or sharpen, and are all held in position in the drum—into which they can be inserted in a very short time—by four long bolts. These teeth are used until worn down, and under average working conditions will turn up 3,000 square yards of road.

It is claimed for this machine that it can be equally well adapted to any existing roller or traction engine, effects a great saving of "metal," and is much more efficient and economical than hand labor. The machine works equally well backward or forward, and can be easily attached to a steam roller, and again detached, to allow the latter to be used in consolidating the material. One of these machines has been in use for some time on Kent roads, and has, we are informed, given excellent results.

NOTES ON SILK BLEACHING.

By S. J. PENTECOST, F.C.S.

WHILE much useful information on the subject of silk bleaching may be obtained from the few books which treat of silk dyeing, some of the statements made therein are either indefinite and misleading or in one or two cases positively erroneous. In the following notes, I propose to review some of the principal methods used, to compare and examine their efficiency, and to mention details of one or two processes more recently introduced.

Silk is composed of the yellow or white filaments which the silkworm spins about itself, when entering the chrysalis state. The thread issues from the caterpillar as a double fiber seen under the microscope as two smooth cylindrical filaments cemented together by the silk gum, and this it throws around itself to form the cocoon. As soon as completed these cocoons are collected and heated in ovens, or by steam to 130° F., to kill the pupæ or insects; should these burst in this process, they soil the silk and these cocoons are put on one side. The outside loose flossy silk—about 18 to 30 per cent. of the whole—is removed before steaming, and with the soiled cocoons is used for spun silk.

There are several varieties of silk which require more or less different treatment when bleached, and these may be conveniently divided as follows:

1. Cultivated silk
 - (1.) White and yellow reeled silk from China and Italy.
 - (2.) Spun silk.
 - (3.) Schappe.
2. Wild silk.....Tussur.

For the production of the reeled China and Italian silks, a few dried cocoons are placed in the basin of the reeling machine, which contains hot water; several ends are then taken up and reeled or twisted into a single thread. Two or more of these are again twisted or thrown by the silk throwster, and constitute the raw silk of commerce.

Spun silk is made of the waste silk of the reeling processes, and consists of silk which cannot be reeled in a continuous thread, viz.:

- (1.) The external floss silk, with outer and inner portions of the thread.
- (2.) Soiled, double and defective cocoons. The silk from these sources is boiled off—all the gum being removed—then combed or carded and spun similarly to worsted or cotton yarns.

It is not generally known, I believe, that much of the spun silk produced is tinted, before being spun, with blue or other coloring matter. I have often had cause to suspect that some of the spun silks worked up in lace fabrics have been weighted also; and I am informed that the weighting of waste or spun silk is carried on to a large extent. It is, therefore, not surprising that at times silks which look clean and lustrous in the fabric before bleaching and dyeing turn out poor in color and dull in appearance after these processes are carried out. The dyer is blamed for this result, whereas the mischief is really caused by the silk spinner or manufacturer. Such practices are to be regretted; and although it is possible to weight silk up to 60 per cent. without materially impairing its color, luster or strength, such weighting, if required, should be left to the silk bleacher. Much of the material used for this purpose is liable in conjunction with the oxidation bleaching processes to tender the fiber, causing loss and damage. Raw silk is also sometimes found to be weighted in a similar manner.

Schappe silk is made in the same way as "spun," but is not boiled off before spinning, being merely softened. In the stripping process it generally gives off a disagreeable odor of decomposed chrysalides.

Tussur silk is the most important of the wild silks. The cocoons are larger than those of the Bombyx Mori, and are of a grayish fawn color. They are very hard, the fibers being stuck together by a peculiar secretion of the caterpillar which gives to the silk its drab color. Much of this silk is combed or carded and spun, the reeling being difficult, although reeled Tussur is much more largely produced than formerly. The fiber is thicker and stronger than cultivated silk, and under the microscope shows striations which appear to be small fibrils, cemented together into one whole fiber.

Broadly speaking, silk consists of an inner cylinder of fibroin and an outer coating of sericin or silk gum, the latter being about 20 per cent. to 26 per cent. of the whole. Reeled Tussur has about 22 per cent. sericin, which may be boiled off. According to Bastow and Appleyard, on treatment afterward with alcohol, a brown wax-like substance may be obtained, easily soluble in NaHO, slowly in Na₂CO₃, and rapidly soluble in soap. Another constituent of Tussur silk which is important to the bleacher is lime. Lime and magnesia salts are present to the extent of about 1 per cent. of the fiber. On calcining a few grammes of the fiber in a platinum crucible at low red heat 5.34 per cent. of inorganic substances were obtained as follows:

	Per cent.
Soda (Na ₂ O)	12.45
Potash (K ₂ O)	31.68
Alumina (Al ₂ O ₃)	1.46
Lime (CaO)	13.32
Magnesia (MgO)	2.56
Acid radicals, etc.	39.0

The means adopted for removing this lime will be mentioned further on.

In nearly all cases when silk is to be bleached it is put through the preliminary process of stripping and boiling off.

STRIPPING.—The operation of stripping consists in working the silk in a bath of soap solution for about half an hour, with the object of first soaking and softening the silk glue and afterward partially removing it, together with the loose dirt, grease, etc., which has become attached to the silk during the manufacturing processes. For this purpose a solution of 13 lb. soap in 100 gallons of water is used at about 190° F. This liquor, containing the silk gum, can afterward be used in dyeing colors, and is known as "boiled-off liquor." In considering the precautions to be observed in carrying out this operation, it is necessary first to insist on the importance of good clear water, free from lime and magnesium salts. Hard water, if not passed through a water-softening apparatus, should be softened before use by adding to the water a suitable quantity of pure powdered 98 per cent. caustic soda. Some text books recommend the addition of Na₂CO₃ for this purpose, but since many hard waters contain more temporary than permanent hardness, this addition in most cases would be unsatisfactory, the sulphates of lime and magnesia only being precipitated, while the bicarbonates would be left in solution. The pure powdered NaHO dissolves at once and removes both permanent and temporary hardness thus:

As an example it may be mentioned that a sample of town water gave on analysis a total hardness of 9.8 parts per 100,000, comprising 6.2 parts temporary and 3.6 parts permanent hardness. It will thus be seen that with Na₂CO₃ added to this water only 1/2 of the lime would be affected. For a water of moderate hardness, such as is found in this district, 2 to 3 oz. of the caustic soda may be added to a barque containing 250 gallons of water, and stirred up thoroughly for three or four minutes before use. Should this precipitation of lime salts be neglected, a quantity of sticky lime soap is fixed upon the silk during the stripping and boiling operations which in turn serves to fix any suspended matter which may get into the bath. At the same time the luster is impaired and the silky feel of the fabric to a certain extent spoiled.

The quality of the soap to be used for stripping and boiling off requires careful attention. In a recent book I find cocoa nut oil soap spoken of as a good one for this purpose. The only point in its favor, however, is that it is not decomposed by hard water with formation of lime soap. Its disadvantages are its alkalinity and the bad smell left by it on the silk. An excess of caustic alkali is inevitable in a thoroughly saponified cocoa nut oil soap, making it unsuitable for toilet purposes, since it attacks the skin; and hence for a similar reason, viz., that it attacks the animal fiber, unsuitable for ungumming silk.

The soap used must be free from caustic alkali, must rinse out well, be a good color and leave an agreeable odor. Potash soaps made from olive oil, tallow, or olein are the best for this operation. Of these, tallow soap rinses out more difficultly than either olive oil or olein soap, the latter being best in this respect. Therefore, having regard to the comparatively high price of olive oil, I consider the best soap for silk is a potash soap made from a good white tallow olein. Cottonseed olein is not so good, and is likely to leave objectionable smell on the goods. Potash soap is preferable to a soda soap, since the former is less keen—all things being equal—than the latter, and appears to preserve the luster, etc., of the silk better. The soap indicated rinses out well and leaves the silk lustrous and with an agreeable odor.

Although theoretically a perfectly neutral soap would seem to be best for stripping and boiling off, it is found in practice that a soap made slightly alkaline with K₂CO₃ gives on the whole somewhat better results; but it should be clearly understood that any alkalinity arising from caustic potash or soda is deleterious to the silk, making it dull and harsh.

BOILING OFF.—The silk after being stripped is, in the case of lace, fabrics, etc., put into boiling bags to be boiled off. The bags are loosely made of thick hempen cord, and then filled and tied at the top and put into the boiling copper, which is generally heated by fire as well as steam. In the case of hank silk, the latter is worked on sticks in the boiling bath or in specially constructed machines. The silk is then boiled in about 15 per cent. of soap, or speaking more correctly, a solution of soap containing 7 lb. of soap to 100 gallons of water, for one or two hours, according to the quality and thickness of the silk. After rinsing first in warm, then in cold water, the silk is ready for bleaching.

BLEACHING.—The several methods used in bleaching silk may be conveniently divided as follows:

1. Bleaching by treatment with acid.
2. Bleaching by reduction methods—
 - (a.) Gas bleaching.
 - (b.) Liquid bleaching.
3. Bleaching by oxidation—
 - (a.) Permanganate potash method.
 - (b.) Hydrogen peroxide.
 - (c.) Sodium peroxide.

1. *Acid Treatment.*—The first method is frequently used in conjunction with the sulphuring process for bleaching raw yellow silk which requires souping, the object of which is to gain the luster and feel of boiled-off silk without removing the gum, or with the loss of only a small quantity of gum. It is usually carried out as follows: The yellow silk is first softened and cleaned by working for about an hour in a warm bath of 10 per cent. soap. It is then well washed and bleached by immersing in a bath of aqua regia at about 3° or 4° Tw. The aqua regia is made by mixing 5 parts commercial hydrochloric acid with one part nitric acid and allowing to stand. The silk lies in this acid bath until it turns greenish. It is then taken out, well washed, sulphured and souped.

Better results, however, may be obtained by using in place of aqua regia a dilute solution of sulphuric acid in which an OH group has been replaced by an NO₂ group, thus:

This is obtained by saturating the oil of vitriol with nitrous fumes, or dissolving in it a suitable quantity of chamber crystals obtained in the manufacture of sulphuric acid. The raw yellow silk after softening by working in a 10 per cent. soap solution at 70° F. for 1 hour is well washed and entered into the acid bath at 4° Tw. and left there for 10 to 15 minutes. If it is allowed to lie in this bath too long, it contracts a yellow tint. It is then well washed and may be sulphured, afterward washing and souping by working about 1 hour in acidulated water at 190° to 200° F. in the usual way.

This acid treatment can be used also to improve the color of boiled-off silk, by working the latter in the acid at a strength of 1/2 Tw. (0.0025 sp. gr.) at a temperature of about 140° to 160° F.

2. *Reduction Methods.*—In bleaching by these methods the coloring matter of the silk is destroyed by the reducing action of sulphur dioxide either in the form of gas or in solution. This reagent has been in use for several centuries, the exposure of silk and wool to sulphur fumes being a very old process. As at present carried out, the silk is hung up and spread out in a chamber generally termed the sulphur stove, heated to 90° or 100° F., which can be securely closed to confine the fumes. The requisite amount of sulphur is then lighted and left to burn itself out, the doors being securely closed. After six hours (or all night), the doors are thrown open; the gas allowed to escape; and the silk being taken out, is washed to remove sulphuric acid, etc., which may form in the goods by oxidation of the sulphur dioxide. The amount of sulphur to be burned should have some relation to the size of the chamber, and the percentages of sulphur given which have regard only to the quantity of silk to be bleached are therefore not always reliable. About 1/2 lb. sulphur per 1,000 cubic feet of stove room is a suitable quantity.

This process gives a distinct improvement in the color of the silk, but its effect is by no means permanent. Exposure to light and air gradually brings back the original yellow or brown tint, probably owing to reoxidation. A passage through soap or an alkaline bath also to a great extent destroys the advantage gained by sulphuring; hence it is very little use for goods which have subsequently to be dyed light colors in a soap bath. It is, however, very largely used; its cheapness being an important consideration.

Bleaching by Sodium Hydrosulphite.—Quite recently another substance which exerts a reducing action upon the coloring matter of the silk has been applied for bleaching, viz.: Hydrosulphite of soda, NaHSO₂. To prepare it a clean bleached tub of 50 galls. capacity may be taken. Into this are put 32 galls. of bisulphite of soda at 66° Tw. (1.33 sp. gr.) and scraps of pure zinc are added until they reach the surface of the liquid, when it is covered up for one hour. Means are taken, if necessary, to prevent the temperature rising too high; earthenware tubes being sometimes suspended in the tub through which cold water circulates. The liquid is then drawn off into another tub which is filled and covered up to prevent oxidation, and left to stand for 12 hours to allow the zinc and sodium sulphites to crystallize out. The supernatant liquor is the bleaching agent, and is also kept covered up in a full tub to avoid oxidation to bisulphite. The hydrosulphite is formed thus:

For use it is only necessary to dilute the standard bleaching agent with an equal volume of water, enter the cleansed goods, and allow them to remain in this bath for six hours; after which they are well wrung and immediately washed. If this washing is delayed, the fibers are rapidly heated and thereby injured in luster and strength. The silk should then be run through a weak hydrochloric acid bath to remove all traces of sodium and zinc sulphites, which would produce yellow stains on finished goods, and finally washed in abundant water. When the bleaching bath falls below its original level it may be replenished with fresh NaHSO₂, and will thus last for a considerable time. The undissolved zinc can also be made again serviceable by washing it with plenty of water acidulated with HCl.

3. *Oxidation Methods.*—Several substances which exert an oxidizing action upon the silk have been tried at various times for bleaching it. One of those most used before the introduction of the peroxides was potassium permanganate. Its action depends upon the fact that it readily gives off oxygen in the presence of organic matter. The silk was steeped in a dilute solution of the permanganate, and afterward worked in an acid bath which dissolved off the brown hydrate formed in the reaction.

The use of permanganate has, however, practically ceased, since hydrogen peroxide has been put on the market at much lower prices than formerly.

Bleaching with Hydrogen Peroxide.—This reagent has now been in use for bleaching some 18 or 20 years. Silk bleached by it was exhibited at the Paris Exhibition of 1878. It is only during the last few years, however, that its reduced price has allowed it general use. It is made from peroxide of barium by introducing the latter gradually into a calculated quantity of hydrofluoric acid until it is just neutralized. The process, which takes about 12 hours, is carried on in a copper vessel, suspended in a wooden vat filled with cold water; great care being taken to prevent a rise in temperature. The hydrofluoric acid may be regenerated from the barium fluoride formed by means of H₂SO₄. The BaO₂ is also sometimes decomposed with sulphuric or carbonic acid. Hydrogen peroxide may also be produced, as follows: Finely ground barium carbonate is moulded into bricks with sawdust and pitch, and heated in a furnace to a temperature of 1,000° C. The barium oxide thus obtained is cooled to 50° C., at which temperature it absorbs oxygen from the air. The BaO₂ is then mixed with water and decomposed by a current of carbon dioxide. The hydrogen peroxide formed is then decanted off and the precipitated BaCO₃ used for another operation. Hydrogen peroxide decomposes very easily, and should be kept in a cool, dark place when stored, to prevent loss of oxygen. It is more stable when slightly acid than when neutral or alkaline. According to the experiments of Kingzett, published in the journal of the Society of Chemical Industry, 1880, its stability is further

maintained by addition of alcohol, while of the acids, phosphoric acid appears to best preserve the strength.

It is sold of 10, 12 or 20 volume strength, in carboys or barrels—the former should be preferred, since in them the strength and color are better maintained. The exact meaning of the term "volume strength" appears to be sometimes misunderstood. I have come across one or two statements to the effect that 10 volume peroxide is such as with the addition of permanganate of potash produces 10 volumes of oxygen. This is plainly an error, since one-half the amount of oxygen is furnished by the permanganate, and such a solution of H_2O_2 would really only contain 5 volumes of available oxygen. A 10 volume solution is such as contains 10 times its own volume of available oxygen.

Estimation of Peroxide of Hydrogen.—Owing to the uncertain strength of many peroxides at present sold, and also to the easy deterioration of their solutions, it becomes very necessary that every lot should be carefully tested for strength. Much of the peroxide of hydrogen sold in this country as 12 volume varies in strength from $4\frac{1}{2}$ volume to 9 volume. Several methods of estimation are available, viz.:

1. Titration with permanganate of potash until a faint pink color is obtained. Two grammes of the peroxide are taken, diluted with 50 c. c. distilled H_2O and titrated with a centinormal solution of permanganate of potash until the pink color appears, the peroxide being first acidulated with about 2 c. c. of H_2SO_4 . The percentage and then the volume of H_2O_2 may be calculated. The reaction is as follows:

Each c. c. of $\frac{N}{100}$ $K_2Mn_2O_8$ taken corresponds to 0.56 volume, or 0.17 per cent. H_2O_2 , and $\therefore$ 2 grms. H_2O_2

of 12 volume strength would require $21.5 \text{ c. c. } \frac{N}{100}$ $K_2Mn_2O_8$.

2. It may also be accurately estimated by addition of potassium ferricyanide and caustic potash thus:

This reaction takes place with quantitative exactness. The caustic potash should be strong and used in large excess. A nitrometer (Lunge's) may be used for the estimation.

3. The strength may be estimated also by adding potassium iodide to an acid solution of peroxide, and estimating the iodine liberated with sodium thiosulphate and starch.

4. A much readier method for practical use, and one which gives approximately accurate results, may be described as follows: A 50 c. c. graduated tube closed at one end is filled with water up to about the 28 c. c. mark, and a little H_2SO_4 (say 1 c. c.) added: 1 c. c. of the peroxide to be estimated is then carefully added from a burette; the thumb placed on the mouth of tube, the latter inverted, and the volume of air read off. A few crystals of permanganate of potash are then loosely wrapped up in a bit of tissue paper and dropped into the tube; the thumb is immediately placed over the tube mouth to make it gas tight, while the hand firmly grasps the tube and shakes it thoroughly for two or three minutes. The tube is then plunged into a glass cylinder of cold water, mouth downward; the mixed gases are cooled to ordinary temperature, and the volume read off. After deducting from this the volume of air space previously ascertained, one half of the residual volume obtained represents the volume of oxygen available in the sample. While shaking, the pressure on the thumb increases, and care must be taken to keep it tightly on the tube mouth to prevent escape of gas.

A consideration of the temperature at which the bleaching is performed may enable us to speak of the two methods of bleaching with peroxide of hydrogen, viz.: (1) the cold method; and (2) the warm method.

Cold Method.—A bath is prepared by diluting a quantity of 12 volume peroxide with three times its volume of cold water, and adding sufficient ammonia to cause the bath to smell faintly of it, and cause small bubbles of oxygen to slowly rise to the surface. The goods are immersed in this liquid for one, two or three days, according to the amount of bleaching required. As a rule, it is unwise to leave goods in this liquor longer than three days, as after this time the luster and strength are likely to suffer. Borax, oxide of magnesium, silicate of soda, and other substances may replace the ammonia; and their comparative advantages are dealt with further on in speaking of Tussur bleaching.

Warm Method.—In this method a bath is made up at 1 part of 12 volume H_2O_2 to 10 parts water or 1 part to 20 of water, according to the amount of bleaching the silk requires. An addition is made to the bath of ammonia, or preferably for this method one of the above named substances; the silk is entered, worked for one-fourth hour, gradually heated up to $190^\circ F$. during one hour, and then worked for three-fourths hour at this temperature, washed and scrooped.

Sodium Peroxide.—Quite recently there has been introduced a new product for bleaching silk, viz.: Peroxide of sodium, Na_2O_2 . It is manufactured by the Aluminum Company, Limited. The method of manufacture as described by Mr. Castner, the patentee, consists in treating metallic sodium contained in aluminum vessels at a temperature of $300^\circ C$., to the gradual oxidizing action of a mixture of oxygen and nitrogen in which the proportion of oxygen is gradually increased. This is done in an iron pipe which passes through the furnace and along which a current of air is passed from one end. The vessels containing the sodium pass along the entire length of the pipe, the sodium being oxidized at first by air which has been almost deprived of its oxygen, the proportion of the latter gradually increasing until it is finally oxidized by air containing the full amount of oxygen.

This method is not unlike that pursued in the manufacture of barium peroxide, in which BaO , prepared by reducing the nitrate in fireclay crucibles, is heated at a high temperature in a retort, air being allowed to pass in at one end and nitrogen to escape at the other.

The average analysis of Na_2O_2 (for which I am indebted to Mr. F. Burton, of London) shows:

	Per cent.
Peroxide sodium.....	93.0
Protoxide ".....	2.0
Carbonate ".....	2.5
Hydrate ".....	2.5

Compared with BaO_2 and H_2O_2 (10 vols.) solution, the available oxygen is as follows:

93 per cent. sodium peroxide.....	19.5 per cent. available O.
91 per cent. barium peroxide.....	8.6 " "
H_2O_2 10 vol. solution 1.6 " "	" "

It is a yellowish white partially powdered substance which dissolves in water with a hissing sound and great evolution of heat. These characteristics are possibly partly due to particles of metallic sodium from which the peroxide is made. As at present delivered to the consumer it is by no means free from impurities, and dark colored particles are found which might be expected to be slightly prejudicial to its bleaching effect. It is strongly alkaline and very deliquescent. *In keeping it care must be taken to keep it dry and to prevent its contact with inflammable materials, such as cotton, paper, etc.* If kept dry, it is more stable than H_2O_2 , and if used carefully it comes cheaper. The makers claim for it that 1 lb. is equal in bleaching power to $1\frac{1}{2}$ gallons of 10 volume H_2O_2 . They recommend its conversion into H_2O_2 by adding it gradually to dilute H_2SO_4 ; but if this is done in strong solutions without the use of suitable cooling arrangements, much loss of oxygen results and the ultimate product is much dearer than ordinary H_2O_2 . To make 10 gallons of 10 volume H_2O_2 take $10\frac{1}{4}$ lb. H_2SO_4 $168^\circ Tw$, mix with 8 or 9 gallons H_2O and cool. Then add $7\frac{1}{2}$ lb. sodium peroxide gradually and with continual stirring, special cooling arrangements being used to keep temperature low, without which it would rise considerably and oxygen would be lost.

It is, however, better in practice to make the Na_2O_2 into H_2O_2 of 1 volume strength or such strength as is required for bleaching, in order that the extra water required may be utilized to cool the whole, and so prevent escape of oxygen. Thus a 1 volume H_2O_2 bath may be made by adding to 94 gallons of water $10\frac{1}{4}$ lb. H_2SO_4 $168^\circ Tw$, previously diluted with 2 gallons H_2O and cooled, then gradually with stirring $7\frac{1}{2}$ lb. Na_2O_2 . In making up these solutions I find they are always slightly colored yellowish brown; and on throwing down this coloration and examining it, it was found to consist of oxide of iron. This impurity is the most serious defect of the sodium peroxide at present sold; and it is to be hoped the makers may be able in the future to eliminate it. It can, however, be got rid of by a suitable addition to the bath, which carries it down to the bottom of the vessel. Another method of using peroxide of sodium will be mentioned later under the head of Tussur bleaching.

Bleaching of Tussur Silk.—In consequence of the secretion which permeates the silk of the Tussur cocoon being more difficult of removal than in the case of cultivated silk, other and keener substances are sometimes used in the stripping bath, such as caustic soda, potash, etc. The following trials were made on reeled Tussur to determine the best scouring agent to use in stripping and boiling off:

No. 1, stripped $\frac{1}{2}$ hour and boiled 1 hour in..	$\frac{1}{4}$ oz. Na_2CO_3 to 1 pint H_2O .
No. 2. do. do.	$\frac{1}{8}$ oz. Na_2CO_3 + $\frac{1}{8}$ oz. soap in 1 pint H_2O .
No. 3. do. do.	$\frac{1}{8}$ oz. $NaOH$ to 1 pint H_2O .
No. 4, steeped 1 night (12 hours) in a bath containing in three pints water.....	$\frac{1}{2}$ oz. soap. 3 c. c. ammonia 0.880. 1 c. c. turpentine.

No. 4 looked cleanest and best, No. 3 better color than 1 and 2, but not quite so lustrous. Nos. 1 and 2 gave practically equal results. These four samples were bleached with H_2O_2 with addition of silicate of soda by the warm method.

No. 4 did not bleach well, the turpentine evidently interfering with the result. Nos. 1, 2 and 3 appeared to be very much alike in color, No. 3 not being quite so lustrous.

The older bleaching processes which are still useful for cultivated silks are comparatively useless for Tussur, and the latter can only be bleached satisfactorily by the use of peroxides of hydrogen or sodium. A number of methods have been proposed, in which other reagents are used previous to the peroxide bath, but the best of these produce no better result than when peroxide is used alone, as will be shown by the bleaching trials given further on, while the luster and feel are more or less impaired by them. Professor Lunge is said to have written favorably of a combination of the sulphuring and peroxide methods (see Hurst, silk dyeing, p. 32). But if the theory given of the action of these processes is correct, viz., that they act by reduction and oxidation respectively, the one process might be expected to neutralize the effect of the other. This appears to be so in practice. So far as Tussur silk is concerned a sample was sulphured for 12 hours, washed and bleached in a peroxide bath of 2 volume strength for three days. The result was distinctly inferior to a second sample bleached in the same strength of peroxide alone. Boiled-off Tussur, was used for this experiment.

Another method given for bleaching Tussur silk in Mr. Hurst's recently published book on silk dyeing, and attributed by him to H. Koechlin, is to boil or steep the silk in a bath of 22 lb. caustic soda, 66 lb. soap, 11 lb. calcined magnesia, 11 gallons 10 volume peroxide of hydrogen, and a little ammonia. This bath would not simply bleach the Tussur, but would dissolve it. It was really recommended by Koechlin for bleaching cotton with hydrogen peroxide and does not give "excellent results" with Tussur as stated by Mr. Hurst.

The following method was proposed by Ch. Girard, and has been applied for bleaching Tussur spun silk on the Continent:

1. Work in warm dilute HCl (1 to 8) for 1 hour,

2. Wash and strip with sodium carbonate or 2 per cent. caustic soda, and wash.

3. Steep in hypochlorite of ammonia for 24 hours. This bath may be repeated.

4. Wash, pass through dilute HCl and wash.

5. Steep in hydrogen peroxide of one-half volume strength with addition of ammonia or borax.

The first hydrochloric acid bath is beneficial, in that it removes the lime present in Tussur silk, but the treatment with ammonium hypochlorite before bleaching with hydrogen peroxide is quite a superfluous process, and no advantage can be gained by its use, as the following bleaching trials show:

No. 1 sample was stripped half an hour and boiled one hour in $\frac{1}{4}$ oz. Na_2CO_3 to 1 pint water.

No. 2 was steeped in warm dilute HCl (1 in 6) for one hour, washed, then stripped and boiled as No. 1, and steeped in hypochlorite of ammonia at $1^\circ Tw$ for 24 hours.

No. 3 was treated as No. 2, but steeped in hypochlorite of soda at $1^\circ Tw$ for 24 hours.

All three were washed and separately steeped in H_2O_2 (1 vol.) with 2 c. c. $AmHO$ added to 22 oz. for three days, then washed and scrooped.

No. 1 gave the best result both in color and luster. No. 3 became tender in the Na_2Cl_2O solution— $1^\circ Tw$, being evidently too strong—but as No. 1 gave best color the trial was not repeated.

The ammonium hypochlorite was made by adding $1\frac{1}{2}$ oz. Am_2CO_3 dissolved in $\frac{1}{2}$ pint water to 1 oz. bleaching powder rubbed down in $\frac{1}{2}$ pint water, allowing to settle and using the supernatant liquor.

The sodium hypochlorite was made by mixing $5\frac{1}{2}$ oz. bleaching powder in 1 pint water, and $3\frac{1}{2}$ oz. crystal carbonate in $1\frac{1}{2}$ pints water; the latter is added to the former mixture gradually; the mixture becoming much thicker, and then suddenly thin again near the completion of the reaction. It was then allowed to settle, and the liquor poured off for use.

Experiments were then made to determine the best and most economical strength of peroxide of hydrogen to use in bleaching. Three samples of reeled Tussur were worked in hot dil. HCl for 20 minutes, washed, stripped, and boiled in Na_2CO_3 solution $\frac{1}{4}$ oz. to the pint, then steeped in peroxide of hydrogen solution as follows:

Strength of 12 vol. H_2O_2 .	$AmHO$ added.	Result after 24 hours.
No. 1.—1 part H_2O_2 to 3 parts water.	2 c. c. $AmHO$ to 22 oz. liquor.	Nos. 1 and 2 were distinctly better than No. 3.
No. 2.—1 part H_2O_2 to 10 parts water.		
No. 3.—1 part H_2O_2 to 20 parts water.		

Left them in bleach three days.

On the second day there was a slight improvement in all. The third day scarcely helped them. On the third day they were heated in their respective liquors to $190^\circ F$. for two hours. This treatment improved the color considerably without impairing the luster perceptibly. After heating No. 1 was slightly better than 2. Nos. 1 and 2 much superior to No. 3.

A third series of experiments was made to determine the best addition to make to the peroxide of hydrogen bath, with a view to producing the best color consistent with strength and luster. Four samples of reeled Tussur prepared as indicated in previous series were bleached in 12 vol. H_2O_2 diluted with 10 times its weight of water, with various additions as follows:

Additions made to 22 oz. peroxide liquor.	Result after 1 day.	Result after 2 days' cold bleaching, then heating to $190^\circ F$. in respective liquors.
No. 1. 2 c. c. $AmHO$ @ 0.880.	Better than 2. Inferior to 4.	About alike.
No. 2. $\frac{1}{4}$ oz. $Na_2B_4O_7$	Darker than others.	
No. 3. $\frac{1}{4}$ oz. MgO	Same as No. 1.....	Slightly better than 1 and 2.
No. 4. $\frac{1}{4}$ oz. Na_2SiO_3 @ $140^\circ Tw$.	Clearer. Rather yellower than others.	Much the best.

No. 4 gave a very good result. It was a clear good color, and lustrous, and its strength was not perceptibly diminished.

Sodium Peroxide.—Very good results may be obtained by bleaching Tussur with sodium peroxide by the following method recently patented by Dr. Haen. For 50 lb. of Tussur a bath is prepared containing 30 lb. epsom salts in 110 galls. water. The silk after being boiled off and well washed is thoroughly impregnated with this liquor and lifted; and then 6 lb. 10 oz. peroxide of sodium are carefully added in three portions during three-quarters of an hour, working the silk in the bath after each addition. It is important not to neglect the first impregnation with $MgSO_4$ solution, as the luster would be impaired by the strongly alkaline peroxide of sodium acting upon the silk. The whole is then gradually heated during three-quarters of an hour to $190^\circ F$., the operation lasting about two hours. Dilute sulphuric acid is then added to clear the liquor, which has become milky through separation of magnesium hydrate. The material is given two or three turns in this liquor, washed, and then worked for half an hour in a bath of 30 per cent. soap to increase and restore its luster, washed and brightened by stringing, etc.

The reaction which takes place appears to be the following:

Samples bleached by this method gave a color scarcely inferior to that obtained by means of hydrogen peroxide and sodium silicate; the luster, however, was not quite so good before soaping. $ZnSO_4$ was tried in place of $MgSO_4$, but did not give so good a result, although it gave a fair color. It may be noted, that by working silk after bleaching for half an hour in a 30 per cent. soap bath, afterward washing and scrooping, the luster of the silk is improved, that being the case especially with Tussur. In concluding I desire to ac-

knowledge the assistance of Mr. Furley Davis in carrying out the bleaching trials.

In the discussion which followed, the chairman among other things said: As to peroxide of sodium, he was glad Mr. Pentecost had referred to the dangerous nature of the chemical, which would easily set fire to cotton, wool, hay, straw, and even wood upon which it had become spilled if water were dropped upon it.—*Jour. Soc. Chem. Ind.*

IMPROVEMENTS IN GALVANIZING IRON.

G. RETTERER, Paris, France.

In the ordinary manufacture of galvanized iron by dipping there is a considerable production of hard spelter and excessive volatilization, owing to the ne-

APPARATUS FOR GALVANIZING IRON.

cessity of uncovering the metal while the sheet is being withdrawn. This invention consists in mechanical means for overcoming these difficulties. The apparatus (Fig. 1) consists of a bath, *c*, divided above into two compartments by the partition, *h*. The bath, *c*, and compartment, *o*, are filled with lead; the compartment, *o*, contains spelter, which floats on the lead. In the compartment, *o*, at the surface of the spelter are two movable bars, *k*, *k'* (Fig. 2), supported by rods, *m*, *m'*, pivoted at *n*, *n'*. In order to coat a plate it is thrust into the compartment, *o*, and submerged until its upper edge is below the partition, *h*. It is then released and floats upward, pushing apart the bars, *k*, *k'*, which in their turn push aside the powdered coke with which the metal is covered. A small clear space is thus produced sufficient for the removal of the sheet. The surface of the lead in the compartment, *o*, is covered with sal-ammoniac.

IMPROVEMENTS IN MELTING FURNACES.

F. H. MALLAHAND, Kirkcaldy, London.

This is a furnace for general melting purposes, and can be used either with coke or gaseous fuel. If the former is used the metal is placed in a crucible, *O*, which

IMPROVED MELTING FURNACE.

is then packed round with coke. An air blast passes from the box, *c*, through tubes, *a*, of which there are several, into the furnace, *A*. It also passes through *P* and *P'* into a lower compartment, *F*, which receives the metal as it melts. The tube, *P*, can be deflected as shown by the dotted lines, to allow of the removal of samples from *F* and for rabbling. The products of combustion from the furnace, *A*, pass through *S* into *B*, and finally escape to the chimney through *U*. The furnace, *B*, contains scrap, or metal receiving a prelim-

inary heating before being transferred to *A*. Any metal which may be melted in *B* passes through *R* into *F*. The openings, *D*, *D'*, in the two furnaces communicate with a channel, *E*, and are for the escape of slag. The channel, *E*, is kept hot by the gases passing from *A* to *B*. The metal is drawn off through the spout, *Q*. If gaseous fuel is to be used the crucible is removed, the arch, *G*, completed, and the body of the furnace filled with the metal to be melted. The blast in *C* is cut off, the flue, *U*, closed, and two ports, *J*, *J'*, are opened. Each of these communicates with a pair of regenerators, conveying air and gas respectively, and the flame is passed from *A* to *B* and from *B* to *A* as the pairs of regenerators respectively become heated and cooled down.

EXTRACTION OF GUTTA PERCHA.

The invention of Dieudonne Rigole, of Singapore, Straits Settlements, relates to a process and apparatus for extracting gutta percha from the leaves and twigs of *isonandras*, *dichopsis* or other gutta percha trees by the use of carbon bisulphide, thus avoiding the common practice of cutting down these valuable trees, which require twenty-five years to reach maturity.

The leaves and twigs from which the gutta percha is to be extracted are suitably pounded so as to uncover the cells containing the gum. In this state they are introduced into an exhausting vessel, *A*.

The carbon bisulphide is put in the boiler, *B*, passes through the tube, *a*, in a state of vapor into the condenser, *C*, where it condenses and then traverses the pounded leaves and twigs. The condensed vapors from the bisulphide containing the soluble principles then return to the boiler, *B*, through the tube, *a'*, the lower part of which is provided with an automatically operating flap, *b*, for permitting the passage of the gum into the boiler, *B*. Across the bore of the tube, *a*, is placed a very thin wire gauze, *c*, serving as a filter or rather as a strainer. After the bisulphide has collected a certain portion of the gum, which it conducts to the boiler, *B*, where the same is deposited, it escapes through the tube, *a*, in order to condense again in the space, *C*, and recommence its exhausting operation until the gum contained in the leaves and twigs

EXTRACTION OF GUTTA PERCHA.

in the vessel, *A*, has been completely extracted. The tubes, *a* and *a'*, are surrounded by a sleeve of cotton, wool or any other non-conducting material which prevents them from cooling. In this manner the carbon bisulphide which is continually being purified by the distillation must in a short time effect the complete exhaustion of the leaves and twigs. Of course the carbon bisulphide contained in the boiler, *B*, must never boil, because the gum collected would otherwise become quite oxidized, which inconvenience is obviated by placing the said boiler in a water bath, *D*, wherein water is kept at the maximum temperature of 45° Centigrade. A steam boiler, *E*, is connected to the vessel, *A*, by a tube, *h*, provided with cocks, *e* and *g*. A tube, *i*, provided with a cock, *f*, leads from the boiler, *B*, to a vessel, *F*. When the exhaustion of the leaves and twigs is complete the valve, *c*, leading from the boiler, *B*, to the tube, *a*, is closed to prevent the communication of the boiler, *B*, with the tube, *a*. I also close the cock, *d*, which connects the tube, *a*, with the vessel, *A*, and open the cocks *e*, *f* and *g*, and introduce into the vessel, *A*, a powerful jet of superheated steam. This steam comes from the boiler, *E*, through the tube, *h*, and passes into the boiler, *B*, through the tube, *a'*. It will carry away the few globules of gum which may still be in the leaves and twigs, traverse the tube, *a'*, in order to pass to the boiler, *B*, containing the gutta percha in solution in the carbon bisulphide, and introduce the vapors through the cock, *f*, into the discharge tube, *i*, the extremity of which dips a short distance into the water contained in the vessel, *F*. The carbon bisulphide having a greater specific weight than water, falls naturally to the bottom of the vessel, *F*. When the gum has all been extracted from the leaves and twigs, the gutta percha is in a liquid state mixed with the solvent. As the steam carries away the carbon bisulphide and precipitates it in the bath, *F*, the gutta percha in the boiler, *B*, thickens, and when the last traces of the solvent are removed the gutta percha has become a solid body but capable of being kneaded if put into warm water. In order that no bisulphide shall remain in the gum the introduction of superheated steam may be prolonged in such a manner that the gutta percha will not be affected by its action and that its oxidation need not be feared.

The complete operation ought not to occupy more than twenty-two to twenty-five minutes for obtaining chemically pure gutta percha.

Other solvents than carbon bisulphide would give similar results, such as benzine, chloroform and the like, but the price of these substances, which I have tried, augments the cost of the gutta percha so much that their employment is not practicable for commercial purposes.

If use is made of benzine as a solvent, the gum collected will contain some traces of this substance, the elimination of which presents almost insuperable difficulties.

CUT NAILS AND WIRE NAILS.

The following is a summary made by consulting engineer William H. Burr from the detailed official report of commanding officer J. W. Reilly, Major, Ordnance Department U. S. A., in command of the United States Arsenal at Watertown, Mass., and of the United States testing machine at that station, showing the results of the recent official tests made for ascertaining the relative holding powers of cut nails and wire nails, of equal lengths and weights; which tests were made at the United States Arsenal at Watertown, Mass., under the supervision of Major Reilly, in accordance with an invitation of the Eastern cut nail manufacturers of the United States to the wire nail manufacturers of the United States, dated November 4, 1892. The tests were made in November and December, 1892, and January, 1893:

The series of tests, each series comprising ten pairs of cut nails and wire nails of one size, were, in number.....	58
The number of nails tested was.....	1160
The nails ranged in length from.....	1½ to 6 in.
The number of series in which the cut nails showed the superior holding power was.....	58
The number of series in which the wire nails showed the superior holding power was.....	not any
All the nails tested were driven in.....	spruce wood
Additional tests were made, of the box nails only, in.....	pine wood
In spruce wood, in 9 series of tests, comprising 9 sizes of common nails (longest 6 in., shortest 1½ in.) the cut nails showed an average superiority of.....	47.51 per cent.
In spruce wood, in 6 series of tests, comprising 6 sizes of light common nails (longest 6 in., shortest 1½ in.) the cut nails showed an average superiority of.....	47.40 per cent.
In spruce wood, in 15 series of tests, comprising 15 sizes of finishing nails (longest 4 in., shortest 1½ in.) the cut nails showed an average superiority of.....	72.22 per cent.
In spruce wood, in 6 series of tests, comprising 6 sizes of	

box nails (longest 4 in., shortest 1½ in.) the cut nails showed an average superiority of.....	50.88 per cent.
In spruce wood, in 4 series of tests, comprising 4 sizes of floor nails (longest 4 in., shortest 2 in.) the cut nails showed an average superiority of.....	80.03 per cent.
In spruce wood, in above 40 series of tests, comprising 40 sizes of nails (longest 6 in., shortest 1½ in.) the cut nail showed an average superiority of.....	60.50 per cent.
In pine wood, in 6 series of tests, comprising 6 sizes of box nails (longest 4 in., shortest 1½ in.) driven with taper perpendicular to grain of wood, the cut nail showed an average superiority of.....	135.20 per cent.
In pine wood, in 6 series of tests, comprising 6 sizes of box nails (longest 4 in., shortest 1½ in.) driven with taper parallel to grain of wood, the cut nail showed average superiority of.....	100.23 per cent.
In pine wood, in 6 series of tests, comprising 6 sizes of box nails (longest 4 in., shortest 1½ in.) driven in end of wood, the cut nail showed average superiority of.....	64.38 per cent.
In pine wood, in above named 18 series of tests, comprising 6 sizes of box nails (longest 4 in., shortest 1½ in.) driven in three ways, the cut nail showed an average superiority of.....	99.93 per cent.
In spruce and pine wood combined, in the whole 58 series of tests, comprising 40 sizes of nails (longest 6 in., shortest 1½ in.) the cut nails showed average superiority of.....	72.74 per cent.

MAGNESIA FIREBRICKS.

SOME weeks ago, at a meeting of the French Society of Civil Engineers, a discussion took place on the possibility of obtaining higher temperatures in steel furnaces. At present the temperature is limited by that at which the walls of the furnace begin to fuse, and even Diners firebricks are not proof against this. Magnesia is claimed to be capable of standing far higher temperatures than the Diners brick. It is used according to a statement made at the meeting referred to, by M. Lencauchez, and was first proposed by M. E. Muller in 1869. The principal difficulty in using it is the excessive shrinkage to which it is liable when heated. Thus, a cube of magnesia of 10-in. edge in the raw state is said to shrink to one of 6-in. edge when sufficiently calcined. For this reason furnace linings made of this material were liable to crack badly. The remedy for this state of things is to cause the magnesia to undergo its maximum possible contraction before being placed in the furnace, but for this an excessively high temperature is required.

These difficulties have, it is claimed, now been overcome, and M. Lencauchez showed the Paris Society of Civil Engineers a number of perfectly solid bricks of magnesia, which were as dense as granite, and had