pasteboard, in a Bramah press, and after a certain interval an iron plate is substituted for the pasteboard, to prevent any inequality in the pile. Finally, the folded pieces are prepared for the market by fastening a band of gilt and ornamented paper around each end, which with the imprinted device is in some way regarded as a guarantee of good quality.

The whole operations of bleaching and finishing occupy on an average eight days, although goods can be hurried through much quicker if occasion arises. The cost, which of course will vary with the price of fuel and other circumstances, is very small as compared with the value of the material, and does not on an average, for shirting calicoes and the like, exceed 1½d. per lb weight of cloth.

Bleaching of Thread.

We have been favoured by Messrs J. and P. Coats of Paisley with the following outline of the processes in the bleaching of thread:—

1. The various Nos. of thread are prepared before boiling.
2. The first boil. The kier used is a common vomiter, into which are put water and a solution of caustic lye,—the proportions being regulated by the number of pounds of thread to be treated.
3. The first bleach. The thread is placed in a box, and a sieve let down upon it. Underneath the box is a well which is filled with water and chlorine. The liquor is drawn up by a pump, and thrown upon the sieve, through which it passes, and filters through the thread into the well.
4. The thread is next moved into a souring-box, also covered with a sieve, where it is washed to take out the chlorine of the previous process.
5. A souring-well under the souring-box is now filled with water and sulphuric acid, and this mixture, called the *sour*, is pumped up on the sieve over the souring-box, through which it runs back into the souring-well in the same manner as described in process No 3.
6. Before removing the thread from the souring-box it is washed with water through the sieve.
7. It is next washed in a washing-machine.
8. The scald, or second boil in kier. Various mixtures are used for it. Some prefer black soap and crystals of soda: others use caustic lye.
9–13. Repetition of Nos. 3, 4, 5, 6, and 7.
14. The thread is now extracted, *i.e.*, dried in hydro-extractors.
15. Stocking. The stocks are boxes about 3 ft. long, by 2 ft. wide, and 2 ft. deep, with a large wooden mallet hung in each, similar to those used in bleaching linen. The thread hanks having been properly prepared, so that they will not get loose, are put into the stocks with a mixture of hot soap and water, and beat there till of the proper colour. It is then taken out, and
16. Washed in washing-machine, and
17. Extracted.
18. The blueing process is done in a box filled with a solution of water and extract of indigo. As much thread is put in as the box will contain. It is let stand for a time, after which it is taken out and thrown on a barrow.
19. It is next taken to extractor and dried, and
20. Placed in the stove. After being a sufficient time there it is
21. Removed to cooling shed, where it is hung up to cool.
22. It is now taken to stretching-machine, where it is passed over hot rollers to take out the curl and moisture received in cooling shed.
23. Taken to warehouse, where Nos. are classed and made up in bundles.

Bleaching of Linen.

The bleaching of linen is a much more tedious and difficult operation than the bleaching of cotton. The process of water-retting, or rotting, by which the fibre is separated from the woody portion of the stalk, lodges a large proportion of colouring matter in the fibre, with which it enters into very intimate combination. The amount of colouring matter which has thus to be dealt with in the bleaching of linen is very great, being as much as one-third of the entire weight of the fibre. In the early part of the century a great amount of public attention was given to a plan proposed by Mr James Lee for preparing flax fibre without the process of steeping or retting, by which it was affirmed that, among other advantages, it would only be necessary simply to wash, in soap, linen fabrics made from fibre so prepared, to render them pure and white. Mr Lee obtained a special Act of parliament allowing the specification of his patent to remain sealed for seven years, and his plans were entered into in a most full and laborious manner by the Irish Linen Board. After the expenditure of many thousands of pounds on his machines and experiments, the plan had to be entirely abandoned as a failure. More recently, Chevalier Claussen renewed the attempt to prepare flax without steeping, by breaking it by means of machinery, separating the refuse part of the stalk from it, and then by a chemical process splitting the hollow fibres, so as to reduce them to a soft cottony state fit for spinning by means of the cotton-spinning machinery. The fibre was proposed to be split by steeping the prepared flax in a solution of carbonate of soda, and then plunging it into dilute sulphuric acid. The sudden evolution of carbonic acid gas within the hollow tube of the flax was said to have the effect of splitting up the fibre and reducing it to fine flat threads possessing the felting properties of cotton. Sir Robert Kane, in his Report to the House of Commons, May 20, 1852, states that the whole process failed. The machinery for the beating and cleansing of the flax failed to separate it sufficiently from the refuse part of the stalk; and the chemical process for the splitting of the hollow tube only broke up small portions of the exposed ends, leaving the greater portion untouched. Various other plans of preparing flax fibres without water or dew-retting have from time to time been proposed and patented, but hitherto none of them has stood the test of extended practical operation. Till towards the end of last century the bleaching of linen both in the north of Ireland and Scotland was accomplished by bowking in cow's dung and souring with sour milk. In the year 1764 Dr James Ferguson of Belfast received a premium of £300 from the Irish Linen Board for the application of lime in the bleaching of linen. Notwithstanding this reward the use of lime in the bleaching of linen was for a long time afterwards forbidden in Ireland under statutory penalties, and so late as 1815 "Mr James Barklie, a respectable linen-bleacher of Linen Vale, near Keady, was prosecuted for using lime in the whitening of linens in his bleach-yard." The bleaching of linen to the present day is conducted much more in the primitive fashion of last century than is the practice with cotton-bleaching. Owing to the stiffness and inelasticity of flax fibres, a great part of the machinery used for cotton is not available for linen, and solutions of acid and bleaching-powder require to be used in a very dilute condition for linen fabrics, involving frequent repetitions of the various processes before a satisfactory white is produced. "Crofting," or exposure to the air on grass, is also very largely resorted to in the bleaching of linens, especially for plain shirting and sheeting, which necessitates the possession of very extensive grass parks in connection with works, and renders the process both tedious and subject to the influences of the weather. A large proportion of linen cloth is half-bleached or improved in the yarn before being woven, and it consequently requires less bleaching than that which comes in its original "green" condition. The following is an outline of the two chief methods, with and without crofting, as pursued in the principal Scotch linen bleachfields at the present day:—

I. Without Crofting

1. Limed.
2. Boiled in open kier for about 6 hours.
3. Washed at washing-mill or stocks.
4. Soured with hydrochloric acid, and piled in sour for some hours.
5. Washed at stocks.
6. Boiled in soda-ash for 8 or 10 hours.
7. Again boiled.
8. Liquored in chlorine solution and piled up.
9. Washed.
10. Boiled in alkali for 6 or 7 hours.
11. Liquored in chlorine solution.
12. Washed.
13. Soured with sulphuric acid.
14. Washed.

When necessary the processes from 10 to 14 are repeated. The whole processes occupy, on an average, four weeks.

II. With Crofting.

1. Boiled in lime.
2. Washed.
3. Soured.
4. Washed.
5. Boiled in alkali and washed.
6. Exposed on grass 3 or 4 days.
7. Boiled in alkali.
8. Washed.
9. Exposed on grass.
10. Liquored.
11. Washed.
12. Soured with sulphuric acid.
13. Washed.
14. Boiled in alkali.
15. Liquored.
16. Washed.
17. Soured with sulphuric acid.
18. Washed, and processes 14 to 18 repeated if required.

With exposure on the grass the bleaching of plain linens usually occupies from 4 to 6 weeks. The finishing processes are essentially the same as in the case of calicoes. The following are the stages in finishing linen damasks:—

1. Nipped in squeezers.
2. Blued in ultramarine in blueing-water mangle.
3. Starched in starching-mangle.
4. Dried on steam cans.
5. Damped with fine spray.
6. Beetled.
7. Calendered.
8. Dried on steam cans.
9. Again calendered.
10. Viewed to detect rust spots and holes.
11. Lapped.
12. Pressed in hydraulic-press.

Charles Tennant of St Rollox made some experiments in 1831 to determine by which parts of the process the chief loss was sustained during bleaching. The result was that in 1000 parts by weight, linen yarn lost—

In the now abandoned fermenting alkaline steep	57 parts.
In 4 boils with caustic soda	70 ,,
In 4 steeps with chloride of lime	170 ,,
In 4 steeps in the sour	18 ,,
Total	315 parts in 1000.

Bleaching of Paper-Making Materials.

In addition to cotton and linen rags, esparto or Spanish grass (*Macrochloa tenacissima*) is now very largely used for the manufacture of the better classes of paper. Wood, especially the wood of the aspen (*Populus tremula*), is also now applied as a paper-making material. Jute has been used for printing paper, and straw is very largely employed, but chiefly for brown and packing papers. These and the numerous other substances used for paper-making are all reduced to the condition of "half-stuff" before they come to undergo the operation of bleaching, and the treatment they receive in this stage varies only in the amount of whitening required, and consequently in the proportions of bleaching solution used. It is therefore unnecessary to notice more than the process followed in the bleaching of the "half-stuff," which in Great Britain is very frequently prepared from a mixture of esparto fibre and rags. The bleaching solution of chloride of lime is either prepared in specially constructed cisterns, fitted with revolving agitators and stored in a reservoir for use, or prepared for immediate use in a wooden vessel. When the solution is made up to the requisite strength, and all insoluble sediment has sunk to the bottom of the vessel, it is ready for pouring into the engine. From 4 to 10 lb of ordinary bleaching-powder are used for every 100 lb of rag half-stuff, but a much larger proportion is required for esparto. Sulphuric acid in not more than a proportion of 1 lb to 4 lb of bleaching-powder is thereafter added in a highly dilute condition, and the whole, after mixing in the engine, is turned into the drainer, which is a large tank provided with a false bottom of perforated wood covered with wire-netting or bagging. In some cases the bleaching-liquids are not added to the pulp material till it is deposited in the drainer; and the acid solution may be poured in first, or both solutions may be alternately used in small quantities. The bleaching process is sometimes carried on in separate engines constructed of materials not affected by the corrosive action of acid substances. Drained half-stuff may also be bleached in a suitable apparatus by the direct application of chlorine gas.

It is of the greatest importance to free the pulpy material from the last traces of chlorine before it is made into paper, as it would react upon the manufactured product and render it brittle. To eliminate the free chlorine and acid, &c., the pulp is washed in the beater with pure water till it ceases to redden litmus paper, or give other characteristic indications of the presence of such compounds. The prejudicial effects of chlorine and its combinations are also overcome by the addition of "antichlor," the hyposulphite of soda or of lime, which forms with them compounds that do not affect the colour of the paper, although it is desirable, as far as possible, to remove such compounds also by washing with water.

Bleaching of Straw.

The fine wheat-straw used in Tuscany and elsewhere for straw-plaiting, after being cut, dried, and tied up in bundles, is stacked for a month. It is then spread out in a meadow, and exposed to the action of the sun and air, being frequently turned during that period. The lower joint of the straw is then separated, leaving only the upper joint with the ear attached,—this being the only part of the straw used. It is then steamed, and after that exposed to the action of sulphurous acid gas prepared by burning sulphur, which complete the bleaching. It is then tied up in bundles, in which state it is ready for the market. In the strawplait-making centres of Great Britain—Luton, Dunstable, &c., in Bedfordshire—straw is bleached, chiefly after plaiting, by the influence of sulphurous acid gas.

Whitening and Cleaning Prints, Maps, Books, and other Articles of Paper.

Chlorine was first applied to this purpose by Chaptal, and his method was employed with the greatest success by Vialard and Heudier, who by Chaptal's process restored several of the most valuable books of the French National Library. Chaptal's *modus operandi* is thus described in his own words:—

"They begin by unsewing the book and separating it into leaves which they place in cases formed in a leaden tub, with very thin slips of wood or glass, so that the leaves, when laid flat, are separated from each other by intervals scarcely sensible. The acid is then poured in, making it fall on the sides of the tub, in order that the leaves may not be deranged by its motion. When the workman judges, by the whiteness of the paper, that it has been sufficiently acted upon by the acid, it is drawn off by a cock at the bottom of the tub, and its place is supplied by clear fresh water, which weakens and carries off the remains of the acid, as well as its strong smell. The leaves are then to be dried, and, after being pressed, may be again bound up.

"The leaves may be placed also vertically in the tub; and this position seems to possess some advantage, as they will then be less liable to be torn. With this view I constructed a wooden frame, which I adjusted to the proper height, according to the size of the leaves which I wished to whiten. This frame supported very thin slips of wood, leaving only the space of half a line between them. I placed two leaves in each of these intervals, and kept them fixed in their place by two small wooden wedges, which I pushed in between the slips. When the paper was whitened, I lifted up the frame with the leaves, and plunged them into cold water, to remove the remains of the acid, as well as the smell. This process I prefer to the other.

"By this operation books are not only cleaned, but the paper acquires a degree of whiteness superior to what it possessed when first made. The use of this acid is attended also with the valuable advantage of destroying ink spots. This liquor has no action upon spots of oil, or animal grease; but it has been long known that a weak solution of potash will effectually remove stains of that kind.

"When I had to repair prints so torn that they exhibited only scraps pasted upon other paper, I was afraid of losing these fragments in the liquid, because the paste became dissolved. In such cases I enclosed the prints in a cylindrical glass vessel, which I inverted on the water in which I had put the mixture proper for extricating the oxygenated muriatic acid gas. This vapour, by filling the whole inside of the jar, acted upon the print, extracted the grease as well as ink spots, and the fragments remained pasted to the paper."

A solution of peroxide of hydrogen (H_2O_2) has been used with great success in the restoration of valuable prints, as well as for cleaning and reviving oil painting darkened by the action of sulphurous vapours.

Bleaching of Wool.

The bleaching of wool and animal fibres generally is a much simpler and less important operation than is the whitening of vegetable fibres. Wool is covered with a peculiar varnish or greasy matter which impairs its qualities, and which it is the object of the bleacher to remove. To this varnish the name of "yolk" or "suint" is given. It is a fatty unctuous matter, chiefly derived from the cutaneous perspiration, but, no doubt, also secreted by the pores of the wool itself; and it imparts that peculiar heavy odour to sheep with which all must be familiar. From the researches of Vauquelin it would appear that this unctuous varnish consists chiefly of a kind of soap, together with a small quantity of waxy matter, a peculiar odorous animal substance, a mixture of potash salts, and a little lime. This varnish, in consequence of its soapy nature, is soluble in water, so that washing in pure water would remove the greater portion of it; but it is found more advantageous to remove it by the process termed "scouring."

Scouring is performed by means of an ammoniacal lye, prepared of river or other soft water mixed with stale purified urine, which is found to contain a large quantity of ammonia, upon which its action probably depends. The mixture is heated by steam to a temperature at which the hand of the workman can be easily held in it for a considerable time. In this bath the wool is left for from half an hour to two hours, according to the quantity of greasy matter it contains. It is then to be taken out and drained into a basket, so that the drainings may drop into the vessel in which it was steeped, that nothing may be lost. It must now be completely rinsed by exposing it in baskets to a continuous stream of clear water, while a workman is perpetually employed in stirring it with a pole, till the water passes off perfectly clear. As a substitute for urine pig's dung is sometimes used, and various other substances have been proposed and introduced, such as ammoniacal salts, soda-ash, phosphate of soda, and soluble glass. Recently a machine, Petrie's wool-washer, has been introduced for scouring wools. It consists of a range of three or four long tanks, clean water entering at one end of the series and flowing through the whole. The wool is introduced at the end of the range where the water escapes, and where it is consequently most highly charged with the impurities of the washing process, and it is carried forward from one tank to another till it is lifted out at the point where the pure water enters.

It is known that the wool is properly scoured by its filaments being smooth, long, slender, white, and perfectly free from foreign substances, and not having lost their natural tenacity. If this scouring be properly done there is no need of further washings in soaps, or otherwise, till the wool is subjected to the process called "sulphuring;" and in point of fact it is very rarely passed through any other process. Some, however, recommend for the finer wools, where a very delicate white is wished, that they should be passed through one, two, or more baths of soft soap. No caustic alkaline lyes can be employed, as they destroy the wool altogether, dissolving it, and forming with it a kind of soap.

The process of sulphuring is applied to yarns and woven goods only when they are intended to be finished white or light bright colours. Formerly, the method of sulphuring woollen goods was to expose them in a close apartment to the vapour of burning sulphur. The goods were hung on poles, and when the chamber was filled, a quantity of sulphur placed in very flat and broad dishes was allowed to burn away gradually in the chamber, while every aperture by which the vapour could escape was carefully closed. After exposure to the sulphurous acid vapours from six to twenty-four hours the bleaching process was complete, and the goods withdrawn from the chamber. The same process is now much more expeditiously performed by Thom's sulphuring process. The goods are passed on a long chain up and down over a series of rollers in a small chamber filled with sulphurous acid vapours, and a few minutes suffice for the operation. Sulphite of soda acidified with hydrochloric acid is also used in France for the bleaching of woollen fabrics.

Cloth which is to be finished white after the sulphuring process is run through a bath containing some indigo carmine, which increases the brilliancy of the white. When it is to be dyed it is treated with dilute sulphuric acid, thoroughly washed, and dried.

Bleaching of Silk.

Raw silk is covered with a kind of varnish, the nature of which was first thoroughly investigated by M. Roard. He showed that this varnish, instead of being a gum, as was usually believed, resembled a mixture of bees' wax and oil, with a resinous colouring matter, and in raw silk constituted 23 or 24 per cent. of the weight. The varnish is soluble in water, and affords a solution which forms a lather like soap. The yellow varnish is of a resinous nature, and is insoluble in water, but is soluble in alcohol. The waxy substance exists in all silks, but the whiter the silk the less wax does it contain.

The comparative composition of yellow and white raw silk is shown by M. Mulder's analysis :—

	Yellow.	White.
Fibroine	53·37	54·04
Gelatine	20·66	19·08
Albumen	24·43	25·47
Wax	1·39	1·11
Colouring matter	0·05	...
Fatty and resinous matter	0·10	0·30

This varnish, or "gum," as it is technically called, gives the silk a stiffness and elasticity which, for many of the purposes to which silk is applied, it is desirable to remove. This is called "ungumming" by the bleachers of silk. Though many different processes have been suggested for this purpose, none seems to answer so well as the old process of scouring in a weak solution of soap. If, however, the silk be kept in the soap too long after the varnish is removed, it begins to lose body, and has its qualities impaired, becoming dull, stiff, and discoloured, in consequence of being partly dissolved. White or yellow silks may be completely scoured in one hour in the soap bath, using about 15 lb of water for each pound of silk, and a suitable quantity of the finest soap. The soap and silk should be put into the water half an hour before it is brought to the boiling point, and then be boiled one hour. They are then removed, wrung out, washed in pure water, and either exposed to the vapour of sulphur or passed through a solution of sulphurous acid gas in water.

The following is the process usually followed by the scourer of silks. A quantity of water is put into a boiler over a fire, and for every 100 lb of silk to be scoured, 30 lb of very fine soap are dissolved. The solution is generally boiled; but before the silk is put into it, the heat must be lowered to about 90° Fahr., and at this temperature it must be kept during the process. The silks are to be hung in the liquor on rods or frames, and left till the gum is sufficiently destroyed,—care being taken to alter their position now and then, so that every part may be exposed to the action of the bath. When perfectly ungummed, they are flexible and of a dull whiteness; in this state they are to be wrung out to clear them of the soapy water, then well shaken, and put into coarse linen bags, in parcels of from 20 to 30 lb each.

These bags are now to be steeped in a fresh bath, or, as the workmen say, are to be baked. The bath is prepared in a manner and proportion much as before, except that the quantity of soap may be somewhat diminished as the heat is to be increased; for the silk is now to be boiled for an hour and a half, taking care to keep the bags from sticking to the bottom of the boiler, by frequently stirring them with a stick. For silk that is intended to be dyed, the former steeping in the lukewarm soap-bath is unnecessary, and the boiling only is employed, using a greater quantity of soap in proportion to the fineness of the colour. After boiling the silk is wrung as before, and then washed, and if it is found to be not sufficiently or not uniformly scoured, it must be submitted to a fresh bath.

The white silk usually sold has a bluish shade given it by a bath impregnated with litmus or indigo. This is prepared by dissolving a pound and a half of fine soap in about 90 gallons of water, in which a small quantity of litmus or indigo has been diffused. This process gives to the silk the tints known by the names of "silver white," "azure white," and "thread white," according to the depth of shade which has been imparted. The "China white" tint is given by adding arnotto to the bath instead of indigo

From these processes the silk acquires a tolerably clear white, but the highest degree is given to it by the action of sulphurous acid, the silk being either, as is usually the case, subjected to the acid in the state of vapour, or immersed in a solution. At Lyons no soap is used in the tinting process; but, after being boiled, the silk is washed, wrung dry, sulphured, and then passed through water properly blued.

Bleaching of Bees'-Wax, &c.

Bees'-wax in its raw condition, as it is first melted up from the comb, is a yellowish coloured substance somewhat greasy to the touch, and having a faint honey-like odour. It often contains mechanical impurities, besides traces of honey, and to remove these and discharge the colour the following process is adopted :—The wax is broken up into small pieces and melted in a copper boiler, with water sufficient to keep it from burning. When melted it is run into a tub containing hot water, and while in the hot fluid condition the mechanical impurities it may have contained subside to the bottom. From this tub the melted wax flows into a vessel, the bottom of which is perforated with small holes. Through these thin streams of wax are received on a cylinder kept revolving in water below; and thus fine threads of solid wax are produced. These are exposed on moistened sheets to the air and light for some days, during which they are occasionally turned and watered. By this exposure the wax loses much of its colour. It is then melted up into solid blocks and left for some time, after which the operations of melting, forming into threads, and bleaching in the light are repeated till it has attained a pure white translucent lustre, is of very firm consistency, and is free from all odour. Yellow wax is also decolorized by treatment with nitric acid, but chlorine, although it bleaches most expeditiously, is not available, as it leaves traces incorporated with the wax, which on burning evolves irritating fumes of hydrochloric acid. Palm oil, used in the manufacture of soap and candles, is bleached by the action of bichromate of potash and acid.

For bleaching generally, but especially for the bleaching of animal fibres and substances, the use of a considerable variety of processes, and of chemicals other than chlorine and sulphur compounds, have from time to time been proposed and to some extent put into operation. To some of these proposals incidental allusion has already been made, and generally their success has not been such as to warrant special notice. Among other substances which have been recommended for scouring wools and silk are feeble solutions of sulphides of sodium and of potassium, or aluminates of these alkalies, the cyanide of potassium, and a mixture of common salt and oxalic acid. The alkaline permanganates have also been frequently regarded as hopeful bleaching chemicals; and a few years ago the permanganate of potash was introduced and used by MM. Tessié du Motay and Maréchal, who, in connection with the permanganate, used a solution of the peroxide of hydrogen. To this latter substance a peculiar bleaching application has recently been given. Under the name of *golden hair water*, or *auricome*, a liquid is sold by hair-dressers which is found to hold in solution a large percentage of peroxide of hydrogen. The use of this solution gives to the hair the brilliant golden yellow tinge which has come to be regarded as a highly fashionable colour. Other applications of this powerful oxidizing and reducing agent have been suggested by its toilet use, and it has been employed for the bleaching of ornamental feathers, hair, &c. Doubtless, if it could be prepared in stable solution at moderate price it would be found extensively useful in bleaching and other industrial applications. It has also long been hoped that a means of applying ozone as a direct bleaching agent might be devised, but hitherto little success has been attained in this direction. In Germany ivory is bleached by steeping it a week in light naphtha or other volatile oil, and exposing it thereafter to the air and sunlight, by which the atmospheric oxygen becomes ozonized in contact with the ivory and thus whitens it. (J. PA.)

BLEEK, Friedrich, one of the greatest Biblical scholars that Germany has produced in modern times, was born on the 4th July 1793, at Ahrensbök, in Holstein, a village near Lübeck. While attending the elementary school there, he gave evidence of such ability that his father sent him, after he had acquired some knowledge of Latin and Greek, in his sixteenth year, to the gymnasium at Lübeck, where he spent three years, and there imbibed so great a love for the languages of antiquity, that he abandoned the idea of a legal career, which he had once entertained, and resolved to devote himself to the study of theology. After spending some time at the University of Kiel, he repaired to Berlin, and there, from 1814 to 1817, enjoyed the instructions of De Wette, Neander, and Schleiermacher. The teaching of these distinguished men, especially of the last named, exercised a decisive influence upon the whole of his after life. So highly were his merits appreciated by his professors—Schleiermacher was accustomed to say of Bleek that he possessed a special *charisma* for the science of "Introduction"—that in 1818, after he had passed the