, and which funnel keeps the boiler ſupplied with water to its proper height, or ſhews when any is wanted, as the ſteam would ariſe through it if water ſhould be wanting in the boiler.

Fig. 2. *Plate* III. ſhews one of the rollers ſeparate from the frame. It is uſually five feet long, one foot in diameter, and made of double tinned ſheet iron, and hollow in the middle, for containing the ſteam; *a* is the lower pivot of the roller, which is an open tube at the end for receiving the ſteam conveyed through it from the cock. This pivot riſes a foot within the roller, at the under part of the roller; at *d* is a ſmall hole for allowing the condenſed ſteam to drop into the trough placed below it as above-mentioned; *b*, the other pivot or axis of the roller, which is faſtened to the top bar of the frame by a latch, as repreſented in *fig.* 1.; *c*. a row of teeth fixed into a ſmall ſlip of tinned ſheet iron, ſoldered to the roller, and thereby elevated to prevent the teeth from tearing the cloth.

Fig. 3. *Plate* III. a machine about three feet in height, for the purpoſe of lapping the cloth upon the rollers. A, the box in which the cloth is firſt laid; B, the fartheſt wooden roller, over which the cloth paſſes from A, and from thence under the wooden roller C, to the tin roller D, on which it is lapped by turning it with the handle E; F, the cloth paſſing under the roller C, to the tin roller D, on which, when it is lapped, it is ready to be carried and placed in the drying machine; G, a weight hung from the projection in the frame at H, over the roller B, to keep the cloth ſufficiently tight as it paſſes from the box A, over that roller to be lapped on the drying roller D.

Fig. 4. *Plate* III. ſhews another method of lapping the cloth on the tin roller, previous to its being dried. A, a perpendicular frame, in the front of which is placed the tin roller B, with a handle for turning it at C; the cloth D extends from the roller B over the wooden roller E, in a frame F to G, where its other end is attached by a wire run acroſs it to ſome wrapper or linen cloth, faſtened to a board H, fixed below the roller B. LL are upright poſts fixed to the outer ſide of the bottom frame KK, having wooden pegs NN in them, on the ſide neareſt the tin roller B. Rails or rods are laid acroſs from theſe to ſimilar pegs oppoſite, to prevent the cloth touching the ground when it is adjuſting in the beginning of the operation, and the number of theſe poſts neceſſary, therefore, are in proportion to the length of the cloth.

At the commencement of lapping the cloth on the tin roller B, the frame F, moveable on ſmall rollers II, running in grooves on the frame KK, is drawn ſo far back, that when the cloth is faſtened to the wrapper G, one half of the piece reaches to the roller F, the other half paſſed over that roller reaches to the tin roller B, to which it is then to be faſtened. On turning the handle C, the cloth is gradually lapped round the

the roller B, the moveable frame F being drawn forward by the cloth; for as the cloth is lapped on the roller B, the frame F is drawn towards it betwixt the uprights L L, and by means of a projecting wood forming an inclined plane fixed at M, on each ſide, near the top of the frame F, the rails O are raiſed off the pegs N N, and carried forward on the part M of the frame F, without impeding its progreſs to the tin roller B, till the wrapper G, to which the cloth is faſtened, paſſes over the roller, and the wire at G, which attaches it to the cloth, is withdrawn, leaving the whole of the cloth to be dried on the tin roller B, which roller is then taken out and placed in the drying frame.

To aſcertain the ſtrength of the oxygenated muriatic acid uſed by the bleachers in France, Monſ. Deſeroizilles made uſe of a ſolution of indigo in the vitriolic acid, for which purpoſe he takes one part of finely pulverized Guatimala indigo, and eight parts of concentrated vitriolic acid, which mixture ſhould be put in a glaſs veſſel, and kept of a gentle heat by ſtanding near the fire or in warm water all night, and repeatedly ſtirred with a glaſs rod or tube. When the ſolution is complete, it is diluted with a thouſand parts of water. One meaſure of this ſolution is put into a graduated tube of glaſs, and oxygenated liquor is added, until the colour of the indigo is completely deſtroyed, and the ſtrength of the oxygenated liquor is aſcertained by its power in diſcharging the colour.

Mr. Roſe has recommended a method which is better adapted for general uſe; which is, "to have ſmall meaſures properly proportioned to each other, and when the liquid is ſtrong, to prevent waſte of the indigo liquor prepared as above, and a tedious repetition of meaſures, let a ſmall meaſure of the liquor to be tried be put into a meaſure containing 24 of the ſame meaſures of water (it then becomes diluted to a twenty-fifth part); to a meaſure of this diluted liquor add as many meaſures of the blue teſt as it will diſcharge, which multiplied by 25, gives its whole ſtrength. It will be proper to have a meaſure of five for the ſake of diſpatch, in adding the blue teſt liquor. It is neceſſary that the experimenter ſhould ſit low enough to view his meaſures horizontally, in order that they may not be overfilled, otherwiſe he may be deceived.

Great care ſhould be taken in the choice of the indigo and the vitriolic acid employed, for unleſs the indigo is of the Guatimala kind, or beſt Eaſt India, and the vitriolic acid highly concentrated and pure, the colour produced will be a greeniſh brown, inſtead of a bright blue.

Mr. Chaptal has employed the oxygenated muriatic acid to the purpoſe of bleaching paper, both by applying it to the rags before worked down, and to the pulp or paſte; he alſo reſtored the white to prints diſcoloured by time, by immerſing them in the oxygenated muriatic acid liquor, or expoſing them to the action of its vapour. And ſeveral patents have been granted in this kingdom for bleaching pulp or paper, amongſt which Meſſrs. Clement and George Taylor, of Maidſtone, in Kent, have obtained one for bleaching the pulp, by incloſing it with a liquor of oxygenated muriate of pot-aſh, in a veſſel reſembling a churn, eight feet diameter at the great end, three feet four inches diameter at the little end, and two feet ten inches in the clear. This veſſel revolves upon an axis at each end, and the pulp, by this motion, and projecting parts within the veſſel, is conſtantly expoſing freſh ſurfaces to the liquor, till the whole pulp is ſufficiently whitened.

Mr. Bigg, of Iping, in Suſſex, has ſince obtained a patent for bleaching paper, and reſtoring to whiteneſs damaged or mildewed paper, by expoſing in cloſe wooden veſſels paper, in quantities of ſix or eight ſheets together, on wooden frames placed at ſmall diſtances from each other, to the action of oxygenated muriatic gas, and after the paper is taken out, preſſed, and dried, previous to its being ſized, wetting it in a ſolution of alum water.

Another method he propoſes, is by wetting and ſoaking the paper in oxygenated muriatic acid liquor, till it is properly bleached; after which it ſhould be well preſſed and dried, and wet out in the alum water, as in the other proceſs.

A patent has likewiſe been granted to Mr. Elias Carpenter, of Bermondſey, London, for a method of bleaching paper in the water leaf or ſheet, and ſizing it without drying; he uſes for this purpoſe a ſtout deal box or caſe, which muſt be carefully cloſed, and capable of confining water or ſteam within this. The paper to be bleached is to be hung on ſtrips of glaſs, about 15 inches long, placed in grooves within the box, about four ſheets on each ſtrip; the paper is taken for this purpoſe when preſſed in the packs in its wet ſtate, and when the box is filled and cloſed, it is expoſed to the action of oxygenated muriatic gas for eight or ten hours, and when ſufficiently bleached, ſized with a preparation made from one hundred weight of pieces of ſkins boiled in water and ſtrained, then fourteen pounds of alum, ſeven pounds of white vitriol, and one pound of gum arabic added; theſe ingredients will make ſize enough for about 50 reams of foolſcap paper; the paper when ſized and preſſed, is finiſhed in the uſual way. To prevent the noxious qualities of the gas to the workmen, he directs a ſolution of pot-aſh in water to be placed at the bottom of the bleaching box, to abſorb the elaſtic vapours which would otherwiſe affect them on opening the box.

Mr. Tennant of Glaſgow, ſubſequent to the patent granted him for his bleaching liquid, has obtained a patent for preparing the oxygenated muriate of lime in a dry form, by which means bleachers may be cheaply and conveniently ſupplied with it by him, and ſave much of the trouble, expence, and hazard which attend the preparation of the former bleaching liquor.

To bleach ſilk from its natural gummy ſtate, whether in ſkain or manufactured, it ſhould be put into a thin linen bag, and thrown into a veſſel of boiling water in which good white ſoap has been diſſolved; the ſilk ſhould boil two or three hours in this liquor, and the bag of ſilk frequently preſſed with a ſtick, and turned, ſo that the gummy matter may ſeparate from it, and riſe to the ſurface of the liquor, from whence it ſhould be ſkimmed off, and thrown away; the bag ſhould then be taken out, and if it contains ſilk goods, they ſhould be well waſhed in clean cold water, to prepare them for printing or dyeing; but if the bag contains ſilk in the ſkain, after it has been well waſhed in clean water, beaten, and ſlightly wrung, it may be put the ſecond time into the copper veſſel, filled with cold water mixed with ſoap, and a little indigo blue, if you wiſh it tinged a little of the blueiſh hue.

The ſilk, when taken out of the ſecond water, ſhould be wrung hard with a wooden peg, to preſs out all the liquor; then ſhaked, to ſeparate the threads; then ſuſpended on poles, in a cloſe room or ſtove where ſulphur is burnt, which improves the whiteneſs of the ſilk.

Woollen cloths or ſtuffs may be bleached and made white by ſoap and water; by the vapour of ſulphur; or by chalk, indigo, and ſulphuric vapour. In the firſt caſe, after the ſtuffs have been cleaned at the fulling mill, they are again worked in warmiſh ſoap and water, to render them whiter, and afterwards waſhed in clear water and dried; in this ſtate they are fit for dyeing any light colours.

To deſtroy or remove the reddiſh hue ariſing from boiling printed cottons in madder decoctions, which prevents the

printed colours appearing to advantage, the goods are uſually boiled for ſome time in bran and water, and then expoſed to the air, by laying them on the graſs, and throwing upon them clear water from time to time. Mr. Grimſhaw, in the year 1796, obtained a patent for clearing printed goods coming from the madder copper, by uſing the grains after brewing malt liquors, inſtead of bran; the plan he recommends is, that the grains ſhould be previouſly four, and that three or four buſhels thereof, more or leſs, according to the colour of the cloth, ſhould be put into a copper of hot water, containing 200 gallons or upwards, and four or five pieces of the printed cotton goods then immerſed therein, and worked over a winch backwards and forwards, for ten or fifteen minutes; the pieces are then taken out of the copper, and well waſhed in clear water, and laid ſtraight upon the ground for two or three days, till the parts which ſhould be white become clear. The ſame liquor, with the addition of a few grains, will ſerve to clear other printed goods, till the whole number wanted to be cleared have been completed; a ſufficient quantity of clear water being added to repleniſh what has been abſorbed by the goods, or evaporated in boiling. After either of the operations above-mentioned, the immerſion of the printed goods in dilute oxygenated acid, will anſwer the purpoſe of the expoſure to the air.

BLEACHING.

BUCKING

Fig. 1.

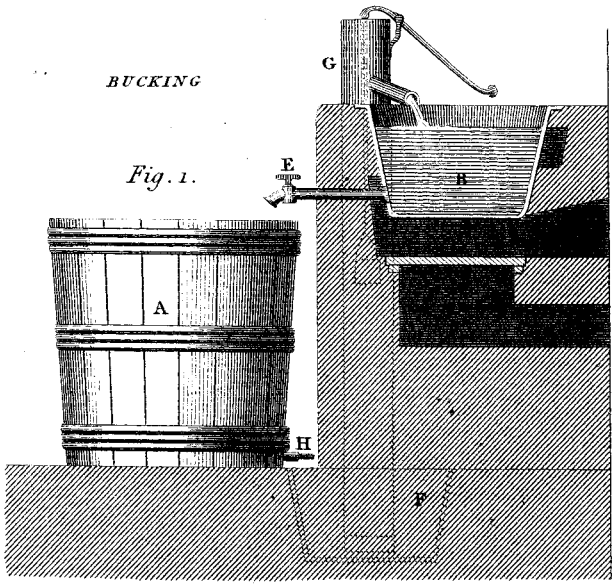
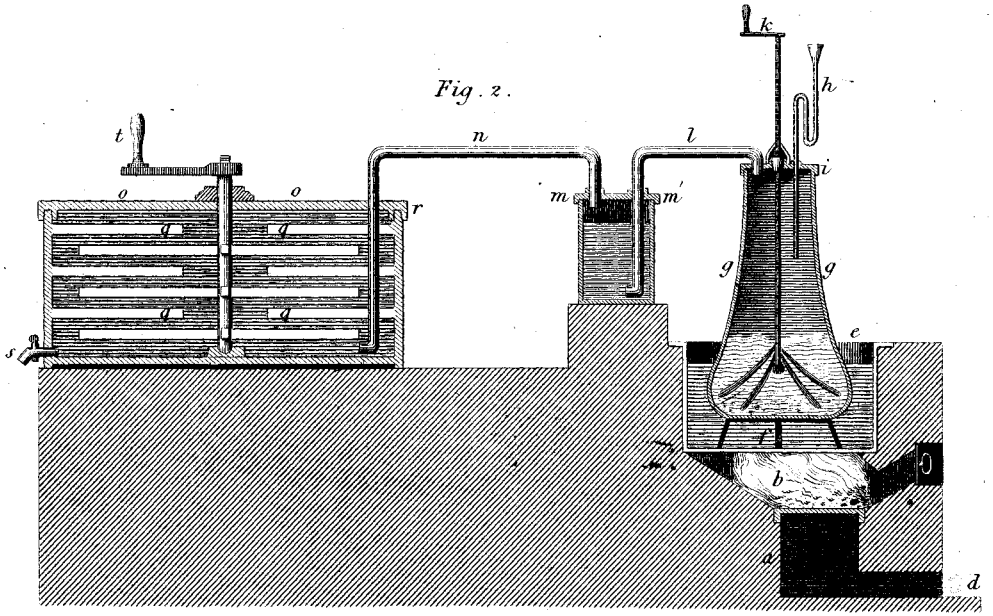


Fig. 2.



OXI-MURIATIC ACID

Fig. 3.

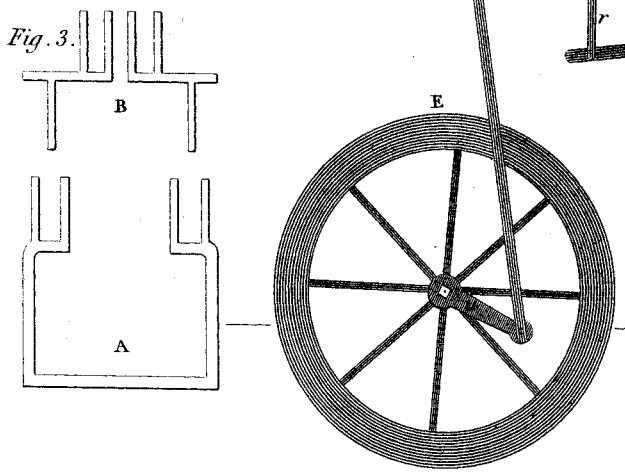
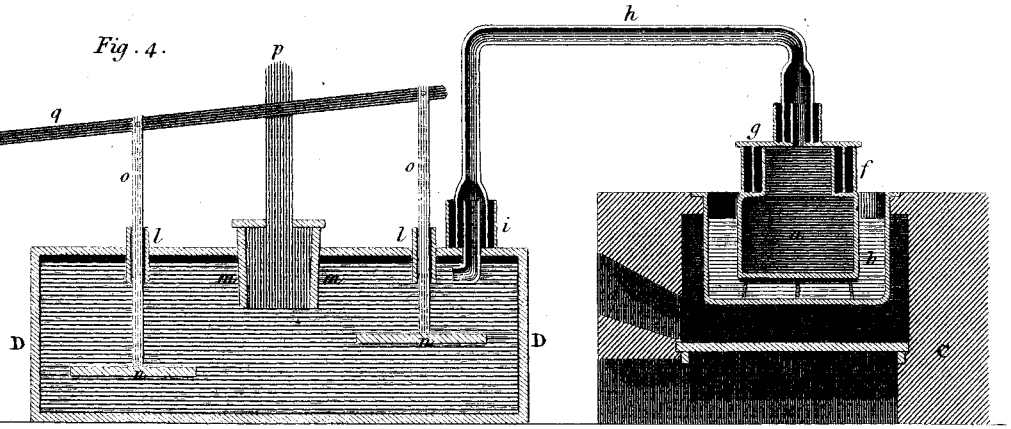


Fig. 4.



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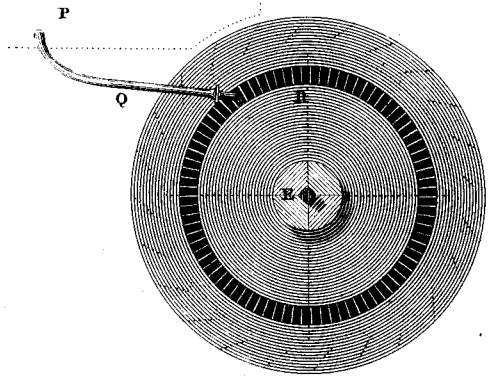
BLEACHING.

WASHING & CLEARING.

Fig. 2.



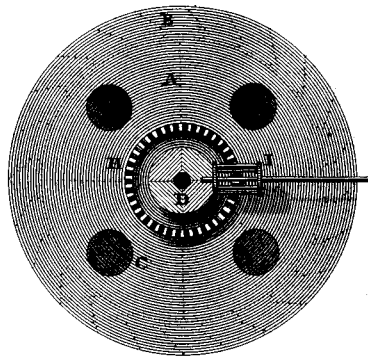


Fig. 1.

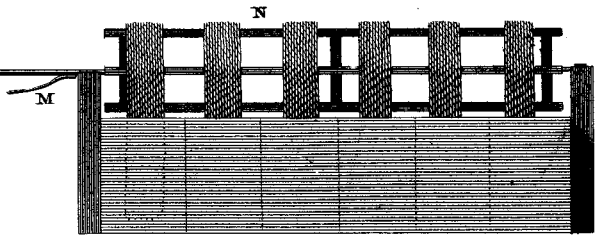


Fig. 3.

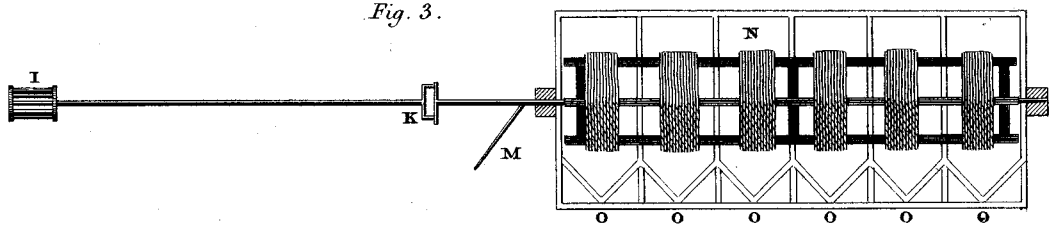


Fig. 4.

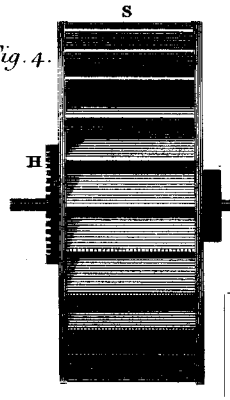
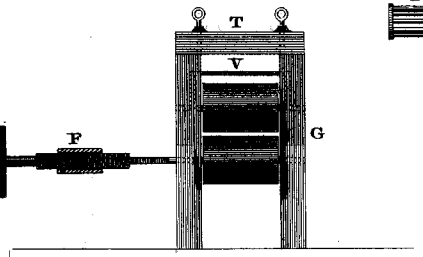


Fig. 5.



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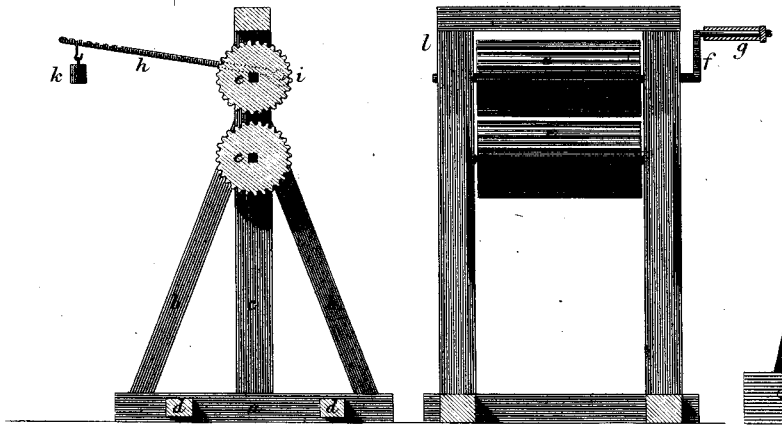
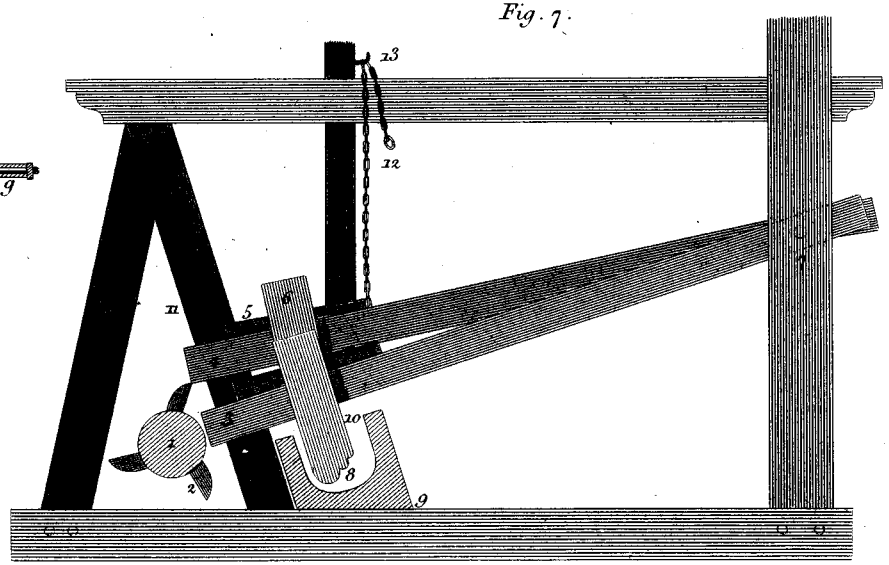


Fig. 7.



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BLEACHING.

DRYING.

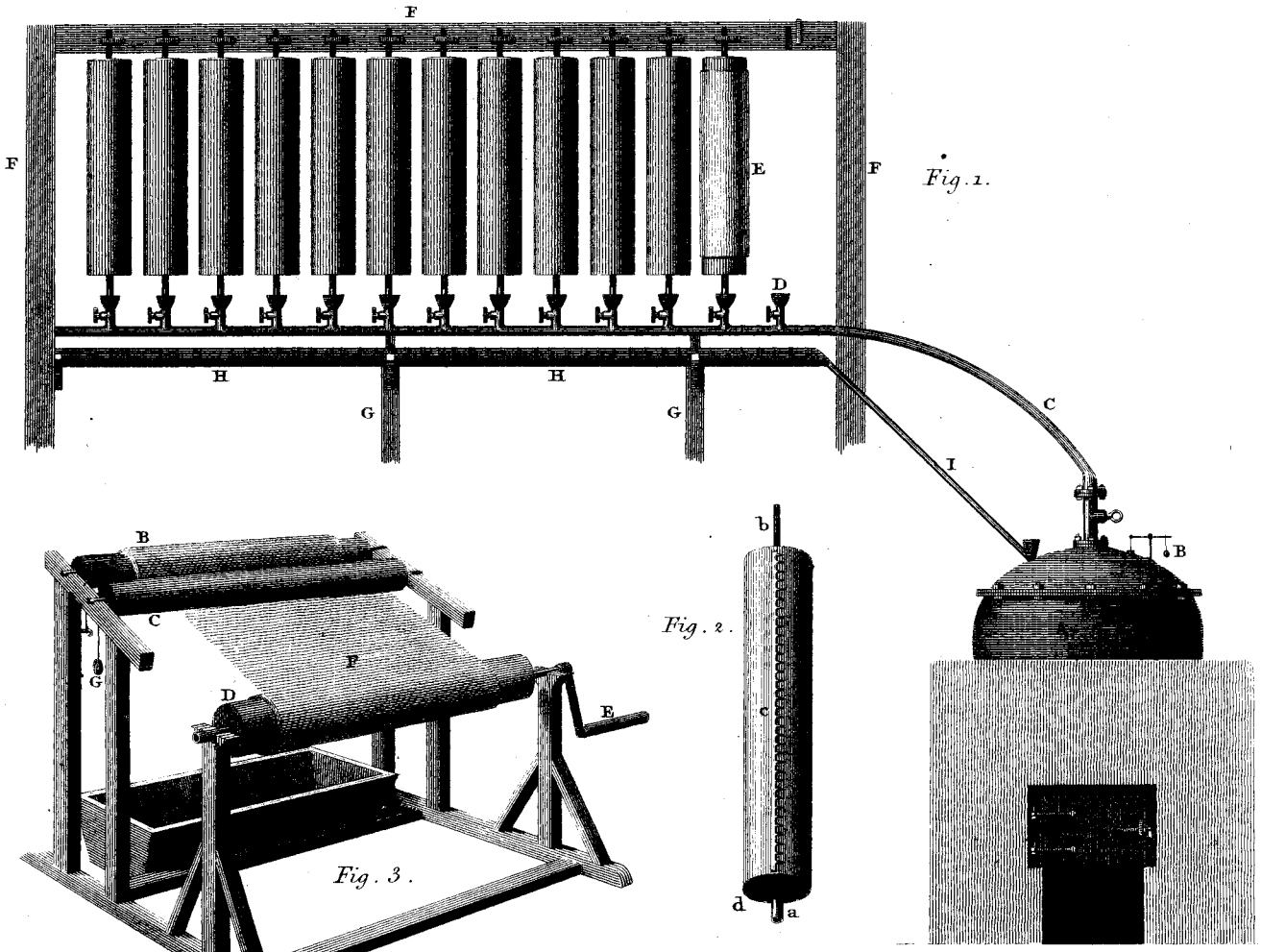

Fig. 1.

Fig. 2.

Fig. 3.

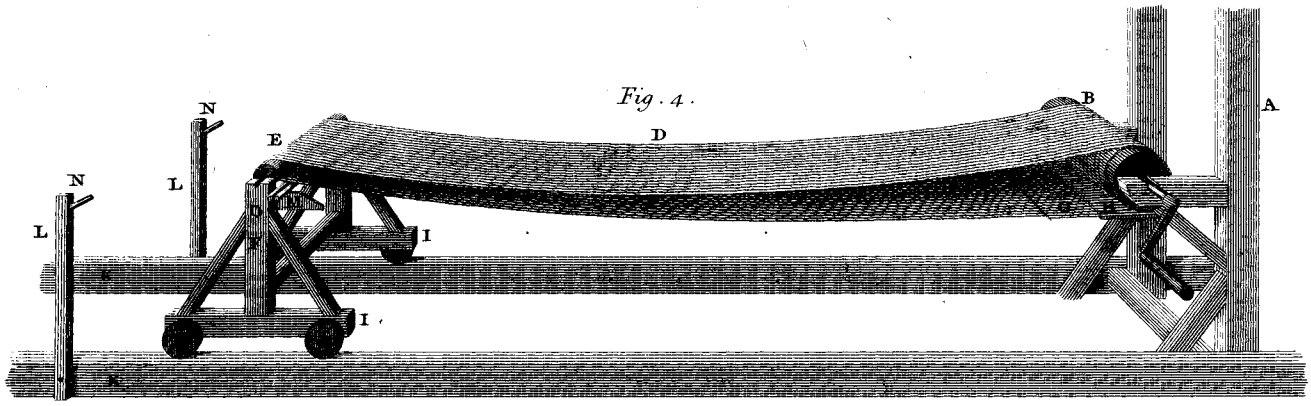

Fig. 4.

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BLEACHING.

Fig. 1.

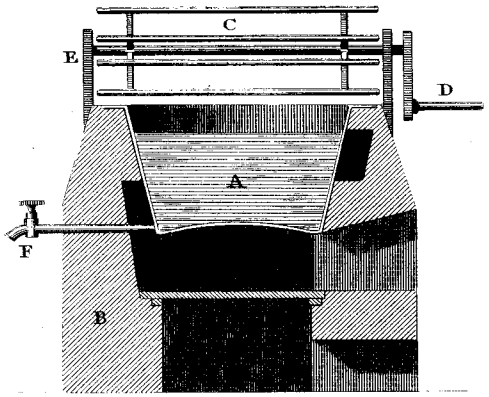


Fig. 2.

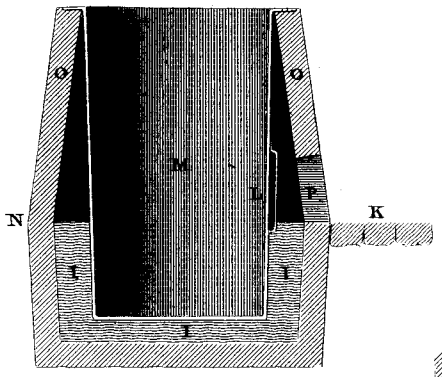
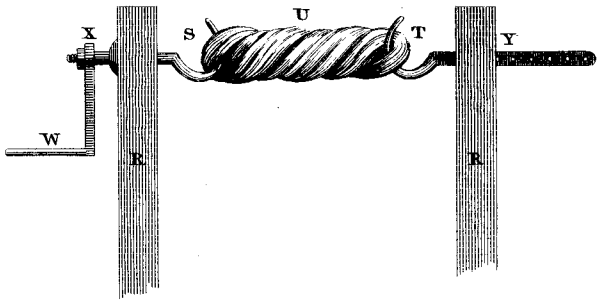


Fig. 3.



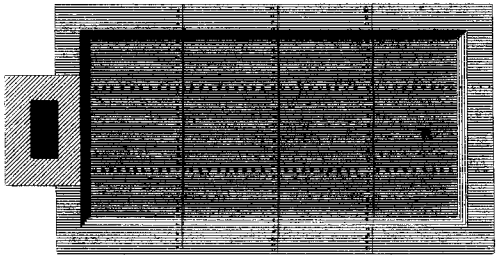


Fig. 5.

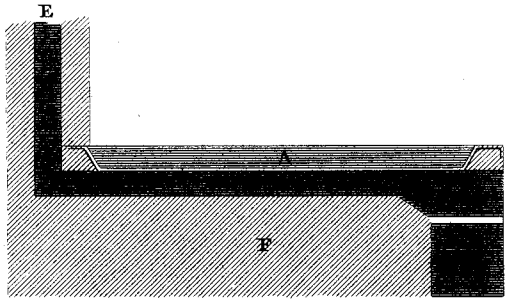


Fig. 4.

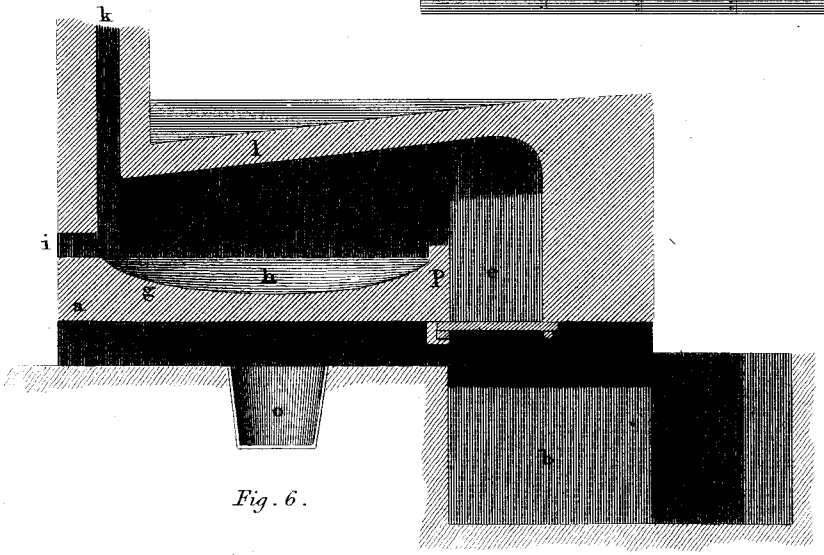


Fig. 6.

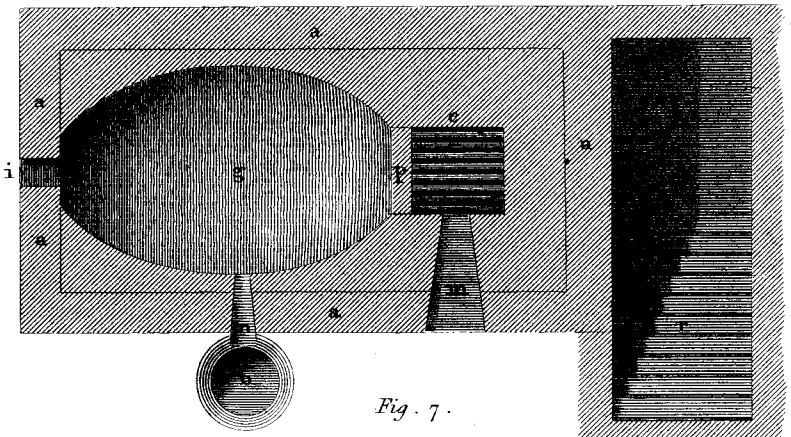


Fig. 7.

Drawn by C. Varley.

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