

DYEING, the art of giving a lasting colour to silks, cloths, and other substances, whereby their beauty is much improved, and value enhanced. This art depends chiefly on three things, viz 1. Disposing the surface of the stuffs to receive and retain the colours, which is performed by washing them in different leys, digesting, beating, &c. by means of which the viscous gluten of the silk-worms naturally adhering to their threads, is washed and cleansed from them, and thus they become fitted gradually to imbibe the colours. By these also the greasy foulness adhering to wool and flax is scoured off. 2. So to grind the colours, as that they may enter the body duly prepared, and preserve their brightness undiminished. 3. The third consists in having beautiful colours.

Dyeing, properly so called, is a chemical process, and in order that it may succeed, it is necessary that the colouring matters should be dissolved in some fluid, and that their attraction to that fluid should be less than that to the stuff. The stuff receives the dye better in proportion to the degree of affinity which the colouring matter has to it, and to the solvent relatively, for if the attraction to the stuff is much more than to the solvent, the stuff receives

the dye too rapidly; if on the other hand its attraction to the solvent is too great, the stuff will either not take the dye at all, or it will take it very slowly and faintly. Wool has a stronger attraction for colouring matters than silk, silk than cotton, and this latter a stronger than linen. The essential circumstances in dyeing are to ascertain the affinities of the colouring substance; first, to the solvents; secondly, to those substances which modify its colour, increase its brilliancy, and strengthen its union with stuff; thirdly, to the different agents which may change the colour, and principally to air and light. In dyeing, the title of *Mordant* is applied to those substances which serve as intermedia between the colouring particles, and the stuff to be dyed, either for the purpose of facilitating, or of modifying their combination, and by their means colours are varied, brightened, made to strike, and rendered more durable. If a sufficient number of colouring matters could be procured which had an affinity to cloth sufficient to answer all the purposes of dyeing, the art would be exceedingly simple and easy. But except indigo there is scarcely a dye-stuff which yields of itself a good colour sufficiently permanent to deserve the name of a dye. This difficulty is obviated by employing an intermediate substance, (*mordant*) which has a strong affinity both for the stuff and the colouring matter, and this is the chief purpose for which the mordant is used. The principal substances employed as mordants are aluminous salts, lime, metallic oxides, some astringent substances, and animal matters. The three simple colours in dyeing are red, yellow and blue; all other colours are compounded of these. Different shades or tints of the same colour are produced by using different drugs, or by varying the quantity of colouring particles, or in the case of compound colours, by varying the proportion of the different simple ones, of which they are composed.

Dr. WILLICH says there are FIVE colours which the workmen call PRIMITIVE, viz. *blue, red, yellow, fawn or root colour, and black.*

The ingredients used in dyeing *blue* consist of pastel or woad, and indigo.

1. PASTEL, or WOAD, (*Isatis tinctoria*), is prepared by gathering it when ripe, suffering it to rot, and then working it up into balls for drying; which weigh in general from 150 to 200 pounds, and resemble a collection of small dry

lumps of earth, intermixed with the fibres of plants. In order to extract the colour, it is necessary to provide large wooden vats, from 12 to 16 feet in diameter, and 6 or 7 feet high, or of a magnitude proportioned to the quantity intended to be used. The preparation of the blue-vat is the most difficult process in the art of dyeing; and the practical directions given by those who understand it, are either defective, or mis-stated. The copper-cauldron should be placed as near to the vat as possible, and filled with pond-water; to which, if it be not sufficiently putrid, may be added 2 or 3 pounds of hay, together with 8 pounds of brown madder, or of the bark of the root. The fire should be lighted about three o'clock in the morning, and the mixture boil for an hour and a half, or two hours, when the liquor is, by means of a spout, conveyed into the vat, in which a peck of wheaten bran is previously infused. The pastel-balls are next to be put in, separately, while the liquor is running into the vat, in order that they may be the more easily broken and stirred with the rake, which is a semi-circular wooden instrument, having a long handle. The mixture is occasionally agitated, till the vat has received all the hot liquor; and, as soon as the vessel is nearly half full, it should be covered with a lid, somewhat larger than its own circumference. A cloth should be likewise thrown over it, in order to confine the heat; after which the whole should be suffered to subside for four hours; when it ought to be uncovered, in order to give it air, and to mix it thoroughly. No *lime*, as is generally, though falsely, directed by dyers, should be put into the vat, but a small air-hole left on the top: the stirring and agitation may once more be repeated, at the expiration of three or four hours.

If the ingredients, after these operations, be not yet ready and *come to*, that is, if the blue does not rise to the surface, but continues to foam, it will then be necessary, after working the mixture well, to let it stand an hour and a half longer, care being taken during that time to observe it minutely, in case it should *cast blue*. The vat is then to be filled up with water, and a sufficient quantity of indigo, dissolved in a ley of pot-ash, pure water, bran and madder. The vat being again covered, at the end of three hours a pattern is to be immersed in the liquor for a similar space of time, when it is to be taken out, to inspect the state of the vat. This pat-

tern, when first taken out, should be of a green colour, but instantly turn blue; if the green be bright and good, the vat is to be stirred again, and then covered up, with the addition of a few handfuls of bran. Three hours after, the same operation is to be repeated, with the addition of more bran, if necessary, when it is to be covered up for an hour and a half longer: and, as soon as it subsides, another specimen is to be immersed in it for an hour, when it must be examined, to ascertain the state of the pastel. If the former be of a good green, when taken out, and turn suddenly to a deep blue, on being exposed to the air, another pattern is to be put in, to discover the effect of the vat; which, if the colour be sufficiently high, is to be filled with hot water, or (which is preferable, if it can be procured), with the liquor of an old madder-vat, and then stirred again. Now the vat is to be once more covered for an hour; after which the stuffs to be dyed should be immersed.

Indigo is the last ingredient in dyeing blues. The vat is about 5 feet high, two inches in diameter, and somewhat narrower towards the bottom, being surrounded by a wall, and having a vacancy for the embers. A vat of this size requires from 2 to 5, or even 6 lbs. of indigo; and this operation is conducted as follows: 1. About 15 gallons of river water are put into a copper to boil for about half an hour, together with 2 lbs. of pot-ash, 9 oz. of madder, and a handful of bran. 2. Immerse 2 lbs. of indigo in a pail of cold water, in order to separate the solid from the volatile particles, which will immediately rise to the surface. The watery liquor is then poured off, and the indigo, settled at the bottom of the pail, should be triturated in an iron mortar, with the addition of a small quantity of hot water, that ought to be shaken from side to side; and the floating particles of indigo, which are those most finely pounded, must be poured into another vessel. In this manner, the indigo remaining in the mortar is continually reduced, fresh water being repeatedly added, till the whole is pulverised so finely as to rise to the surface.

The liquor which had, during the above-stated preparation, been boiling in the copper, is now poured into the vat, together with the indigo, when the whole is well stirred with a rake, the vat closely covered, and surrounded with embers. If this operation commences in the afternoon, the embers

must be renewed in the evening, and also in the morning and evening of the following day, in the course of which it should be twice gently stirred. Similar measures ought to be pursued on the third day, in order to preserve an uniform heat, and intimately mix the ingredients. A brassy scum will then be perceived to rise to the surface, in several detached parts: by continuing the heat on the fourth day, the scum becomes more coherent; and the froth, occasioned by stirring the liquor, appears blue, while the latter is of a deep green. As soon as it assumes this appearance, the vat should be filled; for which purpose a fresh liquor must be prepared, by putting five gallons of water into a copper, together with a pound of pot-ash, and half an oz. of madder. When these ingredients have boiled half an hour, the decoction is poured into the vat, the whole well stirred, and, if it produce much froth, it will be in a proper state for working the next day. This may likewise be ascertained by the brassy or scaly crust, which floats on the surface of the liquor: and, farther, if on blowing, or stirring, the latter with the hand, it assumes a deep green colour, while the surface appears of a brownish blue.

After the vats have been thus prepared, the dyeing of woollen or silken stuffs is very easy; no other process being required, than immersing them in warm water, wringing, and then steeping them in the vat for a longer or shorter time, according to the deepness of the colour intended to be imparted. The stuffs should be occasionally opened, that is, taken out of the vat, wrung over it, and exposed to the air for a minute or two, till it become blue: for it must be observed, that, in all the solutions of indigo, or other dyeing materials above described, the blue colour is produced only by exposure to the air, and the stuff, on being first drawn out of the liquor, always appears green, and will retain that tinge, unless it be exposed to the air. In dyeing blue, therefore, it is necessary to let the colour thus change previously to a second immersion, that the shade may be the better distinguished, as dark blues require to be repeatedly dipped. The method of dyeing cotton or linen blue, varies so little from that already described, as to render any farther directions unnecessary.

A beautiful *Saxon-blue*, for silk and woollen cloths, may be prepared by gradually pouring from five to eight

parts of sulphuric acid on one part of finely pulverised indigo. The mixture must be suffered to stand for 24 hours; at the expiration of which, the effervescence will subside; the solution is then to be diluted with water, when it will be fit for dyeing.

2. The next of the primitive colours to be considered is red, of which there are many shades and varieties; but the principal are scarlet, crimson, and madder red. The process to be adopted for obtaining these colours, essentially differs from that of blues; as the former require a peculiar preparation of the stuffs to be dyed, on the exactness of which, the goodness of the colour in a great measure depends. These preparatory ingredients consist of alum, tartar, aqua-fortis, or a solution of tin in this acid. Galls and alkaline salts are also sometimes added, though they do not materially contribute to the colour.

A fine *orange-yellow* tinge may be imparted to silk or cotton, by grinding anotta on a moistened slab, and boiling it in double its weight of pearl-ash and water: the liquor is then suffered to settle for about half an hour; when it is drawn off, while hot, into a proper vat, and the stuff immersed, till it acquire the requisite shade. In order to heighten and fix the colour, it will be proper to dissolve some cream of tartar in hot water, and to add the solution to the liquor, so as to render it slightly acid: after which, the stuff may be rinsed, and dried in the usual manner.

There are three kinds of *scarlet*, namely, that dyed with *kermes*, with *cochineal*, and with *gum-lac*.

The first of these, called *Venetian scarlet*, is the most permanent, but the least bright: it is also apt to be less spotted than the others; but, on account of the difficulty of procuring the insects which afford the colour, it is very seldom, if ever, used.

The second kind of scarlet, namely, that dyed with *cochineal*, is less permanent than the Venetian scarlet, though the drug is procured at a more reasonable price. It is, however, very difficult to dye the true cochineal scarlet: the success of this operation equally depends upon the choice of the material, the water employed, and the method of preparing a solution of tin, which is the only ingredient by which that delicate colour can be produced. To eight ounces of spirit of nitre, an equal quantity of river-water is to be added; in this mixture are to be gra-

dually dissolved, half an ounce of the purest and whitest sal-ammoniac, and two drachms of purified salt-petre. An ounce of tin, reduced to grains, by being dropped into cold water while melting, is next to be added drop by drop to the liquor thus prepared; the first being perfectly dissolved before a second is introduced. The solution resembles that of gold, and, if fine tin be employed, will be perfectly transparent, without any dust or sediment. With this liquor are to be mixed such proportions of cochineal as may be thought proper, and the stuffs dyed in the colour will acquire a most beautiful scarlet.

The scarlet produced by *gum-lac*, though not so bright as cochineal, is more permanent; the best lac is that which is of a blackish brown colour on the outside, and white within. The process of preparing this colour is very difficult; but the best method, we believe, is that of previously mixing the gum with comfrey, or other mucilaginous roots. These should be dried, finely pulverised, afterwards boiled for fifteen minutes in the proportion of half a drachm to a quart of water, then strained through a linen cloth while hot, poured upon levigated gum-lac, and passed through a hair-sieve. The whole is then digested in a moderate heat for twelve hours; and the gum remaining at the bottom should be stirred seven or eight times. The liquor thus impregnated with a fine crimson colour, is afterwards poured into a vessel, sufficiently capacious to hold four times the quantity, and filled up with cold water. On adding a small proportion of a strong solution of alum, the coloured mucilage subsides; and, should any tinge remain in the liquor, it may be precipitated by gradual additions of alum, till it become perfectly colourless. As soon as the crimson mucilage has entirely subsided, the clear water must be carefully decanted, the remainder filtered, and the fluid parts suffered to evaporate. If the whole of the colour should not be extracted by the first operation, it ought to be repeated, till the residuum changes to a pale straw-colour.

In order to dye scarlet with this extract of gum-lac, the requisite proportion of the latter dried and pulverised, is to be put into an earthen or block-tin vessel; a little hot water poured upon it; and, when it is well moistened, a proper quantity of the composition added; the whole being stirred with a glass pestle. By this means the powder, which before was of a dark, dusky pur-

ple, acquires an exceedingly bright scarlet colour. A solution of the crystals of tartar is then to be poured into the liquor, and as soon as it begins to boil, the cloth is to be repeatedly immersed in it, according to the common method. The remainder of the operation is to be performed in the same manner as if cochineal had been employed.

Crimson is the colour produced by cochineal, with alum and tartar only, without any solution of tin. For this dye, two ounces and a half of alum, with an ounce and a half of white tartar, are to be taken, for every pound of wool; and being put into a cauldron with a proper quantity of water, the solution should boil before the stuff is dipped. The wool is then immersed into the boiling liquor, where it continues two hours; after which it is to be taken out, wrung gently, rinsed in water, and put into a bag. A fresh liquor is next prepared for the dye, in which an ounce of finely-powdered cochineal is used for every pound of wool: when this decoction boils, the stuff is immersed, and managed in the manner already directed for scarlet. For producing the finest crimson dye, however, the wool is again to be dipped in a weak lixivium, made of equal parts of sal-ammoniac and pearl ashes.

The preparation of the ingredients for *madder-red* is always with alum and tartar, the proportions of which are by no means ascertained even by dyers. The more general practice is, to put 5 ounces of alum and one of red tartar to every pound of worsted, a twelfth part of acid water being likewise added, and the wool boiled for two hours in this solution, in which worsted is to be kept for a week; but cloth will be sufficiently saturated in four days. A fresh liquor is then prepared for dyeing this wool; and when the water is nearly boiling, half a pound of the finest madder is to be thrown in for every pound of wool; being carefully stirred and well mixed in the copper, previously to immersing the stuff, which is to be kept in the liquor for an hour; during which the latter must not boil, lest it should tarnish the colour.

The third primitive colour is *YELLOW*, for obtaining which there are ten different ingredients; but four of these only yield a good and permanent dye, namely, dyers'-weed, or, as the dyers call it, weld, savory, dyers' green-weed, and fenu-greek. The first of these, namely, *weld*, in general affords the

truest yellow, and is therefore preferred to all the others. Savory and dyers' green-weed, being naturally somewhat green, are more advantageously employed for dyeing that colour; and the last yields different shades of yellow.

In order to dye worsted and stuffs yellow, they undergo the usual preparation with tartar and alum: of the latter 4 ounces are allowed to every pound of wool, or 25 lbs. to every 100; of the former, one ounce is sufficient for yellow; after dissolving both, the wool is boiled in the same manner as in the preceding colour. A fresh liquor is next to be made for the *welding* or *yellowing*, in the proportion of 5 or 6 lbs. of dyers'-weed to every pound of stuff. Some inclose the drug in a clean woolen bag, to prevent it from mixing with the cloth to be dyed; and, in order to keep the bag down in the copper, they lay a cross of heavy wood over it.—Others boil the weld in the liquor, till the water has imbibed all its colour, and the drug sinks to the bottom, when the stuff is suspended in a net: others, again, take the weld out, as soon as it is boiled. According to the shade required, other vegetables are occasionally mixed with that drug. By varying the proportion of the salts employed, as well as the quantity of colouring ingredients, and the time of boiling, different shades may be produced.

The fourth primitive colour is that denominated by dyers the *FAWN*, or *root* colour. It is a kind of brown, and the process for dyeing it is widely different from those just described; the wool merely requiring a simple immersion in water, as already directed for blue. The materials employed consist of the green shell of the walnut, the root of the walnut-tree, the bark of alder, santal, or saunders-wood, sumach, and soot. The green walnut-shells are collected, when the nuts are thoroughly ripe; they are put into tubs or casks, which are afterwards filled with water, and are thus preserved till the succeeding year.

Santal, or saunders-wood, is much inferior to walnut-shells; because, if used in too large a quantity, it stiffens and consequently injures the wool. It is in general mixed with galls, sumach, and alder bark, without which its colour could not be extracted: and though it yields very little with alum and tartar, it is nevertheless used in large quantities, on account of the solidity of its colour, which is naturally a yellow-reddish-brown.

The best of the different ingredients employed in dyeing fawn-colours, is the bark or rind of the walnut-tree. Its shades are uncommonly fine; its colours solid; and it renders the wool dyed in it flexible and soft. A cauldron half full of water is placed over the fire; and as soon as it grows warm, bark is added in proportion to the quantity of stuffs intended to be dyed, and the lightness or depth of the shades required. It is then boiled for about a quarter of an hour, when the cloths, being previously moistened with warm water, are immersed, frequently turned, and well stirred, till they have sufficiently imbibed the colour. They are aired, dried, and dressed in the usual manner.

Next to the rind or bark, the root of the walnut-tree is the best dye for a fawn-colour: it also affords a variety of shades, similar to those produced by the bark, for which it is frequently substituted. The root, however requires a different process: A cauldron is filled about three parts full of river water, into which the root is immersed, after being tied up in a bag. When the liquor is very hot, the wool or stuff is plunged into it, repeatedly turned, and occasionally aired. The lighter stuffs are next to be dipped, till the colour is completely extracted. During this operation, proper care should be taken to prevent the liquor from boiling, as in such case the piece first immersed would imbibe the whole of the colour.

The process of dyeing with the bark of *alder*, is nearly the same as that pursued with walnut-roots: the boiling of it is at first not very material, as this drug very freely communicates its colour. It is chiefly used for worsteds, imparting shades darkened with copperas; and for wool that is not required to be very dark, as it equally withstands the effects of the sun and rain.

Sumach possesses nearly the same properties as the bark or rind of the walnut-tree; its colour is not so deep, somewhat inclining to green, but is solid and permanent. Where dark colours are required, sumach is frequently substituted for nut-galls, in which case a greater proportion becomes necessary. These different substances, however, are not unfrequently mingled together, and, as they are of a similar nature, and differ only in degree, it is easy to obtain various shades.

With respect to the method of compounding the different ingredients with pulverised *saunders-wood*; 4 lbs. of the

latter are to be put into a copper, with half a pound of powdered nut-galls, 12 lbs. of alder-bark, and 10 lbs. of sumach. The whole is to be boiled, when a small portion of water should be added, to check the boiling: after immersing the cloth, stirring, and turning it repeatedly, it is aired, and washed in river-water. The quantities of these ingredients may be increased, or diminished, according to the depth of the shade required.

The last substance employed in dyeing the fawn-colour, is *soot*, which is not only less solid than the others, but also hardens, and imparts a very disagreeable smell to the wool, or stuff, dyed in it: it is therefore seldom, if ever used, unless the other ingredients cannot be easily procured.

The fifth, and last, of the primitive colours, is **BLACK**, which includes a great variety of shades. In order to impart a good black to woollen stuffs, they should be first dyed of as deep a blue as possible, which is called the *ground*, and is to be performed in the manner already directed. As soon as the cloth is taken out of the vat, it ought to be well washed in river-water, and afterwards scoured at the fulling-mill. Next, the dyeing process is performed as follows: For every cwt. of cloth, 10 lbs. of logwood cut into chips, and an equal quantity of Aleppo gall-nuts pulverised and inclosed in a bag, are to be put into a cauldron of a moderate size, where the whole is boiled for twelve hours in a sufficient quantity of water. A third part of this liquor is then to be poured into another cauldron, with 2 lbs. of verdigris, when the cloth is to be immersed for two hours, being repeatedly turned and stirred, the liquor in the mean time boiling very slowly, or rather, gently simmering. At the expiration of that time, the stuff is to be taken out, and the second part (being another third) of the liquor added to the first third, together with 8 lbs. of copperas. The fire beneath the cauldron is then to be diminished, and the copperas left for half an hour to dissolve; the liquor being gradually cooling: after which the cloth is to be immersed for another hour, repeatedly turned as before, then removed and cooled.

The remainder of the liquor is next to be mixed with the first two-thirds and the bag carefully expressed; when fifteen or twenty pounds of sumach are to be added, together with two pounds of copperas. The whole is then made

to boil : and, a small quantity of water being added to cool, the stuff is again immersed for two hours ; at the end of which time it is to be taken out, cooled, and steeped in the dye for an hour longer, being frequently turned. The cloth is then to be carried to the fulling-mill, and well scoured, till the water runs from it perfectly colourless. As soon as this operation is performed, a fresh liquor should be prepared with the necessary quantity of dyer's weed, which is only once to be boiled, and when cool, the cloth dipped into it. This last decoction softens the texture, and renders the colour a most beautiful black. Few dyers, however, take so much pains ; for they are satisfied with dipping the cloth, when blue, in a decoction of nut-galls, and boiling the whole for two hours. The stuff is then washed, and after adding some copperas and logwood to the liquor, the cloth is again immersed for two hours, at the end of which it is washed, scoured, dried and pressed.

A hot decoction of Aleppo galls, in water, is first to be prepared in a proper vessel, in which cotton or silk stuffs, previously soaked in warm water, must be worked for some time. The superfluous liquid is now to be expressed, and the cloths should be immersed in a black dye, made by steeping alder-bark, and iron hoops, for several months, in a cask of water ; or they may be plunged into a solution of iron in vegetable acids. When the stuffs are thoroughly wetted, they must be wrung out, and afterwards soaked in a decoction of logwood, to which a little verdigris is added. The last mentioned process ought to be repeated, till the colouring particles be sufficiently imbibed : during the intervals, it will be proper to rinse the cloths in water, and to dry them in order to fix the colour.

The art of dyeing consists of three operations, viz. 1. Fully to cleanse the substance which is to be dyed, and to remove all foreign matters which might prevent it from taking the colour. 2. To dispose it by particular compositions to receive and retain the colouring principle, and 3. To prepare the bath of colour in which it is to be immersed, and to work it according to the rules of the art.

The article DYEING is left as Dr. WILKIN has inserted it, but it conveys little information, and that little is inaccurate. To give all the processes for dyeing different colours and shades of

colours, would of itself occupy a large work. The following sketch, communicated by Dr. COOPER, the present editor of this work, to Dr. MEASE, its former editor, may be useful.

Substances to be dyed are, silk, woollen, cotton, linen, and skins. Of these, some have more affinity to the colouring matter of vegetables than others, as silk and woollen, more than cotton or linen. But this affinity is in all cases increased by the intermedium of the earth of alum, or the calces of iron and tin : The compositions in which these enter, when applied to the cloth, are termed *mordants*, and they serve as the basis on which the colours stick and are fixed. Thus, if without preparation, a piece of linsey-wolsey be boiled in a decoction of madder or weld, the linen will come out white, the woollen part will be tinged. If part of a piece of cloth be run through a hot solution of alum, it will take a deeper and more permanent dye than the part not so treated.

The *mordants*, then, in common use, are *alum*, iron liquor, which is iron in the acid of vinegar, or in the pyroligneous acid procured from the distillation of wood, and *tin* in the nitro-muriatic acid, or aqua regia. Alum is bought every where ready prepared. Iron liquor is made by putting old iron into beer brewed on purpose, or any other mode of obtaining the acetous acid. It is left to stand in the cask and repeatedly drawn off and poured in again for 6 months. In England it is a trade to make it, though till of late years every dyer made it for himself. The mordant of tin is made thus, to 1 lb. of aqua fortis diluted with one pint of water, add 3 ounces of sal ammoniac ; when dissolved, add small pieces of grain tin, till no more be dissolved. Put in but one small piece at a time. The principles of dyeing silk and woollen are much alike. Those who would dye silk, may peruse to advantage MACQUER's treatise on this subject, and the art of dyeing wool by HELLOT, is also translated into English under the title of the *Art of Dyeing*. The work of BERTHOLLET on dyeing is by far the most scientific yet produced ; but none of them are accurate as to the actual processes.

The *mordants* are always kept ready in a dye-house, in a concentrated state, ready to be diluted as occasion may require ; the strength of the colour, until it arrives at its maximum, depending on the compound ratio of the strength of the mordant and the quantity of the

colouring drug. In the following general recipes, I cannot give the exact proportions, because they vary with every shade of colour, and with the quality of the drugs: but a little experience in the dye-house, will teach the method of proceeding.

The processes immediately following, are calculated for woollen or silk. It is to be noted, that, in all the colours dyed on woollen, where the mordant is the earth of alum, the dyers use *white or red argol*, or the tartar of white or red wine. This is usually supposed to brighten the colour, by means of the acid contained in it, but the real effect is to produce a solution of the earth of alum in the acid of tartar by double decomposition. The proportions used are, 2 parts alum and 1 part tartar, which latter might be increased with advantage.

Scarlet and Crimson. Immerse the woollen for an hour in a hot liquor composed of about $\frac{1}{2}$ a pint of the solution of tin to a gallon of water: then for another hour in a hot (not boiling) solution of cochineal: repeat it till you get your colour: brighten it by running it through the tin liquor of half the above strength. A slight alkaline solution will give it a crimson cast.

Some dye it first with alum liquor made with argol, in the proportion of a quart to the gallon, and then in a bath, or decoction of brazil-wood to the amount of $\frac{1}{2}$ of a lb. to the one pound of woollen. Then use the alum solution, and then the cochineal, and brighten finally with the tin liquor.

Purple. Add to the mordant of tin, about $\frac{1}{4}$ of a pint, or less, of a solution of iron in common aqua-fortis, and proceed as above. This gives, according to the proportions of the mordant, all the shades of violet and purple. A false or fugitive purple is also made by means of logwood with the tin liquor, and a small proportion of vitriol of copper.

Red. Alum liquor with argol, as a mordant, then madder in the proportion of $\frac{1}{2}$ lb. of madder and $\frac{1}{4}$ lb. brazil, or brazilletto, to the piece. Red-wood, and nicaragua wood are bad substitutes for brazil. A false red may also be made by substituting logwood in part for madder.

Chocolate. Add to the alum liquor with argol, about one-half of the acetite of iron and proceed as for red.

Pink. Take bastard saffron or the carthamus tinctoria, usually called safflower. Put it in a bag, wash it well

VOL. II.

in cold water, treading it, until all the yellow colour is extracted, and the water no longer tinged. Then put it into an alkaline ley made of pearl-ash in the proportion of about $\frac{1}{2}$ lb. to the gallon of water: this will extract the pink colour from the safflower, and give it out to the woollen or silk immersed in it. Old pieces of pink cloth may be immersed in an alkaline lixivium, and the colour extracted will dye afresh.

Yellow. Alum with argol: then for a fast yellow weld, or quercitron bark (quercus tinctoria of Michaud). For a false yellow, fustic

Orange and Nankeen. Dissolve annatto in caustic alkali, and add of this solution to hot water according to the required tinge: or,

For a faster colour, take iron in the nitrous acid, as much as may be sufficient to produce the required tint, and then run the goods through lime water: or,

Take the alum liquor with argol, then dye with a decoction of mahogany: then run the goods through the tin liquor, and again through the mahogany liquor. The precipitate of platina from AR by sal-ammoniac gives a beautiful nankeen, but too dear to be used.

Blue. The fast colours are made by means of the blue vat with indigo: the false colours by means of the vat of pastel or woad: or by means of vitriolated copper (blue vitriol) and logwood.

The blue vat is made in different ways; by caustic alkali; by urine, or by lime alone, and it may be hot or cold.

A vat with caustic alkali may be made thus: to a pound of indigo well washed, add $1\frac{1}{2}$ lb. of pearl-ash, and 2 lbs. of lime, fresh-slacked with about 2 gallons of water; boil them for two hours, then add them to about 20 gallons of hot water, to which add a quarter of a pound of green vitriol (vitr. iron) and as much red arsenic; stir it frequently: when a green froth has risen, it is ready: or,

Grind a pound of indigo in urine, fresh or stale: add to it about forty gallons of urine: stir it with a rake, till the green scum rises, and the indigo appears dissolved.

The vat, with lime alone, is not so good.

Dip the cloth in this, till the vat be exhausted.

The attempts to dye with Prussian blue have not succeeded in point of expense.

Saxon blue. Take indigo and grind it well, wash it in hot water, till there

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be no more foulness in the water: to each pound of indigo, add 6 pounds of oil of vitriol, which will not answer the purpose, unless it weighs 29½ ozs. to the wine pint, or be of the specific gravity, 1,85. This should be made in a glass retort, and in a warm place, but not with heat.

Green. First dye a yellow, and then a blue.

Olive. Take equal parts of alum liquor and iron liquor, and then dye with the yellow drugs.

Black. Iron liquor, with a small quantity of verdigris; then a dry liquor of about 1 lb. of the drugs, to 1 lb. of wool: the drugs being a mixture of madder ½; and logwood ¾. The colour is mended, by adding a small quantity of nitrated iron to the mordant, and a small quantity of galls to the drugs: the verdigris with the logwood, gives a blue tinge. Lessen the mordant in strength, and you get all the shades of grey approaching to black.

DYEING OF COTTON.

Drab. Mordant; alum and copperas in equal parts. Drugs; fustic and sumach.

Olive. Mordant, blue vitriol, with copperas, for a greenish olive. Drugs; fustic and logwood: for a brown or reddish olive, add sumach.

Mud. Mordant, alum, and copperas. Drug; sumach.

Bloom. Mordant; alum and copperas; or, instead of alum, tin in spirit of salt. Drugs; logwood, and sumach.

Purple. Mordant; tin in spir, salt, or aqua regia: drugs; logwood, if not a blue purple, add brazilletto.

Chocolate and Brown. Vitriolated iron, and fustic; then vitriolated copper and logwood: or if a bright chocolate is wanted, brazil and the tin mordant.

Bufs and Nankeens. Annatto and fustic: or for a good and tolerable fast nankeen, take equal parts of alum and argol, and dissolve them: this will produce a tartarite of alumine, and sulphite of potash. They should be dissolved in as small a quantity of water as may suffice, in 2 lbs. of alum and 2 lbs. argol to 1½ gallon of hot water; of this solution add a quart to a gallon of hot water; immerse the cotton for an hour; take it out; immerse it in a hot decoction of mahogany shavings, 1 lb. to the 1 lb. of cotton; let it simmer till the dye is exhausted; finish by running it through the tin mordant about half a pint to the gallon of water; then wash off.

[Scott's patent nankeen dye. Boil

equal parts of common potash and annatto in water, till the whole is dissolved. Strain it from sediment and bottle it.—T. C.]

Fast Bufs. Tinned iron plates dissolved in aq. afortis, then raised in lime.

Yellow. Alum liquor, and a small quantity of verdigris, with weld or fustic.

Green. Blue vitriol (vitriolated copper) with a fustic and logwood.

Crimson and scarlet. Tin in aqua regia. Then Brazil. Brazilletto or Nicaragua will not give the required colour.

Pink. See the process with safflower, above given

Turkey Red. Boil the grey cotton for 3 hours in pearl-ash and fish-oil, about an ounce of each, to each pound of cotton, and water enough to cover it: wash it and dry it. Immerse it during ten days in fish-oil. Squeeze or rinse it well, and hang it up to dry. Run it through a hot solution of alum, in the proportion of alum, one part; water, forty parts by weight. Then run it through a mixture of cow-dung and hot water. Again through the alum liquor. Then through a decoction of galls or sumach; an ounce of galls to the pound of cotton. Then through a dilute solution of glue. Alum it again after washing. Madder it with half a pound of madder to the pound of cotton. Alum it again and madder it again, with from a quarter to half a pound of madder more to the pound of cotton. Brighten it by boiling it for half an hour, in a very weak solution of white soap.

This colour may be imitated, thus:

Boil the grey cotton in pearl-ash and oil, as above. Wash it and dry it. Alum it as above, and then run it through the cow-dung liquor. Wash it. Take the common printers mordant, of alum 1 lb. sugar of lead 1½ lb. water one gallon. Dissolve. Add another gallon of water. Immerse the cotton for a day in this hot solution. Then madder it with ¼ of a pound of madder and one ounce of galls, to the pound of cotton.

The Process of M. HAUSSMAN.

After making a caustic ley, of one part of good common pot-ash, dissolved in four parts of boiling water, and half a part of quick-lime, which I afterwards slaked in it, I dissolved one part of powdered alum in two parts of boiling water; and while this solution of sulphate of alumine was still warm, to avoid re-crystallisation, I speedily poured into it successively, always stirring it without interruption, the above men-

tioned caustic ley, till the alumine it had at first precipitated after saturation to excess with sulphuric acid, had been re-dissolved. I left at rest this solution of alumine, which exhales ammonia, and which, on cooling, formed a precipitate of sulphate of pot ash in very small crystals, I then mixed a thirty-third part of linseed oil, with which the alkaline solution of alumine formed a kind of milky liquid.* As the oil gradually separates itself from this mixture under the appearance of cream, it must not be employed till it is again shaken. The skains of cotton, or linen, ought to be successively immersed in it, and equally pressed, that they may be then exposed to dry on a pole, in the order in which they have been taken from the mixture. They must be dried under shelter from rain in summer, and in a warm place in winter, and be left in that state for 24 hours: they must then be washed in very pure running water, and be again dried; after which, they are to be immersed in an alkaline ley, pressed and dried a second time in the same manner as the first, taking care, however, to recommence the immersion in the ley, with those skains which have been last in the oily mixture, because the first never fail to carry away a larger portion than the last; it will be proper, also, to consume the mixture each time, that it may not have leisure to attract the carbonic acid, with which the lower region of the atmosphere is always charged, especially in manufactories; for the alkali, by passing to the state of carbonate, suffers the alumine to be precipitated, and loses the property of mixing with the oil.

Two immersions in the alkaline solution of alumine, mixed with linseed oil, will be sufficient to obtain a beautiful red; but by continuing to impregnate the skains a third, and even a fourth time, with the same circumstances as the first, colours exceedingly brilliant will be produced.

The intensity of the red, proposed to be obtained, will be in proportion to the quantity of the madder employed. By taking a quantity of madder equal in weight to that of the skains, the result will be a red, which, by clearing, will be changed to a rosy shade; on the other hand, shades of crimson, more or less bright, will be obtained by employing two, three, and even four times the weight of madder, without ever forget-

* In fact, a saponaceous liquor is formed, containing alumine.—A. TILLOCH.

ting the addition of chalk, if the water employed does not contain some of it. Four parts of this colouring substance will produce a red too intense and beautiful to be employed in commerce, as it would be too dear to find purchasers.

By making an oily alkaline solution of alumine, with two or three parts of water, and impregnating the skains twice, and even four times, in the manner above mentioned, bright shades will be produced without the use of much madder; but they will not have the same intensity, as those procured with even as little madder by means of the same solution concentrated.

The best method of obtaining shades, lively as well as bright, is to expose the dark reds for a considerable time, when they have been cleared, to the action of a ley of oxigenated muriate of pot-ash, or of soda, with excess of alkaline carbonate, in order to have such a degree of shade as may be required: but it may readily be conceived that this method would be expensive.

To have the oily alkaline solution of alum, nearly in the same state of concentration, it will be necessary to employ an hydrometer, to determine the degree of strength of the caustic ley, before it is employed for the solution of the alumine. This caustic ley must be made with the best common pot-ash that can be procured, and the degree it gives by the hydrometer must be noted, in order that if pot-ash of an inferior quality be afterwards employed, the ley obtained may be carried to the fixed degree of evaporation.

Caustic ley, made with four parts of good common pot-ash,† cannot contain a large quantity of foreign salts. By making it on a large scale, when the limpid part has been decanted, it will be necessary to shake the deposit, for some time, twice every day, that the rest of the alkaline liquor may be decanted; and that none of what still remains in the deposit may be lost, it ought to be diluted with more water, which may be afterwards employed to lixiviate the cotton, which must be well purified and cleaned before it is dyed; which may be done by lixiviating and soaping, or merely boiling it in water and then rinsing and drying it. As wringing with the hands may derange the filaments of the skains of cotton and linen, and consequently weaken the thread, it will be

† I have no doubt that, where pot-ash cannot be procured, soda might be employed. THE AUTHOR.

proper, in operating on a large scale, to squeeze them by means of a press.

In regard to thread or linen, to be dyed of a beautiful dark and fixed red, it must be well bleached, and impregnated, at least four times successively, with the oily alkaline solution; because not only alumine and metallic oxides adhere with more difficulty to linen than to cotton, but because these mineral substances, when coloured, abandon linen much easier than cotton when cleared. It still remains to examine whether, between each impregnation with the oily alkaline solution of alumine, cotton or linen thread requires to be left at rest for a greater or shorter time, before it is rinsed and dried.

All fat oils may be employed in the mixture, with proper precautions; but linseed oil mixes better, and remains longer suspended in the alkaline solution of alumine: I never tried fish-oil, which perhaps would be preferable. It is probable also, that in operating on a large scale, it would be best to diminish the quantity of linseed-oil, in the mixtures with the alkaline solution of alumine; for I have had reason often to observe, that too much oil hurts the attraction of the colouring parts of the madder: a thirty-third part of linseed-oil, always produced the best effect, in my trials on a small scale.

In regard to the process of dyeing cotton and linen thread, sufficiently charged with alumine, by the oily alkaline solution of that earth, the skains must first be disengaged from every saline substance, as well as from the superfluous oil, by rinsing them a long time in very pure running water; after which they must be arranged without drying them, on an apparatus which the operator may construct according to the form of the boiler, in which it is to be placed, in such a manner, that during the process of dyeing, the skains may be continually shaken and turned; in order to catch every where, and in an uniform manner, the colouring particles. The bath must be composed with madder, mixed with a sixth of pounded chalk, and diluted with about 30 or 40 parts of water. The heat must be carried only to such a degree that the hand can be held in the bath for an hour without being scalded; and it is to be maintained, at this degree, for two hours, either by diminishing or increasing the fuel. Three hours dyeing will be sufficient to exhaust the madder: the skains, when taken from the bath, must be washed in a large quantity of

water to cleanse them: they are then to be cleared by boiling them a pretty long time, in water containing bran, inclosed in a bag, adding soap and alkaline carbonate, to give the red a rosy or carmine shade.

As I never had occasion to dye cotton or linen thread, on a large scale, I employed a small boiler, which served me at the same time, for the process of clearing; in the latter operation, I confined myself to boiling the skains, properly arranged, in water containing a bag filled with bran, for eight hours successively; and, that I might not interrupt the ebullition, I replaced the evaporated part by the addition of more boiling water. In this clearing, I employed neither soap nor alkali; yet I obtained a red, superior in beauty and fixity to that of the Levant, and which, in every respect, will bear a comparison with the colours dyed in France. For dyeing my red, I employed three parts of the best madder for one part in weight of dry cotton thread.

With the precaution I took to obtain an uniform shade, I could have dyed at one time, but I should always recommend performing this operation at two different times, taking each time, half a portion of madder and of chalk, if the skains cannot be continually turned in the boiler, it may serve also for clearing, by adapting to it a cover, so as to suffer very little of the vapours to escape, because it would be too expensive to replace the part evaporated by more boiling water. By operating on a large scale, and concentrating the heat in the boilers, keeping them almost close, there, perhaps, would be no need of employing eight hours ebullition, to clear and fix the colour. I have every reason to believe, that this clearing of the Turkey red, gave rise to the idea of bleaching with steam: it must have been seen that colours, by being cleared, lose considerably in regard to their intensity; and perhaps it has been observed at the same time, that the pack-threads, employed for arranging the skains, were bleached during the clearing, especially when alkalies were added.

A great variety of colours, and of different shades, may be obtained, by following the process here described for obtaining beautiful and durable reds. In this case the oily alkaline solution of alumine, must not be employed till the required shade of oxide of iron, or indigo blue, has been given, but whatever may be the colour, or shade, which

you wish to give, before you fix the alumine on the skains of cotton or linen, these skains must always be first well boiled, by which means the adhesion of the indigo fecula, as well as that of the oxide of iron, will be increased in the same manner as that of alumine, coloured by the colouring parts of madder, when subjected to the action of the heat of boiling water before they are impregnated with the oily alkaline solution of alumine. As the method of dyeing indigo-blue, in all its shades, is well known, it is needless to detail it; and as to giving a rusty yellow colour, which may be done at little expense, nothing is necessary but to moisten the skains well with the solution of sulphate of iron, to press them equally, and then to immerse them in a caustic ley of pot-ash, which will precipitate and fix the oxide of iron of a disagreeable colour, but which will not fail to assume a rusty yellow shade, by attracting and becoming saturated with the oxygen of the atmosphere: thus yellow will become more or less dark according to the quantity of the sulphate of iron in solution. More intensity, and even more equality, may be given to the rusty yellow, by moistening the skains a second time in the ferruginous solution, and immersing them in the caustic ley. Care, however, must be taken not to use soda for this operation, because it generally contains sulphur, which blackens oxide of iron by mineralising it.

The skains coloured blue and rusty yellow, treated with oily alkaline solution of alumine, will produce by maddering, dark purple and chamois colours, violet, lilac, puce, mordore, &c. It may be easily conceived, that if, instead of maddering, the same skains prepared for maddering, be dyed with kermes, cochineal, and Brazil-wood, logwood, wood of St. Martha, woad, yellow-wood, quercitron, yellow berries, &c. a great variety of colours will be obtained: the shades may even be varied *ad infinitum*, by mixing the colouring ingredients with each other in different proportions. The affinity of adhesion of the colouring parts of all these ingredients, varies also, to such a degree, that the shades arising from a yellow or olive green, will be changed, or totally metamorphosed, by a second dyeing with madder, kermes, cochineal, or Brazil wood; and will furnish orange shades, capucine, carmelite, burnt bread, bronze, &c. As the preliminary preparation of the skains by the oily

alkaline solution of alumine, might be too expensive for some of these colours, the process I described in the *Annales de Chimie*, for the year 1792, p. 250, may be substituted in its stead. The process consists in treating the skains, alternately, with soap and sulphate of alumine, the excess of the acid of which has been saturated with one of the alkaline carbonates, or with lime: this method is very expeditious. In the course of a day, especially in summer, the skains may be prepared and dyed red as well as other colours; which, for the most part, may be subjected to ebullition, and will bear clearing with bran for a quarter or half an hour, and even some of them for a whole hour. It is also to be observed, that there are none but madder colours, the alumine and oxide of iron, bases of which have been fixed on the stuffs, by means of the oily alkaline solution, that can acquire perfect fixity by the action of heat of boiling water; and that the fixity is very inferior in all madder colours, the earthy and ferruginous bases of which, have been applied to stuffs by means of acid solvents.

Alumine fixed in abundance on cotton or linen stuffs, by means of a highly concentrated alkaline solution attracts very easily the colouring parts in the process of maddering. The case is not the same when the same earth is applied, by the most highly concentrated acetic solution of alumine; and it is absolutely impossible to finish maddering at one time, even when a profusion of madder is employed, and the operation is repeated three and even four times.* This circumstance will give rise to new and interesting experiments; but my observations prove in the mean time, that maddering, in general, requires to be managed with the nicest attention.

* Concentrated acetic solution of oxide of iron, is attended with nearly the same difficulties.