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on longitudinal vibrations. There is this difference, however, that, as far as I have observed, the tone, when the vibrations take place in a spiral direction, is a fifth lower than when the rod vibrates in a longitudinal direction under the same circumstances.

By the spiral vibration one phenomenon, which I have mentioned in my discoveries respecting the theory of sound, but respecting which I formed an erroneous opinion, can be explained. On a prismatic rod, one end of which was fastened in a vice, when I rubbed one of its edges, in a diagonal direction, with a violin bow, and strewed sand over one of its horizontal sides, there appeared on this side a line proceeding along its length, where the sand, which was thrown from the other parts by the vibration, remained at rest; and this appearance took place on each side of the rod when held horizontally. The reason of this is, because at the edges which are further distant from the axis the range during the vibrations is greater than in the middle of each side; and on this account the sand which is thrown from the nearer places to those on the edges must accumulate themselves longitudinally in the middle of each side nearest the axis where the vibrations are weakest.

XLIII. *Observations on Maddering; together with a simple and certain Process for obtaining, with great Beauty and Fixity, that Colour known under the Name of the Turkey or Adrianople Red.* By J. M. HAUSSMANN.

[Concluded from p. 175.]

The Process.

AFTER making a caustic ley of one part of good common potash dissolved in four parts of boiling water, and half a part of quicklime, 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-crystallization, I speedily poured into it successively, always stirring it without interruption, the above-mentioned caustic ley, till the alumine it had at first precipitated after saturation to excess with sulphuric acid had been redissolved. I left at rest this solution of alumine, which exhales ammonia, and which, on cooling, formed a precipitate of sulphate of potash in very small crystals. I then mixed a thirty-third part of
finest-

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 twenty-four 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 left 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 forgetting 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

* In fact, a saponaceous liquor is formed containing alumina.—EDIT.

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 oxygenated muriate of potash, 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 areometer 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 potash that can be procured, and the degree it gives by the areometer must be noted, in order that, if potash of an inferior quality be afterwards employed, the ley obtained may be carried to the fixed degree by evaporation.

Caustic ley made with four parts of good common potash* 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 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 clearing. 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.

* I have no doubt that, where potash cannot be procured, soda might be employed.—THE AUTHOR.

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 of 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 best 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 colours. 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 packthreads 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 a solution of the sulphate of iron, to press them equally, and then to immerse them in a caustic ley of potash, 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 be 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

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 mineralizing 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, mordoré, &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. This 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 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 stuff 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

tion 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.

XLIV. *A new Method of separating Silver alloyed with Copper in Bullion.* By C. NAPIONE †.

METALLURGISTS well know that argentiferous copper, which does not contain half its weight in silver at least, cannot be subjected to cupellation. In that case, recourse is had to an operation, called *liqutation*, with lead; but, unhappily, it is attended with inconveniences which in many cases render it impracticable.

To extract silver from copper completely, in one liqutation, practice has shown in the founderies where this operation is performed on a large scale on black copper, that for a quintal of the latter there must be at least 70 or 80 pounds of copper, and more than 8 or 9 ounces of silver; and in this case the proportion of lead to the copper ought to be 11 parts of the former and 3 of the latter.

But as in *billon* (base) money the silver generally forms from 1-12th to 1-4th of alloy, and sometimes more, it is evident that several liquations must be repeated to impoverish the copper; for though in the first the lead carries with it a great deal of silver, it is not always in the same proportion, and the latter portions are more difficult to be extracted.

If we suppose that four successive liquations are sufficient to extract the silver of our *billon* money, which is of the quality of 3 deniers 10 grains, estimating it at the lowest, we should have 55 livres for the whole expence of the separation for each quintal of that money.

If the process of the celebrated Cramer, of which M. Jars has given a short account in the third volume of his *Voyages Metallurgiques*, can be attended with any advantage, it would, however, be of very little use to us.

C. Napióné, knowing that sulphur has a greater affinity for copper than for silver, conceived the idea of reducing into scoriæ a large quantity of rich copper by combining it directly with sulphur, in the hope of obtaining, by this kind of dry *depart*, the silver concentrated in a portion of the copper

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

† From the *Annales de Chimie*, No. 122.