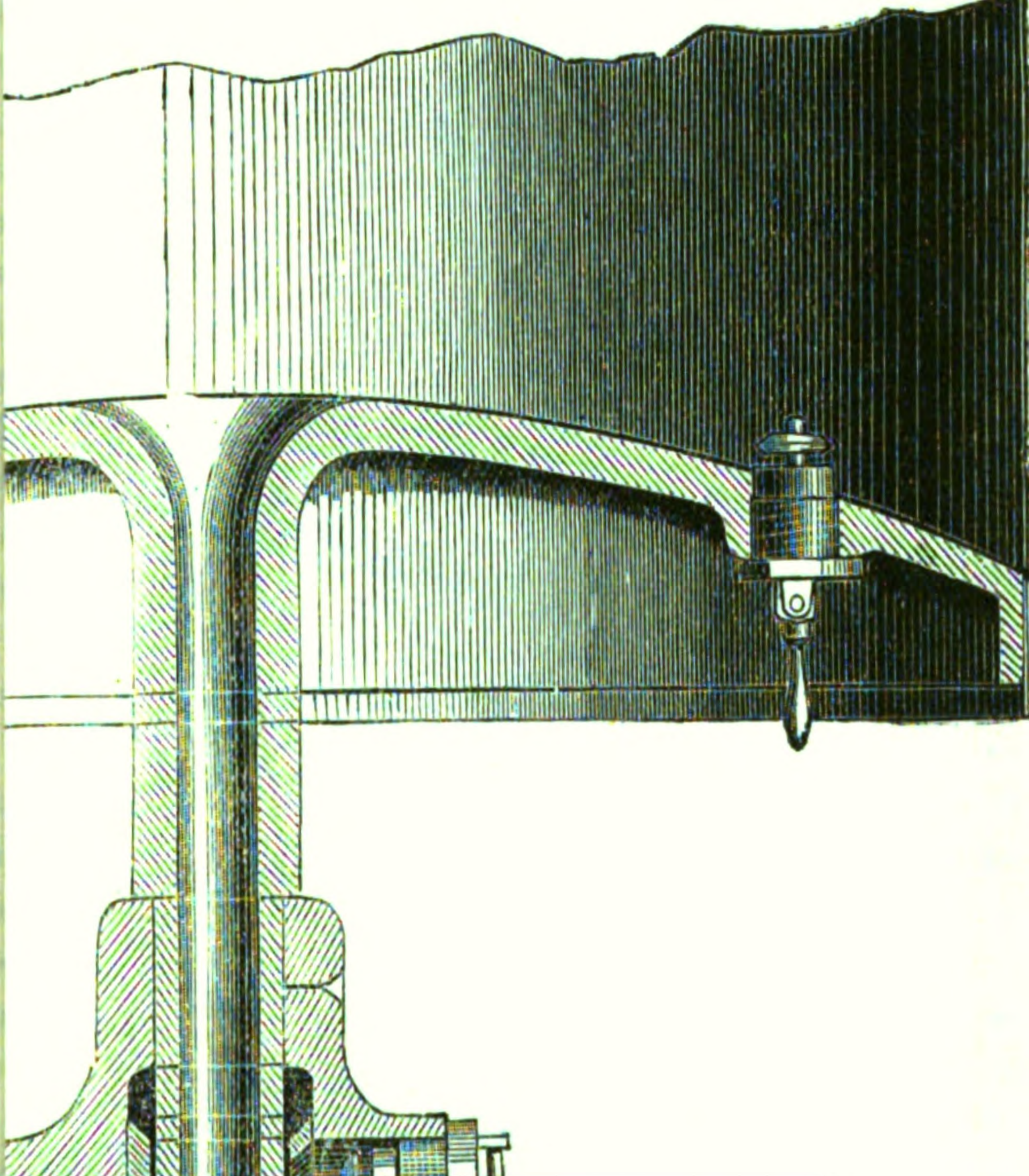

The printing of textile fabrics

Charles Frederick Seymour Rothwell


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THE PRINTING

OF

TEXTILE FABRICS:

A Practical Manual

ON THE

PRINTING OF COTTON, WOOLLEN, SILK AND HALF-SILK FABRICS.

BY

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WITH PLATES, ILLUSTRATIONS IN THE TEXT, AND SPECIMENS OF PRINTED FABRICS.

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PREFACE.

THE following work is intended to form a Companion-Volume to the well-known *Manual of Dyeing*, by MM. Knecht, Rawson, and Loewenthal.

As the chemical properties of the various Mordants, Colouring-matters, &c., used in the Textile Industries are exhaustively treated in that work, it has not been considered necessary to include here information of a purely chemical or theoretical character. I have accordingly endeavoured to confine myself as far as possible to the practical side of the subject. The Processes and Machinery described are principally those of which I have had actual practical experience. Where information has been culled from other works, the source has, in each case, been duly acknowledged.

I have pleasure in expressing my obligation to the different Firms who have kindly rendered assistance as regards Patterns and Blocks, illustrative of the best modern practice in Textile Printing.

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MANCHESTER, *February*, 1897.

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ABBREVIATIONS.

c.c. or c.c.'s	=	Cubic centimetre or cubic centimetres.
A.L. & Co.	=	Farbwerke Mühlheim, vorm. A. Leonhardt & Co., Mühlheim-on-Maine.
B.A.S.F.	=	Badische Anilin und Soda Fabrik, Ludwigshafen-on-Rhine.
Cassella	=	Leopold Cassella & Co., Frankfort.
F.B. & Co.	=	Fr. Bayer & Co., Elberfeld.
Kallé	=	Kallé & Co., Biebrich-on-Rhine.
M.L. & B.	=	Farbwerke, vorm. Meister, Lucius, & Bruning, Hoechst-on-Maine.
R.H. & S.	=	Read, Holliday & Sons, Huddersfield.

TEXTILE PRINTING.

INTRODUCTION.

By the term **textile print** is meant a piece of cloth having upon its surface a figured design due to colour alone, as distinct from any pattern or design produced during the manufacture of the fabric, as in the case of "figured cloths." Sometimes the pattern is due to the printing as well as the way in which the piece is woven, or the nature of the fibres of which it is composed, as, for example, in the case of printed "unions" and half-silk goods.

Methods of Textile Printing.—It would be impossible to give an outline comprising all the operations through which each textile fabric passes during its transformation into a "print," because so many different methods of treatment are required by the use of the large number of colouring-matters now placed at the disposal of printers, each **group** of which necessitates an alteration in the subsequent treatment of the cloth after printing. ~~Some idea of these different methods will be obtained from the remarks which follow~~. Speaking generally, however, the following is what may be considered the usual series of operations through which textile fabrics pass in the production of prints :—

Scouring.—Cloth, as received by the printer, contains the natural and accidental impurities due to its origin and process of manufacture. The cloth is scoured to remove all these impurities and leave the fibre in as pure a condition as possible. Scouring does not usually remove the whole of the natural colouring-matter of the fibre, hence it is necessary in most cases to destroy this, which is done in the next process.

Bleaching.—Bleaching has for its object the removal of the whole of the colouring-matter remaining in the cloth after scouring, in order to render the cloth white, so as, in the case of prints that show some of the original cloth uncoloured ("whites"), there shall, when the print is finished, be as much contrast obtained as possible.

Preparing.—Although the cloth is often printed after being merely bleached, the majority of the colouring-matters yield better results if the fibre is impregnated with certain substances which assist or help to form the colour-lake on the fibre.

Winding on.—The fibres are then wound on to wooden centres, and are ready to be placed on the printing machine to receive the "colour."

Printing.—In the printing machine, the various prepared colours are applied to the cloth by means of engraved copper rollers, which, in the case of multiple colour patterns, is done by several rollers, each engraved with the portion of the pattern corresponding to the colour that it is printing. These rollers are adjusted by the printer, so that the whole pattern fits and registers, each colour being applied in its proper place in relation to the other parts of the pattern.

Drying.—The pieces, after leaving the printing machine, are passed over steam chests to dry the colours; they can then be safely handled and sent for further treatment.

The after-treatment of the printed pieces depends upon how the colours are to be produced or developed upon the printed parts; an outline of the various processes or "styles" is given below.

The pattern or design may be obtained by—

A. Printing, with engraved rollers or blocks, upon the fabric the already-formed pigment or colour, along with a material to bind the pigment to the fibre.

B. Printing a dyestuff or colour, which has itself an affinity for the fibre upon which it is printed, either alone or with the addition of other chemicals, added merely to assist the combination of the dye with the material upon which it is printed.

C. Printing a dyestuff mixed with certain substances, known as **mordants**, which upon subsequent steaming of the cloth produces the desired colour, and at the same time fixes it in and upon the fibre.

D. Or, the dyestuff may be printed along with other materials, which, by subsequent treatment and passage through certain salt solutions, cause the colour to be formed and fixed on the cloth.

E. The colour may also be built up on the fibre, in the parts required to form the design, by printing upon the surface of the cloth one component part of a colouring-matter, and afterwards passing the whole fabric through a solution containing the other necessary constituent of the colour; the colour being produced only where the two ingredients are present.

The same end is also obtained by first uniformly impregnating the fabric with one constituent of the colour, and afterwards printing the other constituent in the required pattern.

F. The cloth may be printed with certain metallic compounds which may be of themselves without colour, but which can be converted into insoluble colouring-matters, or **lakes**, by the application of dyestuffs.

G. The whole fabric may be evenly impregnated or evenly coated upon its surface with a metallic compound, and the pattern produced by printing upon the so-prepared cloth a material having the power of removing the coating, or of reducing the metallic compound to such a condition that it is not fixed upon the parts of the fabric printed with the material; thereby preventing, when the fabric is afterwards treated with dyestuffs, the formation of a colour on the parts so printed.

H. The tissue may be printed with a material, or mixture, having the power to prevent the fixation of colour, or the formation of a colour-lake; so that when the fibre is afterwards printed evenly, or in a pattern, with a colour-producing mixture, the colour is formed on those parts only of the tissue not printed with the resisting mixture.

I. Or, the resisting mixture may be printed after the cloth has been coated or impregnated with the colour-producing substance.

J. The tissue may be first dyed a uniform colour, and then the colour removed and changed, or removed and another different colour formed upon the parts printed.

K. Or, lastly, the pattern may be produced by a combination of two or more of the above methods.

Styles.—These methods, or **styles** as they are technically called, receive various names, which owe their special origin to the particular nature of the colouring-matter, or the treatment of the fabric after it has been printed. The following names are given to the styles enumerated above, with notes pointing out the kind of materials to which they are applied. The same letters are used as in describing the methods of application :—

A. **Pigment Style.**—Used chiefly for cotton piece goods.

B. **Direct Printing Style.**—If the goods are afterwards submitted to the action of steam, they are then sometimes classed as "steam style colours." Used in the printing of all kinds of fabrics.

C. **Steam Style.**—Applied to cotton, linen, and occasionally to silk and woollen goods. The so-called *adjective* colours are applied in this way.

D. **Steam Style.**—Comprising the class of colours fixed by means of tannic acid and final treatment with antimonic salts. The colours so applied are sometimes called *tannic colours.* Printed generally upon cotton and linen piece goods.

E. Colours produced by this method are frequently termed *naphthol colours,* and this term is applied to the colours built up in this manner, even if the chemical known as naphthol does not enter into the composition of the colouring-matter. Used principally for printing cotton pieces.

F. **Madder or Dyed Style.**—So-called because, before the introduction of artificial alizarine, madder was extensively used for the production of prints in this way. This method finds its chief application in calico printing.

G. **Resist Style.**—Used largely in calico printing.

H. **Resist Style.**—Used upon cotton piece goods, and occasionally upon silk.

I. **Resist Pad Style.**—Used upon cotton and wool.

J. **Discharge Style.**—Employed in printing all fabrics.

In addition to the styles mentioned, there are other colouring-matters requiring special processes for their application.

From what has been said in the preceding paragraphs it will be evident that there is no clear and distinct line to be drawn between the practice of printing and dyeing, prints being produced in many cases by local dyeing. Hence, the textile printer should make himself acquainted with the properties of all the different colouring-matters, both natural and artificial, and the manner in which they are applied in printing and dyeing, so as to enable him to effect new combinations or imitate any particular colouring of pattern that may be presented to him.

PART I.

THE MACHINERY USED IN TEXTILE PRINTING.

The machinery used generally, or for a large number of styles and kinds of tissues, will be described here; while special machines, or those used only for certain styles, will be noticed when the particular style is described; this will obviate the necessity of frequent cross-references.

Sewing Machines.—The machines used for attaching the ends of the various pieces together are generally simple in construction, and vary in pattern according to the requirements of the work.

The Donkey Sewing Machine is such a simple contrivance as scarcely to merit the title "machine." It consists of a solidly-made wooden stand about 2 feet 6 inches in height, the top measuring about 4 feet long and 6 inches wide. At one end two bronze cog-wheels are mounted, gearing into each other, one of which is provided with a handle, so that when this is turned both the wheels revolve. The centre part of the teeth or cogs of these wheels is cut away, forming a groove around the circumference of each wheel. Between the end of the stand and the mounted cog-wheels, a holder for a straight packing needle is provided, consisting of a steel rod running loosely through a bearing, which allows it to slide in a direction parallel to the length of the stand. This rod has at one end a notch into which the eye end of the threaded needle fits, and a spring presses it away from the cog-wheels as far as the bearing will allow.

The method of working the machine is as follows:—Two pieces of the cloth to be sewn together are arranged, with the two ends together, one on the top of the other, on the table of the machine; the needle is threaded with the cord used for this form of machine, and placed so that the eye fits into the notch in the holder, while the point rests in the groove between the two cog-wheels. One edge of the pieces—*i.e.*, two thicknesses of cloth—is placed between the cog-wheels, and the handle is turned, the cloth being guided evenly all the time. The cloth is folded or crimped by the cogs, and, at the same time, forced on to the packing needle. When all the cloth is on the needle, the latter is taken out of the holder, and the cloth pulled down the cord with which it is threaded, arranging the cloth so as to lie evenly.* When it is required to sever the two pieces of cloth, the cord is removed by merely pulling it out from one end.

The stitch given by this machine is of so coarse a nature as to be unfit for many departments of the works, and is only used where a rough but quickly unsewn stitch is required; such, for instance, as in stitching the various batches together in the preparing and dye-houses when the pieces are dyed or prepared full width.

Portable Sewing Machines.—In those departments where it is necessary to fasten the pieces together in a firmer and neater manner than the donkey sewing machine is capable of doing, one of the many forms of portable chain-stitch sewing machines, driven by foot power,

Fig. 1.—Portable sewing machine (W. Birch).

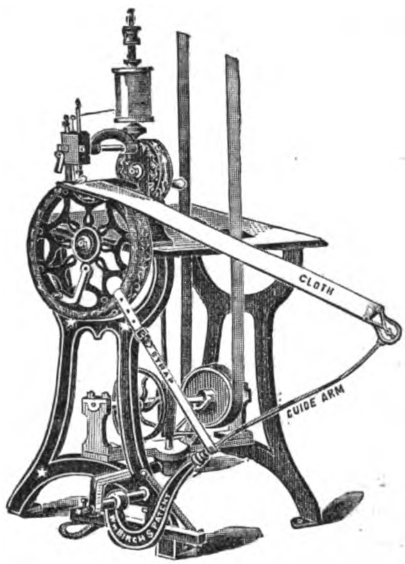


Fig. 2.—Power-driven sewing machine (W. Birch).

is used. One very popular pattern of this type of machine is shown in Fig. 1. The machine is mounted at a convenient height for sewing on an iron stand. At the bottom of the stand three wheels will be noticed, two of which are attached permanently to the stand itself, and the third one is attached to a kind of bell-crank lever, which also forms the handle. When the machine is being used for sewing, the handle is turned towards the machine, and the latter then rests on the iron foot shown, and on the two wheels fixed to the frame, the weight of the machine on the iron foot making it perfectly solid and firm, and practically immovable. When it is required to move the

* Should the cloth be wet, a little tallow is put on the needle previous to sewing.

machine to another part of the workroom, the handle is pulled forward which puts the wheel connected with it on the ground, and at the same time raises the machine off the fixed iron foot, so that the machine can be wheeled in any direction, and the mere placing of the handle in a more or less vertical position makes the whole machine firm again and ready for use. The sewing machine itself gives a flat form of chain stitch, which is far less bulky than the loop-chain stitch. It will sew from one piece on to the next, and the ends will be sufficiently fastened to hold even against a severe strain on the cloth.* When the machine is arranged to work by foot-power, the motion is communicated to the small driving-wheel of the sewing machine proper, by a cord or round leather belt from the large wheel underneath, propelled by the treadle and crank situated at the lower part of the stand; but it can also be arranged to work by hand, by turning a small handle at the side of the machine on a level with the sewing needle, the hand-wheel being geared up on the sun and planet system. Brakes can be attached to the machines to prevent them running backwards. This machine will sew the pieces either in the wet or dry state, and irrespective of thickness. The stitch is adjustable from a fine to a $\frac{3}{4}$-inch stitch. This type of machine is used in nearly all the departments of the works.

Power-Driven Machines.—In the white and grey rooms, where girls are employed continuously stitching pieces together, the machines are generally fixtures, and are driven by steam power. The sewing machine is of the same pattern as described above, but is mounted on a wooden or iron stand firmly bolted to the floor. Fig. 2 represents one of these machines driven by a strap from overhead gearing, and shows it fitted with Birch's patent "guide arm" for the purpose of automatically guiding the piece into the machine, while the operator is arranging other pieces for sewing, thus saving a considerable amount of time. Generally, power machines are driven by gearing placed just underneath the boarding of the floor, so arranged that they can be put in or out of gear by pressure of the foot, the machine being in gear so long as the pressure is maintained, the clutch instantly springing out of gear as soon as the pressure is released. This is far preferable to the use of overhead or exposed gearing, as it is not liable to catch the clothing of the operator.

The stitch given by all these machines being of the chain variety it can, of course, be quickly undone by merely pulling one end of the thread; the end that should be drawn is the one at which the machine finished sewing, and is generally known by having a platted tail projecting from the side of the piece.

Sometimes great annoyance is caused by the stitching refusing to

* The cloth is fed into the machine by the wheel shown on the left hand of the illustration, having steel points around its circumference the cloth after sewing being detached from these points by a steel lifter.

be undone easily; the cotton breaking at every few inches. This defect is generally due either to bad or careless sewing, or to the use of an unsuitable sewing cotton. In the latter case, if the cause of the break is carefully examined, it will generally be noticed that the cotton has twisted itself into a small knot, and this is a certain indication that an unsuitable cotton is being used, being twisted far too tightly. This defect is more likely to occur with those goods that have been through the bleaching operation or been subjected to processes where they are treated with hot liquors, especially caustic or soda ash liquors, as these cause the cotton to shrink, and if the sewing cotton is not selected with great care, a considerable part of the operator's time will be wasted in endeavouring to undo the seams.

Appliances for Opening the Cloth to the Full Width.—The cloth after bleaching, and after some of the processes through which it passes when printed, is in the rope form, and before it can

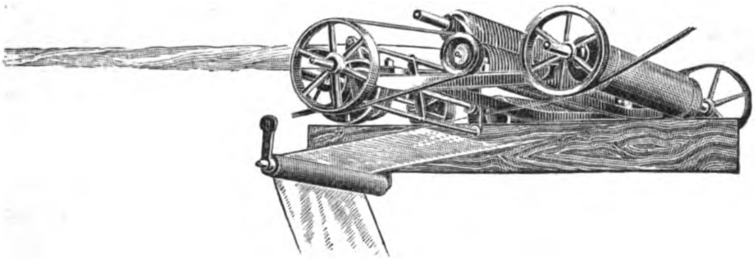


Fig. 3.—Scutcher for opening cloth (W. Birch).

be dried over the ordinary drying cylinders, it is necessary that it should be opened to the full width of the cloth.

Formerly the cloth was pulled out and the twists removed by hand, an exceedingly slow process, but at the present time nearly all printers and bleachers perform this operation mechanically by the use of Birch's patent scutcher or cutler (Fig. 3), by means of which it is possible to open out the cloth in a continuous manner at the rate of from 250 to 300 yards per minute. The principle upon which the action of these scutchers is based is that in a considerable length of cloth there will probably be as many twists in one direction as in the other, and consequently if the length is shaken, and suspended in such a manner that the piece can freely turn, the twists in one direction will neutralise or balance those in the other direction, and thus the cloth will pass on free from twists. This equal arrangement of the twists does not, of course, always occur, and it is necessary to occasionally stop the machine in order to take out twists that the scutchers fail to remove, and sometimes it is necessary to separate the ends of the pieces before this can be accomplished. The greater the length of the goods hanging free from the supports the better, because the machine will then work with fewer occasions for stoppages.

In practice the cloth in the rope form, and generally in the wet condition, is passed through a pot-eye situated near the roof of the room from which it passes over the beaters or scutchers to the spiral rollers which complete the opening out, and these rollers and beaters are placed as far as possible from the pot-eye through which the cloth first passed; thus the cloth hangs freely between the pot-eye and until it touches the scutcher. The scutchers consist of two metal frames geared together, and revolving on separate centres in a direction opposite to that in which the cloth is travelling; and they thus knock or shake the entire length of cloth and provide the motive power for the cloth to untwist itself. These beaters do not pull the cloth out of shape, as hand opening is liable to do, as the pulling and friction is applied to the full width of the cloth and not to the edges only, as is the case when the operation is done by hand.

The scutchers only take out the twists from the cloth and open it roughly to full width, leaving the piece full of small creases, which must be removed before it passes through the drying machine. The cloth, after passing the beaters, is taken up on a plain roller, and, before it enters the drying machine, the creases are removed by passage over or through one of the many forms of expanders.

The simplest form of expander generally used for cloth, which will afterwards be sent through another and more elaborate one fixed on the drying machine itself, consists of a wooden roller having a rope fastened upon it spirally radiating from the centre, so that when the roller revolves the cloth resting on the rope spirals is drawn out from the centre and the creases are removed.

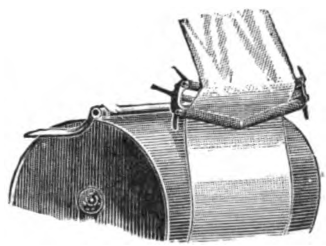


Fig. 4.—Angular openers for cloth (W. Birch).

Before the cloth actually passes into the drying or similar machine, it is often caused to pass over and press tightly against a fixed iron or brass bar, having upon its surface, where the cloth touches, a series of V-shaped grooves, tending to throw out the edges of the cloth. The boy in charge of the machine guides the pieces against this bar, which takes out the very small scrimps, and is consequently called the *scrimp rail.*

Another form of opener, or rather crease remover, is Birch's automatic opening rollers (Fig. 4), very largely used for guiding and removing creases from wet pieces before they pass through squeezing rollers and into drying and other machines. Being made of metal, they are very useful for pieces impregnated with caustic alkalies and substances liable to act on the fingers. The appliance consists of brass tubes mounted on iron rods, so that the tubes can revolve freely upon them. Each tube is equal in length to a little more than half the width of the piece, and they are mounted on the centre rod in such a manner that they form a V passing across the piece. There are two sets of tubes, situated about 3 inches from each other, and they are mounted in a frame which can either be fixed rigid to the machine or swivelled from the centre. Each tube has a coarse screw thread put upon it, running from end to end, and this is arranged in such a position that the piece is thrown out or opened as the tubes are turned round by the piece passing over the tubes. When the whole frame carrying the tubes is swivelled from the centre it sways from side to side, according as the piece moves its position, and when the piece departs from the truly central position, the frame sways over to the side where the piece has travelled, the cloth immediately begins to ascend the rollers, and the piece again assumes the central position. This action will always take place, providing the cloth does not run off the rollers at the extreme end. The cloth is generally passed under one set of tubes and over the other set; thus it is drawn tight against the tubes, and, consequently, the rollers come into contact with both sides of the cloth. When it is necessary that one side of the cloth should not touch metal rollers, the piece is passed either over the front or the back of the opening tubes.

A form of opener somewhat similar to the one just described, but having conical instead of straight rollers, is shown in Fig. 5, working in connection with a cylinder drying machine, in which place this form is generally used. The two conical rollers have each of them a screw-thread, traversing from the narrow to the thicker end of the rollers. The piece first comes into contact with these rollers at or near the edges of the piece, and the thread on the rollers immediately begins to throw the edges outwards, this action being continued when the other parts of the piece come into contact with the parts of the rollers of less diameter. The opening is thus commenced while the centre of the piece is free, the operation being completed as the piece passes entirely over the rollers. From the illustration it will be seen that these rollers are mounted in a frame suspended from the centre, being connected with the suspending-bar by means of a swivel joint, allowing the whole frame to sway slightly from side to side. When the piece moves out of the central position, the frame sways to the side to which the piece has travelled; on account of the roller being of greater diameter at the side, the piece works up the roller, and, in doing so, presses the latter against a rubber brake, which immediately arrests the motion of the roller, and the roller at the opposite side being free to move, the latter draws the cloth into the centre again, and, consequently, relieves the roller. Thus the device not only opens out the cloth, but guides it centrally into the drying machine. The cloth, of course, is fed into the machine from rails, fixed so as to produce considerable drag on the conical rollers.

The first cylinder of either the horizontal or vertical drying machine is often replaced by an adjustable expanding roller, for pulling out the

Fig. 6.—Adjustable expanding roller (Hawthorn & Co.).

cloth, and feeding it evenly on to the drying tins. A very good form of expanding roller is shown in Fig. 6.

From the illustration it will be observed that this expanding roller consists of a number of pulleys having toothed edges mounted on a central shaft. The angles at which the separate pulleys revolve upon their separate centre bearings increase gradually from the centre to the outside so that the stretching power of the outside pulleys is greater than those near the middle, and thus the cloth is pulled outward from the centre. The edges of the several pulleys are so cut that the pulleys lock into each other, and thus the cloth is prevented from dropping between them. When the teeth on the pulleys have become somewhat worn it is necessary to take out the pulleys, an operation easily performed with this particular expander, and sharpen up the teeth, either by filing or in the lathe. This expander has a considerable advantage over those patterns having complicated slides and other mechanical arrangements, owing to its simple construction and the small number of working parts requiring oiling, which reduces the possibility of accidental oil stains. The expander can be used for the lightest kinds of cloth, as it is easily driven, and very little strain is put upon the fabric.

Squeezing Machines and Hydro-Extractors.—After the goods have been soaped, dyed, or washed, the excess of water is taken out of them, before drying, either by means of a squeezer or hydro-extractor; the former is generally used after prolonged soaping operations and bleaching, and the latter after dyeing and ordinary washing.

One kind of squeezer will be found illustrated on p. 88, under the Section on *The bleaching of cotton piece goods for printing.* The water is expelled by the piece passing between two sycamore bowls, the degree of pressure exerted being regulated by means of the screws shown above the bowls.

Where the cloth is treated in the detached or lump form, or in those cases where the pressure of the ordinary squeezer would be liable to cause the colours printed or dyed on the piece to mark off, the water is expelled by centrifugal force in the machine known as the hydro-extractor or whirler. The machine consists of a perforated shallow cylindrical vessel, made of metal, open at the top, and mounted on a spindle so as to enable it to be revolved at a high rate of speed by connection with suitable gearing, driven generally by a small steam engine. The revolving cage is surrounded by an iron casing, which, however, does not touch the cage, and this prevents the liquor expelled from the goods from being thrown over the place where the machine stands. Fig. 7 represents one form of hydro-extractor commonly used at the present time, this particular machine being one of the kind known as the direct steam-driven hydro-extractor; but there are many patterns in use driven by strap and gearing.

Strap-driven hydro-extractors should, on account of the high speed at which the cage revolves and the weight of the wet material placed in them, be securely bolted down to a firm concrete foundation.

The cage is sometimes revolved at the rate of about 900 revolutions per minute. The pieces should be made up into bundles and placed well against the sides of the cage, loading it evenly all round the sides first, and afterwards filling in the centre with the other pieces. If only a few pieces are to be whirled they should be so arranged that the weight is evenly balanced, otherwise the machine will have a tendency to rock or "wobble," or in extreme cases, it may be strained. The machine requires some little time to elapse after it is started before full speed is attained; and after the clutch or strap is thrown off it should be allowed to slow down somewhat before the padded wooden block, which generally does duty as a brake, is applied to the upper edge of the revolving cage in order to quickly bring the cage to rest.

The driving of these extractors with a strap is sometimes very troublesome owing to the strap breaking, and, as they require to be

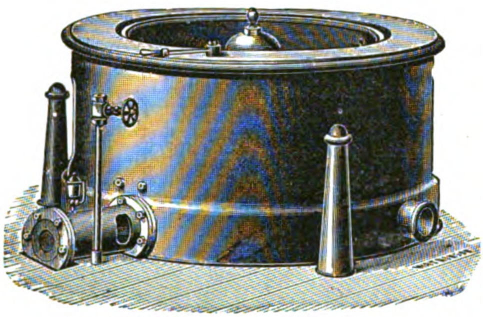


Fig. 7.—Suspended steam-driven hydro-extractor (Broadbent & Sons).

very firmly fixed to a solid concrete foundation, some firms, notably Messrs. Broadbent & Sons, of Huddersfield, have turned their attention to direct steam-driven machines which require neither shafts, bolts, nor counter gearing; as these require no special foundation they can be placed either on the ground floor or on an upper one.

The system of direct driving by steam is preferable to the use of a strap and gearing for many reasons, one of which is that the slip and friction on starting the machine is reduced to a minimum; as the machines when in use are constantly being started and stopped, this is a very important consideration.

With direct steam-driven extractors much time is saved in attaining full speed. Straps, especially when used in a steam laden atmosphere, such as generally obtain in dye-houses, are very liable to decay and to break when starting the machine; consequently by using direct steam-driven extractors much expense and annoyance is saved. In the hydro-extractors made by the firm above named there are few working parts; as these are large surfaces, and the lubrication is arranged to work automatically, there is little wearing of parts when in use; and in order to take up this small amount of wear and tear, all the wearing parts are arranged so as to be easily adjusted by the screws provided for the purpose. Steam-driven machines being self-contained are not dependent upon any outside engine for motive power, and they are thus available for use in any suitable position, irrespective of the position of the other machinery, and at any time, without undue expense in driving. Owing to the small amount of vibration and shake, the cost of wear and tear is less than with the strap machine; while the initial cost of laying them down is less, because no elaborate foundation is necessary.

The cages are made either of galvanised steel or copper, and are either wired or perforated. Some makers fit a brake to their machines for the purpose of stopping the machine quickly.

Drying Machines.—Drying machines may be divided into three classes, viz.:—Cylinder drying machines, where the drying is effected by passing the cloth over and around cylinders heated by steam, and arranged in series either horizontally or vertically; wheel drying machines, where the cloth passes around the circumference of a large wheel, the periphery of which is made hollow and is heated with steam in chests; and stentering machines, which dry the cloth by hot air, and, if necessary, stretch it at the same time. We shall describe each of these machines here under their respective titles, leaving special methods of drying used in connection with special processes for description when dealing with the processes themselves.

Cylinder Drying Machines. — **The Horizontal Cylinder Machine.**—The horizontal drying machine is generally made after the type shown in Fig. 8. The cylinders are arranged in two heights, in the manner shown in the illustration, and the cloth passes under and over the fixed wooden bars shown at the right-hand side of the figure, which produce a certain amount of tension or drag on the cloth, after which it passes under the cylinder situated below the wooden bars, then over the cylinder above, underneath the next lower cylinder, and so on until it leaves the machine in a perfectly dry condition at the far end of the machine, being folded or plaited down mechanically. The machine is generally driven by means of a small independent engine. The various cylinders are geared together by means of spur-wheels or bevel gearing driven by a shaft; the latter is by far the method to be preferred, as each cylinder is then independent, and should any accident happen to either cylinder or wheel the repairs can be delayed until a suitable opportunity occurs to effect them; thus the machine need not be stopped immediately the breakdown occurs, which enables the pieces then on the machine to be run off before another cylinder or wheel is substituted.

The cylinders are made either of tinned iron or copper, strengthened inside with iron rings and provided with iron ends, or, in the case of very light cylinders, steel ends with brass or iron nozzles. Copper is in every way better than tinned iron for the construction of the

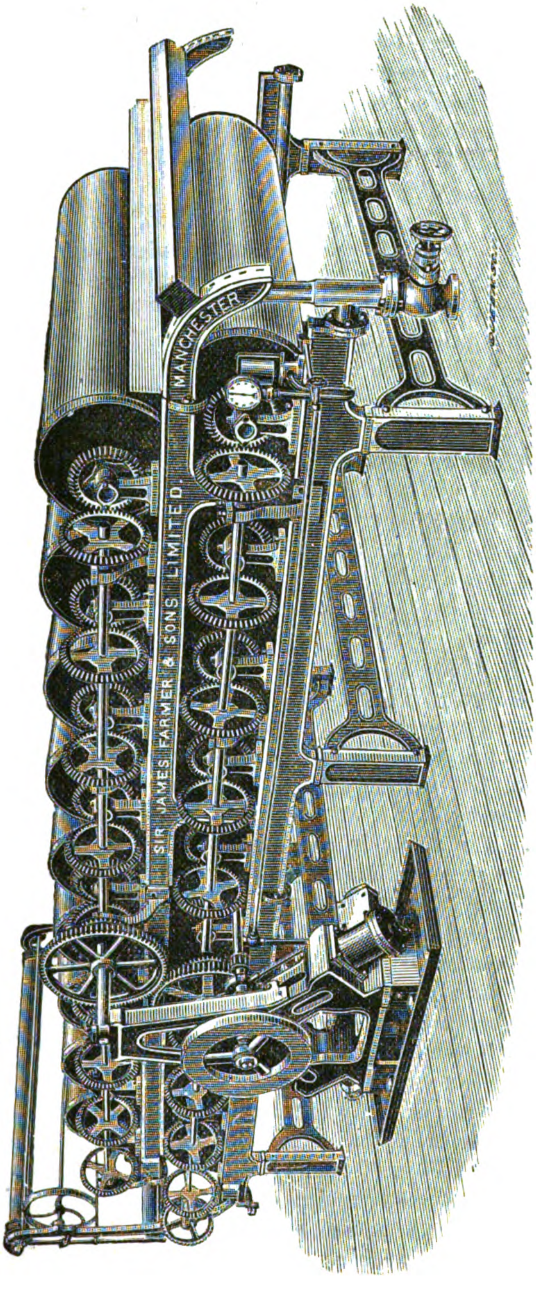


Fig. 8.—Horizontal drying machine (Sir James Farmer & Sons).

cylinders in those parts where the cloth is brought into contact; the pieces dry quicker, owing to the copper being a much better conductor of heat than tin-plate, and the metallic tin on the surface of the tinned iron is liable to wear away, or chip off, leaving the metallic iron exposed to the wet piece; if the piece has traces of free acid this may lead to the production of iron stains. Copper is, however, very much more expensive than tinned iron, and for some purposes is not suitable, as it is liable to affect the colours on the pieces—*e.g.*, when drying after buffing with chrysamine.

The machines are made to dry either one, two, or three pieces running side by side; consequently the cylinders vary from 4 feet to 10 feet in length; the most useful and generally used machine is that taking 2 pieces side by side. The number of cylinders fitted to the machine depends principally upon the weight of the cloth to be dried, and the speed at which the machine will be required to work, also on the material of which the cylinders are made, and on the pressure of the steam used for heating the cylinders. Each printer should fix the number of cylinders required for his special work, after a careful consideration of these points, taking care to provide a few cylinders too many rather than too few, or he will have the annoyance of being compelled to run the machine at a slow speed should the batch of cloth requiring to be dried be rather heavier in make than usual, or when orders are wanted in a hurry.

Before the steam enters the drying cylinders it is advisable to pass it through one of the many forms of steam dryers, so as to reduce the amount of water which will be condensed in the cylinders as much as possible, and thus reduce the amount of water to be carried away by the buckets fitted inside the cylinders. The steam enters the cylinders at one end through the bearing on which they revolve, the similar bearing at the opposite side serving to convey away the waste steam. The steam is generally supplied at about 5 to 10 lbs. pressure, although sometimes the pressure is both lower and higher than this, according to the class of work in hand; especially when used for certain styles of finishes.

The water condensed from the steam inside the cylinders is constantly being removed by means of one of the forms of buckets, of which each maker has his special pattern; one very good form being shown in Fig. 9, which clearly shows the manner and principle on which these buckets work.

An improved form of bucket for drying cylinders has been invented by Messrs. Hawthorn & Co., of New Mills, which is shown fitted to drying cylinders in Figs. 10 and 11. The principal advantage arising from the method of construction employed by this firm is that the buckets may be taken out of the cylinders without removing the latter from the drying machine, necessary with the older patterns and methods used for fitting them. The buckets are double-acting, and will work with the cylinders revolving either way, discharging the condensed water twice at every revolution. Fig. 10 shows the

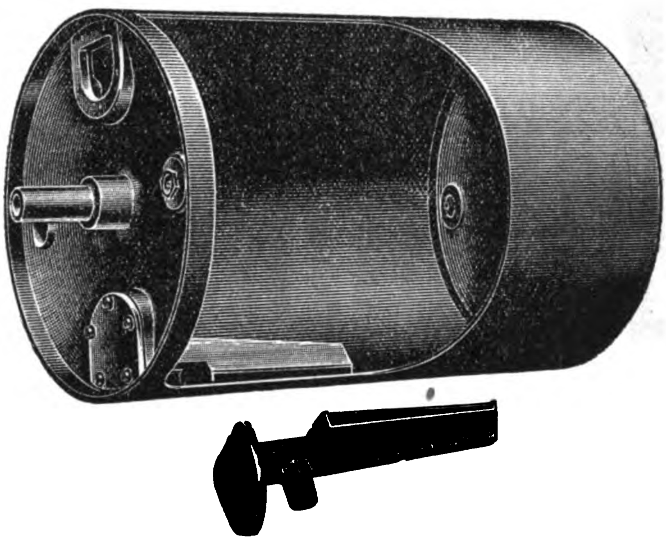
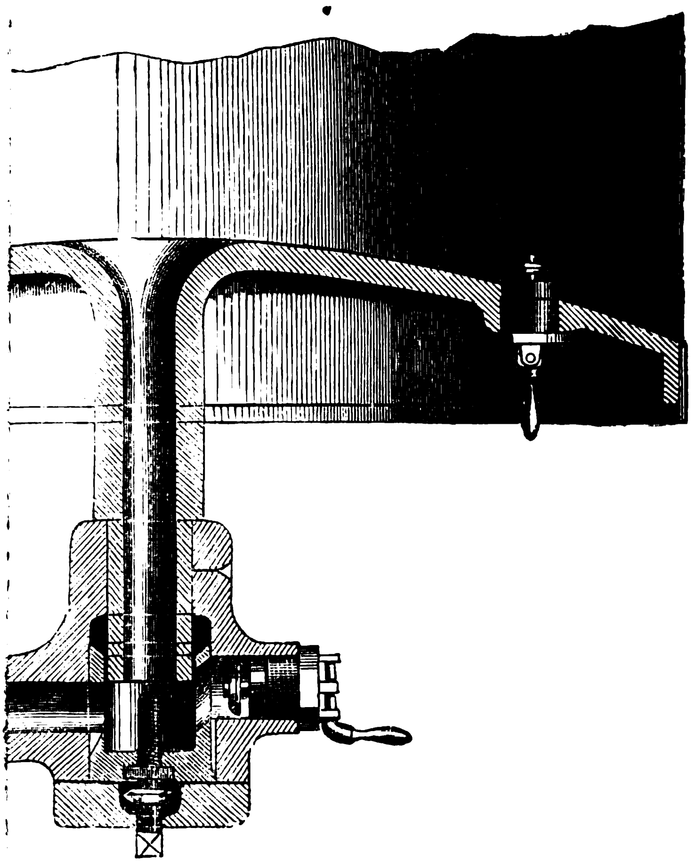


Fig. 11.—Drying cylinder (interior) with one bucket removed, also detached bucket (Hawthorn & Co.).



…d to end of drying cylinder (Mather & Platt).

internal arrangement of a cylinder with the buckets in position, and Fig. 11 shows a cylinder in which one of the buckets has been removed by drawing it through the end of the cylinder from the outside; thus saving a considerable quantity of time and trouble compared with that required to perform the same operation with the older methods of construction.

It is necessary to pay particular attention that the buckets are performing their work in an efficient manner, because, unless the condensed water is removed, the running of the machine will be affected, and considerable loss, both of steam used for heating as well as motive power, will occur. Exhaust steam is sometimes used for heating drying cylinders on the score of economy, and is occasionally mixed with live steam from the boilers; but it is not a method to be recommended, as exhaust steam is always contaminated with grease and dirt which are deposited inside the cylinder in the form of grease balls, and, owing to the action of the fatty acids contained in this foreign matter, the inside of the cylinder is liable to be corroded, and thus the durability of the cylinder to be shortened.

To guard against the collapse of the cylinders after the steam has been turned off, all cylinders are fitted with safety valves, which remain shut so long as there is any pressure from the inside of the cylinder, but open easily as soon as any pressure is exerted by the outside atmosphere. Generally these valves are arranged automatically, but in common with many other automatic machines they have the objection of occasionally refusing to work when most needed, and many cylinders have collapsed from this cause. This has led to the introduction of safety or vacuum valves fitted with arrangements for opening by hand. Such an arrangement is shown in Figs. 12 and 13. Fig. 12 shows the valve in a position similar to the ordinary vacuum valve, the valve being free to act, and the ordinary spring keeping it up to its facings; being, in fact, so far, exactly like a valve of the ordinary construction. Fig. 13 shows the valve opened by means of the lever handle, and it will remain open until the handle is placed again in the position shown in the figure. These valves being readily opened and closed by hand enable the operator to let the steam out of the cylinder after the work is done, and thus prevent it from condensing in the cylinders; of course, when the machine was started again the condensed water would have to be expelled by the steam through the buckets, &c. Again the cold air in the cylinders can be allowed to escape through the open valve when starting the machine before the valve is closed, thus saving much time in attaining the proper temperature of the tins before passing the pieces over them. Fig. 14 shows the end of the drying cylinder with these vacuum valves fitted to it.

The framework on which the whole series of cylinders are mounted should be very strongly made, and the whole well bound together

2

with strong cast- or wrought-iron stays. The part of the framework upon which the stands carrying the bearings of the cylinders rest should be planed over the full length to ensure the cylinders being perfectly true with each other. The engine should be arranged so as to be started or stopped at either end of the machine.

The whole drying machine should be covered over the top with a wooden hood, for the purpose of conveying the steam produced by the drying of the pieces, and the steam escaping from the machine itself, out of the room into the open air, the ventilation being assisted, if necessary, by a fan placed at the top of the hood.

When starting a drying machine the steam should not be turned on at full suddenly into the cylinders, but time should be allowed for the air to escape and the cylinders to get warm. If the steam is turned on full at first, there is great danger of straining the cylinders by the sudden pressure applied, unless they are fitted with valves that are opened by hand, like those described above; and the cylinders are further liable to be strained by the unequal expansion of the metal parts owing to the uneven heating, causing the joints to separate.

In those cases where it is essential that the face of the cloth should not come into contact with heated metal drums, the bottom row of cylinders are removed, and a series of wood lagged guiding rollers introduced in their places. The back of the cloth only then touches the drying tins, while the face comes in contact with the wood rollers. This method of working the machine is applied chiefly when working cloth having a figured design woven on the surface, which is required to be well thrown up or displayed in the finished print.

Vertical Cylinder Drying Machines.—Where the ground space is limited the vertical or upright cylinder machine is used, an example of which is shown in Fig. 15. The construction of the machine is similar to the ordinary or horizontal form; the same kind of drying tins and fittings being used, the only difference being in their arrangement. Where it is possible the horizontal form should be employed in preference to the upright form, as the various parts are much easier to get at for cleaning and threading up, or in the case of breakdowns. It will also be found that a larger number of cylinders are required for the same drying efficiency when they are arranged vertically, as the upper cylinders are always surrounded by a steam laden atmosphere when the machine is working, which reduces the effect of the upper tins; consequently, more cylinders will be required if they are to be arranged vertically, or, what amounts to the same thing in practice, the machine will require to be run slower.

Wheel Drying Machine.—In some special cases, especially in the finishing of fancy or figured cloth, the drying is done on the large wheel or pulley dryer shown in Fig. 16. The cloth when dried on this type of cylinder is of course dried from one side only. The rings forming the cylinder are made of cast iron, in segments well bolted

together. The body through which the steam circulates is formed of tinned iron plates fixed to the framework through a turned up flange, and secured by a ring and bolts, making a perfectly steam-tight joint. The outside of the body where the cloth touches it is formed of copper plates, firmly riveted together, the edges being turned up, forming a flange which is fastened with a ring and bolts. These large cylinders are difficult to construct, owing to the unequal heating and consequent

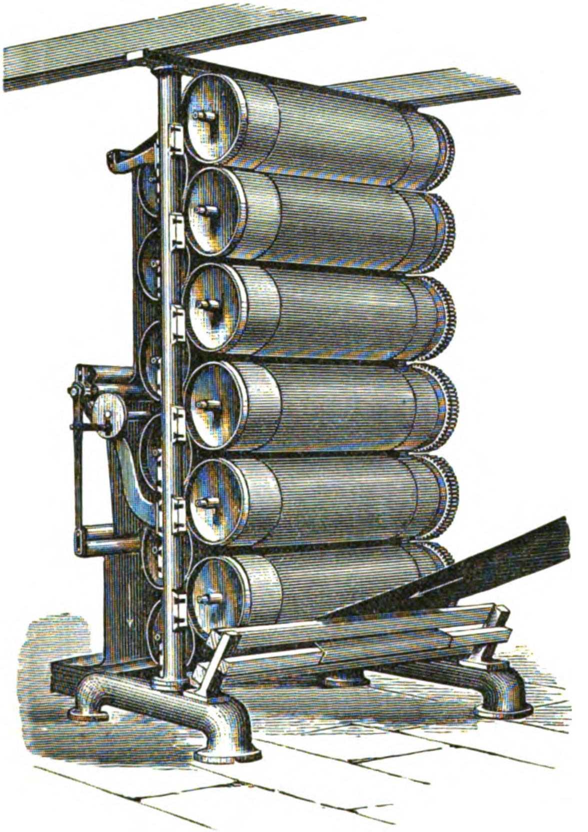


Fig. 15.—Upright drying machine (Mather & Platt).

expansion to which they are subjected, and in practice they will be found to require considerable attention to keep them steam-tight. The other details of their construction will be understood from the figure.

Stentering Machines—Hot Air Drying.—Many goods, especially delaines and woollen goods, are dried on the tentering or stentering frame by means of hot air, the drying being done in a continuous manner. The machine is adjustable for varying widths of cloth, and it is also used for pulling out the cloth to the width required during the drying. It is used very largely in finishing many styles of cotton prints, notably Turkey-red and lawn handkerchiefs, the application of the finishing material, drying, and stretching all being done at one operation on the machine.

The stentering machine consists of a long iron framework, the two sides of which are adjustable to or from each other, so as to accommodate cloth of several widths, the various adjustments being made by means of screws underneath the framework. Along the frame at each side are two continuous chains carrying clips or pins which grip the selvedges of the cloth and carry it to the other end of the frame. At the end of the frame where the cloth enters, the clips are opened mechanically to allow the cloth to pass under them, after which they spring down and bind the cloth until it reaches the end of the frame, when they are opened again and the cloth is drawn out of the machine. The clip is constructed in such a manner that the greater the pull the cloth exerts, the firmer the clip attaches itself. The distance between the chains at each side of the frame at the entering end of the machine is so adjusted that it is somewhat less than the width of the piece in its present wet condition, thus it enters the machine slack, the distance of separation being gradually increased as the piece passes along the frame until it reaches the width required; the extreme width between the two travelling chains should be a little over the width which the piece is required to be when finished, as it contracts somewhat when it leaves the frame. The part of the machine between the entering end of the frame and the end where the cloth leaves the clips is generally enclosed by dividing the room, in which the machines stand, with wooden partitions, this part being well ventilated by air fans fixed near the roof, drawing the hot air out of the room. The drying of the cloth is effected by means of hot air supplied from a number of tubes situated underneath the stretched cloth, the air being forced through these tubes with a form of hot air blower. The dry cloth as it leaves the machine passes over rollers, and is either plaited down on to a stillage or wound on to a wooden centre, both being done mechanically, the power being derived from the same source that drives the stentering machine.

The spring clips are far preferable to the old-fashioned pins for holding the cloth on the frame, as the latter cause the cloth to be marked permanently with small holes along the edges, and if the selvedge of the cloth should have become damaged in any of the operations through which it has previously passed, it will be very liable to break away from the pins, especially if the degree of stretching is great.

The widening of the cloth is often required, because most of the operations of bleaching, dyeing, and printing, and the subsequent operations through which the cloth has passed, have all tended to increase the length of the piece, and at the same time to reduce its width. When the piece is again stretched to its former width or thereabouts, the length is reduced.

Most modern stentering machines are so made that the cloth, if required, can be given a kind of zig-zag motion from side to side, as well as the direct pull for increasing the width. This movement is chiefly employed when the pieces are being finished on the machine, and are impregnated with the finishing material or mixture. The side-to-side motion causes the warp and weft threads to continually pass over each other during the drying of the piece, and thus they are prevented from being pasted together with the size; cloth so worked retains its thready feel and appearance, and is softer to the touch.

Colour-Shop Machinery.—**Colour Pans.**—The pastes or colours used for printing the fabric are prepared, mixed, boiled, and cooled in jacketed or cased copper pans similar to those shown in Fig. 17, generally all placed together in a range in an apartment known as the colour shop.

The colour shop should be situated in close proximity to the machine room where the printing machines are fixed, to avoid as much as possible the necessity for wheeling the prepared colour through places where it will be liable to become contaminated with dust and grit, the latter causing damage to the engraved copper rollers by scratching them. The colour shop is generally built of one storey only; it should be well ventilated near the roof to carry away the large quantity of steam that is produced during the boiling of the colours, which is very often charged with the vapour of acetic acid; this vapour renders it extremely injurious to the workmen, and chiefly affects the chest.

Small and medium sized colour pans are made entirely of copper, and are mounted so as to turn over for emptying and cleaning; but very large pans are often made with the lining of copper only, the outside being constructed of iron, the pans themselves being fixed in position. Above each pan a cold water tap is placed for filling-in the quantity of water required for the particular colour in hand, and for rinsing the pan after use; but very often for the latter purpose (cleaning the pans) a separate pipe and tap is used, the water being warm and being supplied from one of the many forms of steam economisers now so largely used for heating the feed water for steam boilers. The steam for heating the colour in the copper pans is conveyed through one of the trunnions, which support them, into the casing, the other trunnion conveying cold water for cooling the colour; the steam and water find an exit at the bottom of the casing into the drains. Each pan is provided with stirrers working on the sun and planet principle, so that the colour is stirred round the sides of the pan as well as in the centre. The stirrers are arranged to be put in and out of gear by means of clutches, which are generally situated above the pan on the driving shaft, as shown in the figure. The smaller pans are merely tilted over by hand, but those of a larger

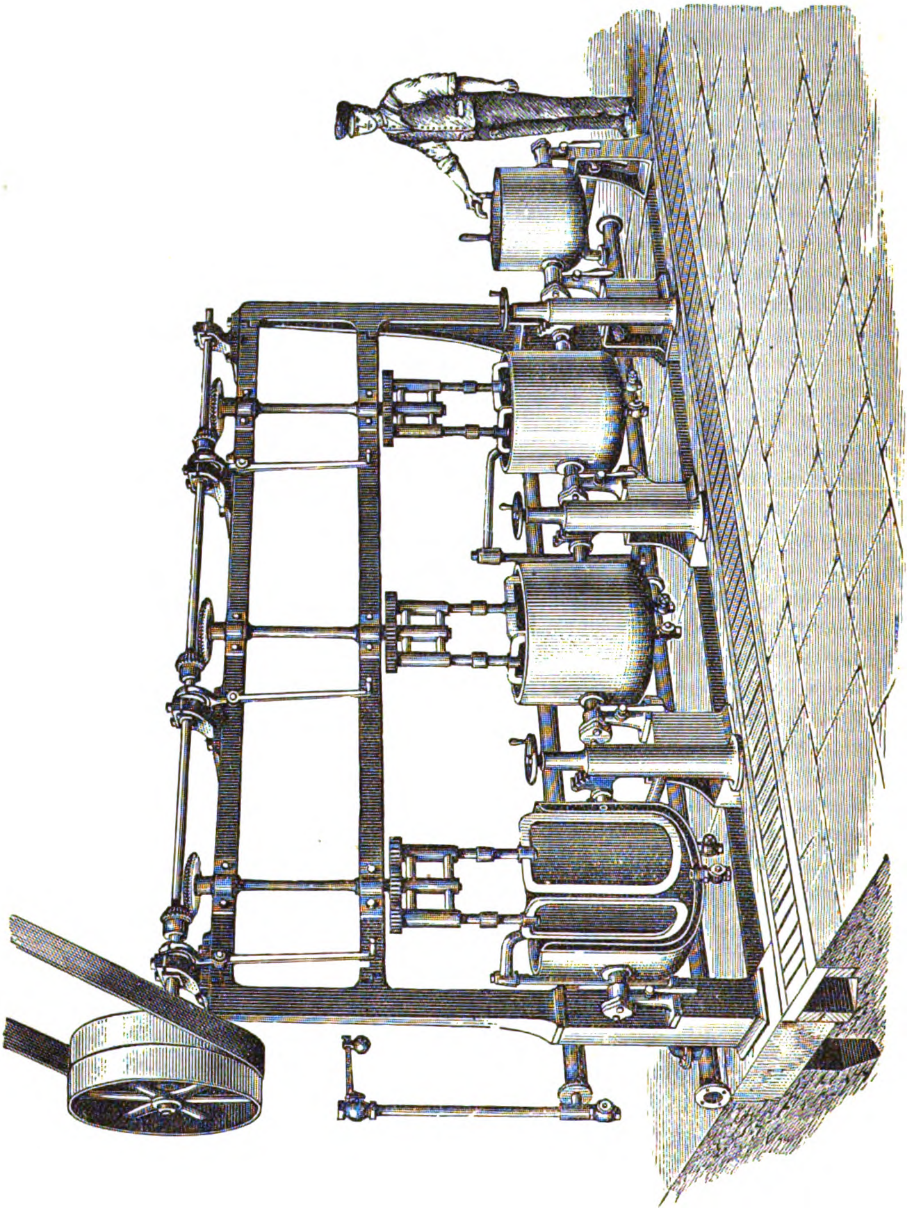


Fig. 17.—Double-cased copper swivel colour pans (Mather & Platt).

size are fitted with mechanism for this purpose, generally consisting of a worm and wheel. Some firms fit three stirrers to each pan, but two, if properly arranged, are quite sufficient. The stirrers should be made of brass, and should be coupled to the bearings in a simple and efficient manner, so that they can be quickly taken out and replaced when emptying and cleaning the pan.

After the various ingredients for the colour have been put into the pan together with the requisite quantity of water, the stirrers are started; after the expiration of a little time the steam is gradually turned on, and the colour boiled, or in some cases merely heated to a given temperature, and this is maintained for a time, depending upon the kind of colour in hand. After the colour has been heated the steam is turned off, and the colour is then cooled by gradually turning the cold water on, stirring being continued until the colour is quite cold, after which it is either put into the stock cask or strained ready for the printers.

Straining of Colours.—When the printing colour has been boiled, cooled, or otherwise prepared for printing, it is necessary that all lumps and solid particles that are not in an extremely fine state of division should be removed, because if these were allowed to pass on to the printing roller they would cause streaks on the printed cloth, and, if these particles are of a hard nature, the copper printing roller will be scratched and damaged. On this account all colours are strained through cloth or other fabric before they are taken into the machine room.

The operation is generally done by hand in the following manner:—A clean colour tub, rather larger than would be required to actually contain the colour, is placed on the floor near the vessel containing the colour to be strained. A piece of cloth large enough to cover the top of the tub and hang well over the sides is taken, rinsed well in water, wrung out, and spread over the top of the empty tub, the cloth being secured in its place by tieing the two opposite corners of the cloth together to form a loop, and passing them underneath the iron handle fixed on each side of the tub. A portion of the colour, the quantity depending upon the size of the straining cloth and the strength of the operator, is ladled into the stretched straining cloth, the ends of the cloth are then gathered together, the whole raised clear above the tub, and the colour is forced through the meshes of the cloth by pressure with the hands and by twisting the cloth round upon itself. When all, or nearly all, has passed through, the cloth is opened carefully so as not to allow any of the lumps in the straining cloth to fall into the colour again, adjusted (as before) over the top of the tub, another portion of the colour placed in the cloth and the straining continued (as before) until the whole of the colour has been passed through the cloth.

Some colours that are difficult to strain are first passed through a coarse straining cloth and then through one of finer texture.

The operation of colour straining being always a very unpleasant one, and as some of the colours act injuriously upon the hands of the operator, machinists have for many years turned their attention to the construction of machines for performing this operation; but, although there has been a large number of machines made, there is at the present time no machine on the market that can be said to be satisfactory or has the slightest possibility of displacing hand straining. Although these straining machines are, we believe, never used as general colour strainers in the colour shop, they are always used for straining those colours that could not be strained by hand, owing to their corrosive action on the human skin, such as those colours containing a large proportion of caustic alkali in their composition; consequently, they find a place in every colour shop where this class of work is done.

One pattern of straining machine which we believe works as satisfactorily as could be expected is constructed in the following manner:—The base of the machine consists of a strong iron box, on one side of which there is a door large enough to admit a colour tub, the door being provided with indiarubber packing, making it absolutely air-tight when closed. This box is connected with a steam pump by means of which the air inside the box can be withdrawn. Above the box there is a large funnel-shaped iron hopper, hinged generally to one side of the top of the box, and the fine wire gauze through which the colour is generally strained is fixed between this hopper and the box, indiarubber packing being usually employed to render the junction air-tight. The method of using the machine is as follows:—A clean colour tub is put inside the iron box to receive the strained colour, after which the door is closed and securely fastened. The colour is put into the hopper and the pump started. In about a couple of minutes, if the machine is in proper order, the colour will be observed to begin passing through the sieve, the pump at the same time indicating that most of the air has been withdrawn from the box, after which the colour gradually passes through the sieve. The action of the air pump will indicate immediately when the whole of the colour has been strained, the sudden rush of air into the box reducing the amount of work on the pump at once. The tub is then taken out of the box, and the machine made ready for receiving the next lot of colour.

From the above description of the manner of working this machine, it will be noticed that the colour is forced through the straining fabric by the atmospheric pressure being exerted on the upper surface of the colour contained in the hopper.

Brushing Machine for Printers' Greys.—The back-greys, before they are taken into the printing-machine room, are wound on to a wooden centre or shell, and both sides of the cloth are brushed to remove the lint from it. This is done on the machine known as a canroy shown in Fig. 18. The machine is shown threaded up with cloth. The cloth as it passes through the machine is depressed by means of rollers against the revolving circular brushes, three of which brush each side. The rollers that press the cloth into contact with the brushes can be raised or lowered to enable the cloth to be threaded before starting. Each brush is arranged in a separate trough, which receives the lint from the cloth; this lint is withdrawn from the troughs by means of exhaust fans, thus preventing it from spreading over the room and injuring the health of the operators. The cloth is wound or

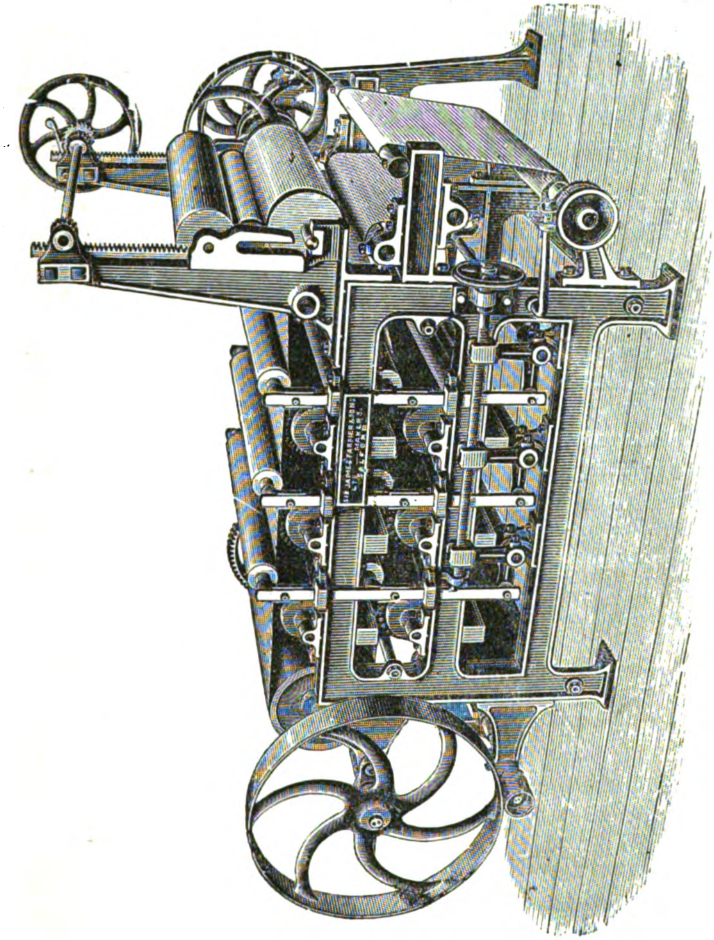


Fig. 18.—Six-brush canroy (Sir James Farmer & Sons).

batched on the shell at the same end of the machine that the pieces enter it, which is a considerable advantage, as the workman can see that the cloth not only enters the machine properly, but that it is wound on evenly and free from creases or turned edges.

Shearing and Brushing Machine for Pieces.—After bleaching, and before they are printed, the pieces require shearing and brushing. When the goods were singed the small fibres were burned off the face of the cloth, but the thicker threads and knots are not removed by this process. The "fluff" or small fibres that were bedded in the cloth when it was passed over the singeing rollers have, during their passage through the operations of bleaching and washing, been raised or caused to stand out from the face of the cloth, and would, if allowed to remain, seriously interfere with the printing. All these irregularities on the face of the cloth are removed by shearing and brushing. Generally the pieces are sheared on one side only, but where reversible prints are required, either produced by printing through, or by discharging slop-padded mordants or dyed goods, the pieces are sheared on both sides by passing them twice through the machine, or using a special machine that shears both sides at one operation.

The machine resembles in appearance the canroy, and is practically the same kind of machine with the addition of shearing rollers. These shearing rollers are made with blades of steel, kept very sharp, and passing spirally round the roller, which take off the knots and loose fibres as they revolve at high speed against the cloth, the lint produced being taken away by the brushes in the same way as on the canroy.

Printing Machines.—Fabrics may be printed by impressions received from engraved blocks, plates, or rollers; the latter method being the one most used at the present time, having displaced block and plate printing in the production of most printed goods, with the exception of a few special styles or classes of goods.

In the roller or cylinder printing machine the colour is applied to the surface of the cloth from an engraved copper roller, the pattern itself being sunk into the roller or being in intaglio. The method by which such a roller is used will be understood on reference to Fig. 19. A is the bowl of the machine, having its outside surface covered with several thicknesses of cloth, forming an elastic cushion, upon which the cloth rests when receiving the colour. The bowl of the machine revolves during the actual printing, and the cloth to be printed passing around its circumference travels with it. B is the box containing the colour, which is supplied to the engraved copper printing roller, C, by means of the roller, D, generally known as the furnisher. The furnisher consists of a wooden roller covered with cloth, or a brush roller. The lower part of the furnisher is immersed in the colour, and, as it revolves, it carries the colour to the engraved roller, working in contact with it, and forces the colour well into the engraving, at the same time smearing the whole surface of the roller. The colour on the surface of the engraved roller is then removed with a copper-plated steel blade known as the *colour doctor*, situated a

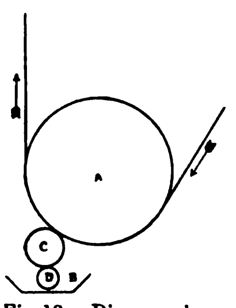


Fig. 19.—Diagram showing the action of a printing machine.

short distance from the furnisher and pressing against the engraved roller. At this stage the engraved roller should have all the engraving properly filled with the printing colour, and the surface or plain parts of the roller should be perfectly clean or free from colour, otherwise the "whites" in the resulting print will not be pure, and it will indicate that the colour doctor is not properly adjusted. The cloth to be printed is held at the back of the machine in the form of a roll wound upon a wooden centre, and held so that it can be unwound as the printing proceeds. The cloth is printed against an elastic cushion provided in the following way :—The bowl of the machine is wrapped, or lapped, with a woollen or union blanket, or lapping, which passes tightly around the bowl several times, the ends being arranged as described on p. 28. Passing in a continuous manner between the printing rollers and the bowl of the printing machine is a blanket of leatherine, or other suitable material, which acts partly as a printing pad, but is used principally to receive any of the printing colour that passes over the edges of the cloth or through the meshes of it. The cloth is, however, also always delivered into the printing machine with a continuous supply of unbleached calico, called the "back-grey," which protects the blanket and receives the bulk of the printing colour passing over the edges of the piece printed. Practically two-thirds of the cloth received at the print works is used first for "back-greys," and, after bleaching, is then printed with the pattern ordered. The cushion against which the printing is done is thus produced by the lapping on the bowl of the machine, the blanket, and, lastly, the thickness of the "back-grey." The lapping on the bowl of the machine travels around with it continuously, only the top surface ever being presented to the cloth. The blanket is usually carried to the room above, and is there scrubbed and washed with the washers shown on p. 35, after which it returns to the printing machine, working in a continuous manner. The back-grey is separated from the printed piece in the chest place (drying room), and after itself being dried winds on to a wooden centre, and when the centre has about fifty pieces, about 40 yards in length, upon it the grey is removed to the croft for bleaching. The printed cloth, after drying, is plaited down upon stillages and is then ready for the finishing processes. The cloth, as the roller revolves, is then pressed against the engraved roller, the elasticity of the covering of the bowl, combined with the pressure exerted between the two rollers, serving to force the cloth into the engraving, the colour being thereby transferred to the surface of the cloth, and some of it forced into the fibres of the cloth. After the engraved roller has left the printed cloth it comes into contact with another copper-plated steel blade, having for its object the removal of any loose threads or fibres that may have attached themselves to its surface, and which, if allowed to pass into the colour box, would mingle with the colour and eventually cause streaks on the cloth by getting to the colour doctor, and preventing it from performing its work. This blade is consequently called the *lint doctor*. The cloth, after leaving the first printing roller, passes on to the other printing rollers, which are arranged around the bowl of the machine, when more than one colour is being printed in the pattern, all the various rollers being adjusted so that the various parts of the pattern fit perfectly with each other, each separate roller having the usual complement of separate colour boxes, lint, and colour doctors.

Lapping the Printing Bowl.—The material used for covering the bowl of the printing machine is generally composed of fabric woven with a linen warp and a woollen weft, about ten thicknesses being commonly used. The lapping on the bowl should be very neatly put on, otherwise the piece being printed will show marks running across the width of the cloth. The following is the usual manner of putting a new lapping on the bowl of a calico printing machine:—The required length of the lapping cloth is taken, and both ends are cut perfectly even and at right angles with the length of the cloth. The weft threads at one end are now removed so as to make a kind of fringe about two inches long, and this end is carefully arranged and pasted down on the bowl of the machine, after which the lapping is very evenly and tightly wound on the bowl until the end is nearly reached, when the cloth is trimmed so that the end will lay over the part where the first end of the lapping was pasted on the bowl. The weft threads are then taken out as before and the end so adjusted as to form an even coating, as free as possible from ridges or hollows, which can be done if the edges are properly arranged and the threads taken out as required.

The Doctors.—As stated above, the doctors are generally formed of copper-plated steel rule, the actual wearing part only having the steel exposed to the action of the colour. So far, no material has been found to work as satisfactorily as steel for the doctor blades, but many colours act upon steel, and the iron salts so produced have considerable influence on many of the shades, generally having the effect of destroying some of their brilliancy of tone, and sometimes, if the machine should be stopped, causing a dark streak across the piece, an effect noticed especially in the case of bright alizarine pinks and clarets. The doctor is copper-plated in order to reduce the area of surface of steel exposed to the action of the colour, and consequently to minimise this defect; but although many alloys or compositions have been brought out as a substitute for steel for the construction of doctors, none of them have been found hard enough to stand the wear or work as satisfactorily as steel; yet for very brilliant and delicate colours that are soiled by contact with iron they are used, and require particular attention on the part of the machine printer. Doctors are made in several thicknesses of material to suit the various styles of engraving on the copper rollers—a thick doctor being used for heavy open engraving, such as that used for the blotch roller; and the thinner grades for fine engraving, as flower or sprig patterns, the average thickness being about 23 on the standard wire gauge. All printing machines are fitted with mechanism for imparting to the doctors a to-and-fro motion, in a direction parallel to the width of the piece. This motion is given to the doctors in order to prevent them wearing away unevenly, as, of course, the doctor would, if fixed in position, wear chiefly in those parts where there is the most friction—viz., on the parts in contact with the unengraved parts of the roller and where the edges of the engraved parts strike it; hence by giving a lateral motion to it the whole surface of the doctor wears more evenly, and it requires much less adjusting and trueing up during use.

The doctor blades, being thin, are clamped, supported, and stiffened by being clamped between two thick brass plates, the lower one being provided with bearings at each end fitting the frame of the machine. The doctor blade is bolted between these two plates and can be adjusted between them to compensate for wear and tear in use.

Preparing the Doctor.—As the success of the operation of printing depends to a considerable extent upon the condition of the doctors, any defect in their condition showing itself in the form of streaks along the surface of the cloth, owing to the colour being imperfectly removed from the plain or unengraved parts of the roller, they require special attention, and, owing to the fact that they are liable to wear away unevenly, it is occasionally necessary to remove them from the machine for the purpose of filing or trueing up. The filing up should be done in a good light, consequently the brackets for holding the doctors during the operation are fixed immediately underneath the window nearest the machine. The doctor in its holder is placed on the brackets, with the blade uppermost. The cleaning edge is then carefully examined, either by inspection only, or assisted by the use of a straight edge. Any irregularity is then removed with a file, and the trueing up is then completed by finishing off with a stone, to take away the coarse file marks. The doctor is then tried on the machine and if not perfect in action the operation is repeated. Considerable experience is necessary before a doctor can be perfectly and, at the same time, quickly put in order.

The Furnisher.—The furnisher in the colour box can be driven either in the same or in the reverse direction to that which the engraved roller is travelling, according as the gear wheels are arranged. The furnisher generally revolves the same way as the printing roller, and consists then of the ordinary cloth-covered wooden roller; but when pigment colours, or any colour that has a tendency to stick in the engraving, are being printed it is usual to use a brush furnisher and to work it in the opposite way. The failure of the engraving to print in certain parts, and generally attributed by printers to the colour sticking in the engraving, is often due to the nature of certain colours which do not readily pass into the deeper parts of the engraving, and when the doctor has cleared away the surface colour, there is no colour, or very little colour in these parts, and, consequently, they do not print at all; or, should they do so, the impression is faint. Thus the cause is not really due to the colour sticking in the engraving, but to the failure of the furnisher to properly supply colour to these parts. Fine patterns should always be printed with a carefully lapped soft furnisher.

Driving the Machine.—Each separate printing machine is at the present time provided with a separate engine for driving, generally of the two-cylinder pattern, but the three-cylinder pattern is considered by many to be the best type of engine for this purpose. The engine is usually placed alongside the printing machine, and the steam cock arranged so as to be easily reached by the printer when standing opposite the front of the machine. Printing machines are often driven by electrical power, especially in recently built print works; in these cases the works are lit throughout with electricity.

Fig. 20 will give a very good idea of the general appearance and arrangement of a printing machine, the particular one shown being a three-colour machine.

Construction of Machine.—The framework of all printing machines should be strong and massive, free from any tendency to yield or spring under the strain that it will be required to bear, and it should be firmly bolted down to a perfectly rigid foundation. The printing rollers are held in bearings, generally of gun metal, fitted in the large side blocks shown in the illustration, and their position relative to the bowl of the machine can be adjusted by means of the screws shown. These side blocks should be made long so as to allow plenty of adjustment in all the moving parts. All the working parts should be kept well lubricated, the bearings of the printing roller especially, as they are subjected to heavy pressure; one of the best lubricants for this purpose is tallow mixed with some finely powdered plumbago; but any lubricant suitable for heavy machinery may be used. If the mandrel on which the copper cylinder is fitted becomes overheated during printing, notwithstanding the fact that it is kept properly supplied with grease, it is a good plan to place upon the end of the mandrel a continuous loop of cloth, the lower end of which is immersed in a vessel containing water. The revolving mandrel will then turn the band of cloth, causing a fresh part, saturated with cold water, to be continually presented to the heated mandrel, lowering its temperature considerably.

The Printing Rollers.—Before the engraved copper cylinders or shells are put into the printing machine they are forced on to wrought-iron centres or mandrels, fitting the bearings on the machine. In order to prevent the shell revolving upon the mandrel the latter is made with a projecting tongue running parallel with its length from one end to the other, which fits into a corresponding groove in the inside of the copper shell. The copper cylinders are forced on the mandrels by

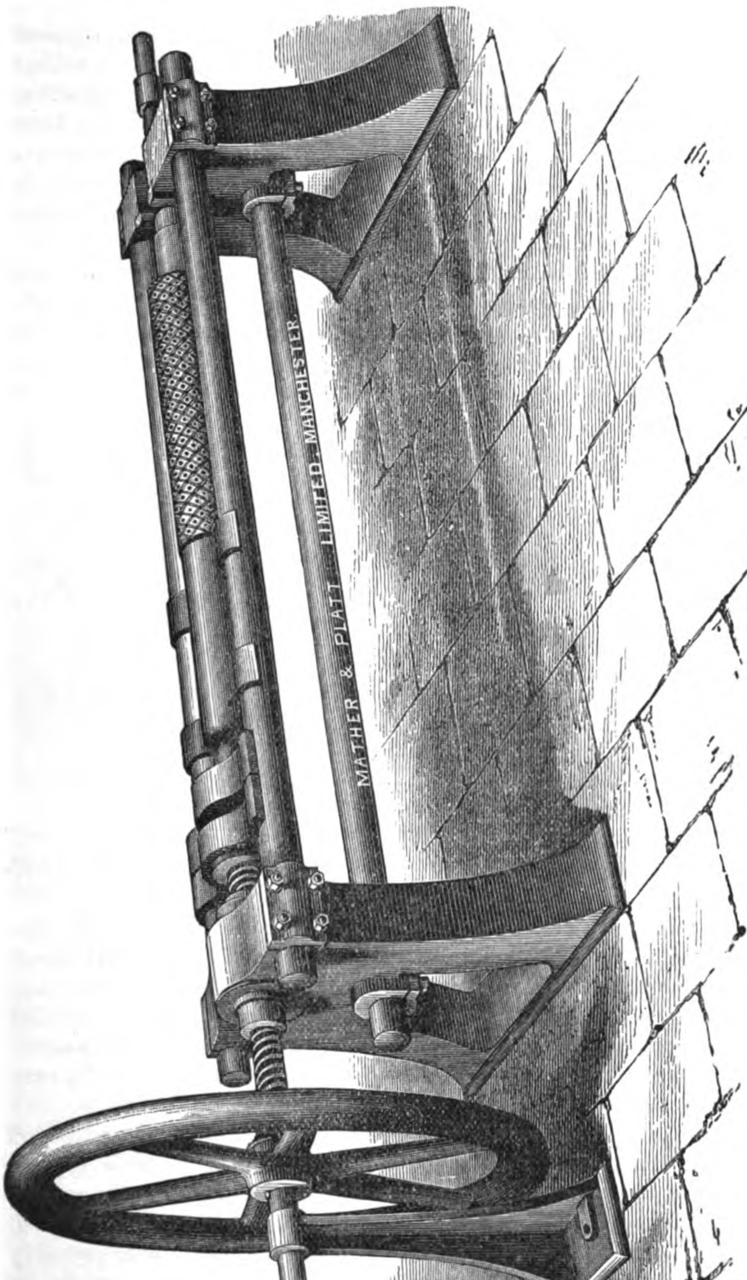


Fig. 21.—Forcing machine for engraved rollers, worked by hand (Mather & Platt).

means of the machine shown in Fig. 21, which represents one worked by hand power, but they are also made to work with steam power (Fig. 22). These machines are generally placed a short distance behind the printing machine, where they are out of the way of the operatives and yet conveniently placed when required. These machines force the copper roller on the centre without injuring the necks of the rollers or straining the mandrels. The machines are, of course, very strongly made, with strong cast-iron frames, strengthened with wrought-iron stays, and they must be firmly secured to the floor.

In a multiple colour machine the whole of the printing rollers are geared to the one central spur-wheel, working off the centre of the pressure bowl, being geared to it by means of box-wheels. The central wheel is made with teeth from $\frac{7}{8}$ inch to $1\frac{1}{2}$ inch in pitch. It is better to use the coarser pitch, if it can be arranged without

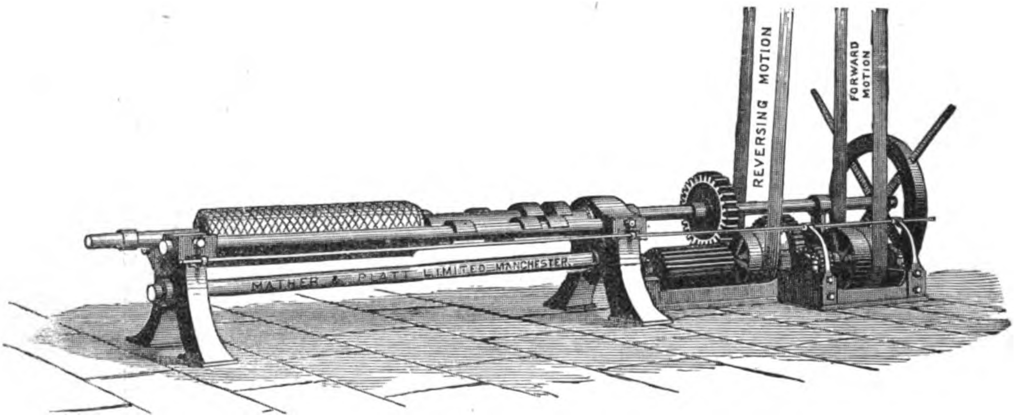


Fig. 22.—Forcing machine for engraved rollers, worked by power (Mather & Platt).

reducing the total nnmber of teeth on the wheel below 22. All the various adjustments for gearing should be placed on the right-hand side of the printer when he is looking at the piece being printed, and not on the opposite side, as is the custom with some makers, as being the most convenient. It is also essential that the teeth on the central wheel, and on all those that work in connection with it, should be very accurately cut and fitted.

Instead of using solid copper for the construction of the engraved printing rollers, which, on account of the cost of metallic copper, entails the sinking of a large amount of capital in stocking the rollers, a few firms have used a roller made of iron and thickly copper-plated, but this form of cylinder has not come into general use, probably because, although the ordinary copper shells are expensive, they always represent sunk but available capital, as one pattern can be turned off when done with and another pattern engraved upon the same shell.

Colour Boxes.—The boxes or troughs that hold the colour are made of copper, wood, or wood lined with copper, and have bearings at each end for the furnishing roller (see figure). The colour boxes are supported on iron or wooden stands, and can be raised or lowered by means of screws fitted for this purpose. In order to place the colour box in the machine the stands are lowered with the screws, the box placed in position, the furnisher with its spur-wheel placed in the gun-metal or brass bearings on the colour box, and the screws then adjusted until the whole is brought into the required position. The toothed wheel on the end of the furnisher gears into one fitted on the end of the mandrel carrying the engraved copper roller, and they are usually geared to work at the same speed, or sometimes slightly faster; but some printers believe it would be of some advantage if the furnisher travelled about one-third slower than the printing roller. When the furnisher and pattern roller are thus connected directly by two wheels only, they revolve together in the same way, but where it is desirable to have the furnisher working against the pattern roller a small intermediate toothed wheel, called a stud wheel, is placed between the wheel on the end of the furnisher and the one on the pattern roller mandrel. This is always done when the pigment colours are being printed, as they contain so much solid matter in suspension that it is necessary to adopt this method in order to force the colour into the engraved parts of the pattern roller.

The Blanket.—The cloth to be printed, having previously been wound on a wooden centre, is placed on the machine at the back. Passing around the lapped bowl of the printing machine and into the drying room, where the pieces are dried after impression, is a continuous piece of thick woollen cloth, the ends being sewn together to form as even a joint as possible. This cloth is called the *blanket*, and in addition to the covering on the bowl forms a cushion upon which the printing takes place.

The nature of the blanket used on the printing machine has a considerable influence on the character of the print obtained from the engraving. For heavy patterns the ordinary woollen printers' blanket, woven with a woollen weft and a linen warp, is used generally, but only the finer qualities can be employed for small and fine patterns. For fine patterns it is usual to employ either washable or cotton blankets. A cotton blanket is generally formed of two thicknesses of cotton cloth cemented together with a solution of Para indiarubber in naphtha, the ends being carefully joined together so as to make an even surface and thickness with the rest of the blanket. The washable blanket is made from leatherine cloth, and may be used without back-greys when one of the blanket washing apparatus is used in connection with it. To prevent the blanket as much as possible from being soiled, the cloth while receiving the impression is backed with some cloth that has not been bleached; this receives the colour that passes through the cloth actually being printed which would otherwise pass to the blanket. These pieces, or *back-greys* as they are called, are afterwards bleached and printed with their own patterns. Although back-greys are thus used, some of the printing colour finds its way on to the surface of the blanket, and this renders it necessary to employ one of the various forms of blanket washing apparatus.

Workmen.—For each printing machine three men are usually required, viz. :—The *printer*, the *back tenter*, and the *lurrier*. The printer is, of course, the principal man, and is generally a highly skilled artizan, having, in this country, served a seven years' apprenticeship. The mechanical operation of printing a many-coloured pattern is one that can only be successfully performed after considerable experience has been obtained, and very little information can be given on paper. The back tenter's work is to guide the piece and back cloth into the machine, to remove creases or scrimps from the cloth, to keep the colour boxes at the back of the machine properly supplied with colour, and to generally assist the printer. The lurrier brings the colour required from the colour shop, the pieces and back-greys from the stock room, and also does any odd jobs required by the printer.

The Pressure Bowl.—The bowl of the ordinary printing machine occasionally moves sideways in its bearings, particularly after the machine has been in use for a considerable time, however accurately the parts may have been fitted at first, causing at each shift a portion of the pattern to be out of register, the defect occurring at irregular intervals and being quite beyond the control of the printer. This defect has been remedied by a simple device invented by Mr. S. Bridge, of the Dinting Vale Print Works. The device consists of a disc mounted on the end of the shaft at the side at which the traverse movements of the doctors are worked, and so arranged that the disc can, by means of an adjustable screw, be forced against the side of the framework of the machine, thus preventing the bowl from moving laterally. Instead of the disc pressing directly against the framework of the machine, a washer may be interposed.

With regard to the arrangement of the rollers in the printing machine very little information can be supplied, as it depends upon the kind of pattern being printed and the nature of the colours employed. As a general rule, however, the blotch roller, or the roller printing the ground colour, is the last one to be printed, and with regard to the others they are arranged according to the form of the pattern or the brilliancy of the colour; where it is found that one colour has a tendency to mark off on to the next roller, and has a modifying effect on the shade, a plain copper roller is placed between the two rollers, working in either plain gum water or starch paste. This roller receives the colour that marks off from the preceding roller, and either mixes with the paste in the box or is scraped off with the doctor; thus the brilliancy of the next colour is preserved.

Blanket-Washing Apparatus.—The printers' blanket, although protected with a back-grey from colour as much as possible, still

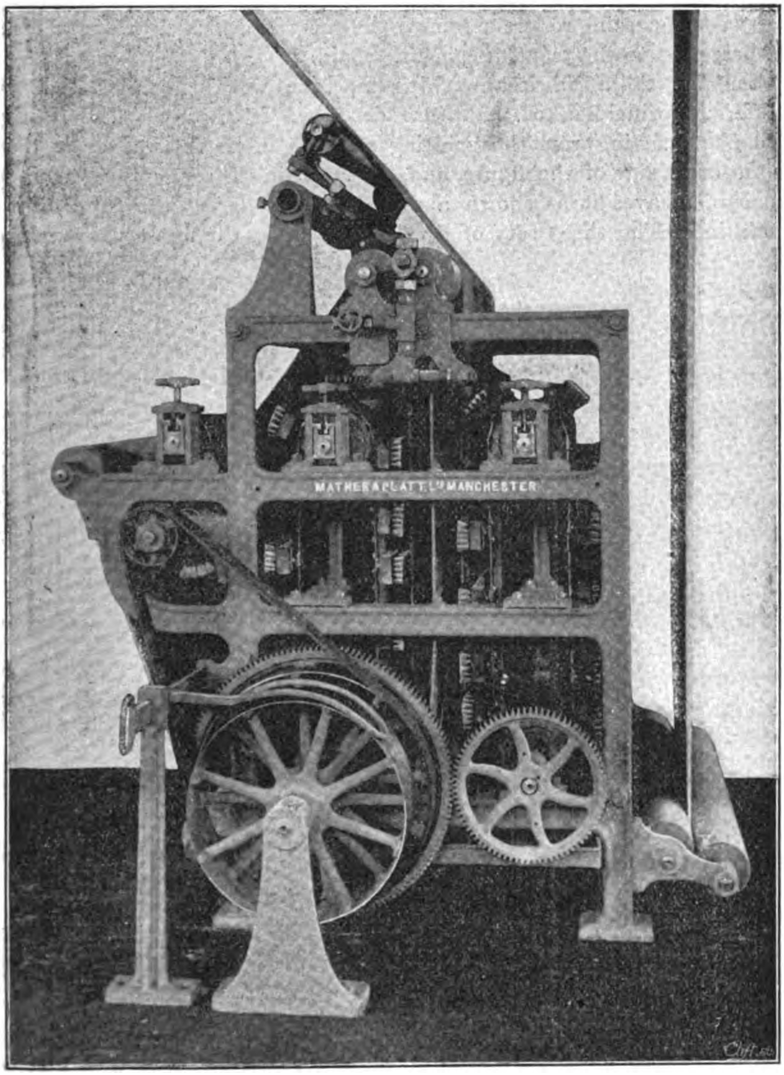


Fig. 23.—Patent blanket washing machine (Mather & Platt).

receives a large amount of the printing colour, especially at the two sides that are not covered by the piece or the back-grey. In order to remove this colour various patterns of blanket-washing apparatus are used. The principle upon which these apparatus are constructed is very simple. The blanket is generally submitted to the action of a spray of water from a series of perforated water pipes, while the surface of the blanket is rubbed with revolving brushes. By this means most of the colour is washed away. The blanket then passes between squeezing rollers to remove the superfluous water; after which, it passes on to the printing machine again.

In Fig. 23 a blanket washing machine working on a slightly different principle to that just described is shown. The cloth (blanket) coming from the printing machine enters the washer at the right-hand side of the figure, and, after passing through the washing machine, leaves it as shown above the top roller at the top of the machine. The three sets of brushes shown in the figure pass across

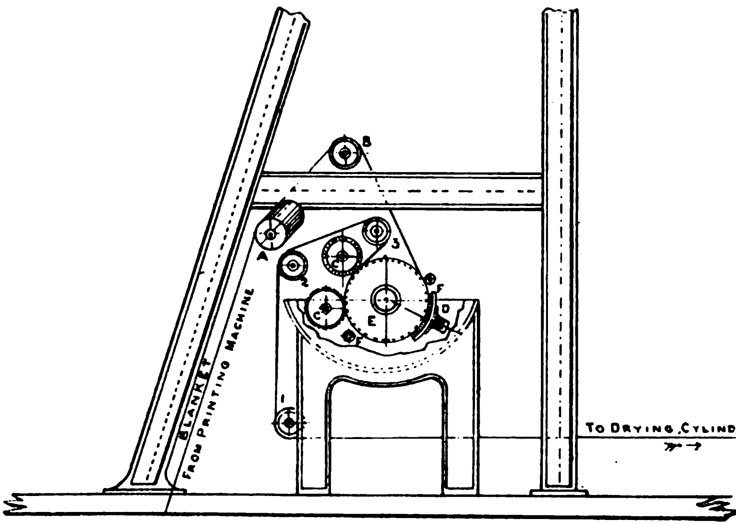


Fig. 24.—Blanket washing apparatus (John Hawthorn & Co.).

the whole width of the blanket, being slightly longer than the width of the blanket. The brushes are mounted on travelling bands, as shown, the bands being worked by connection with the spur wheels and straps seen in the illustration. The brushes, as they travel round, rub against the face of the blanket, and as they are kept constantly wet, they clean the surface of the blanket. The trough at the bottom of the machine is kept supplied with water, into which the brushes dip in their passage around the rollers; they are thus kept wet, and any colour upon the brushes is washed away. This machine is the latest pattern designed by Messrs. Mather & Platt, Ltd. When these washers are used, some printers do not use a back-grey.

Another form of blanket-washing apparatus recently introduced by Messrs. John Hawthorn & Co., of New Mills, is described in the *Dyer* *and Calico Printer* (Jan. 21, 1895), from which we extract the following:—

"Fig. 24 shows the washing machine arrangement as standing on the same floor as the drying framing over the machine room.

"The leatherine blanket on leaving the printing machine passes over the angular guide rollers A on to Hawthorn's improved governing roller B, on which is an ingenious arrangement controlling the angular rollers, so that, should the blanket travel a little out of its place on the roller B, a mechanical motion operates the angular roller on the side to which the blanket travels, causing the blanket immediately to resume its proper central position. The angular rollers keep the blanket free from creases. From the roller B the blanket passes under the spurt pipe F and between concave brushes, round the copper cylinder E, through the washing machine, over the rollers 3, 2, and 1, and on to the drying cylinders before returning to the printing machine. CC are roller brushes running in an opposite direction to the blanket, which take off any water which may have been left after the last spurt pipe F. Hawthorn's concave brushes being 8 ins. long or more, and made to the same curve as the body of the cylinder, and the width of the machine, it follows that, in a machine 40 ins. wide, there is a surface of brush equal to 320 sq. ins. always acting on the blanket as it passes through the machine, the said concave brushes being in sections of 4 ins. each. The sections are mounted on an iron bar, and separately regulatable as to pressure on the blanket, so that the brushes working nearest to the edge of the blanket can be set harder on than those bearing on the centre portion of same, which requires much less washing than the edges. The bar on which the concave brushes are mounted is traversed to and fro crosswise to the blanket by means of an eccentric, the whole arrangement giving the blanket a most thorough scrubbing, and effectually loosens all colour, &c., which is then washed off by water from last spurt pipe and roller brushes."

Drying Apparatus for Drying the Pieces after Printing.— After the cloth has been printed, the colours require to be dried as soon as possible, and in doing so it is essential that the face of the piece should not be touched until the colours are dry, or nearly so. To accomplish this two systems are in use—viz., chest drying and hot air drying; the former being the method principally used.

In chest drying, as its name denotes, the pieces are dried by passing over, but not quite in contact with, iron steam chests, the cloth being prevented from actually touching the chests by means of rollers fitted between them, which raise the cloth slightly above the surface of the heated metal. The room, or apartment, in which the chests are placed, is situated either on the same floor as the printing machine itself, or on the storey above; generally the latter. The cloth is arranged over the chests in such a manner that the back of it only touches the guiding rollers, at any rate until it is practically dry.

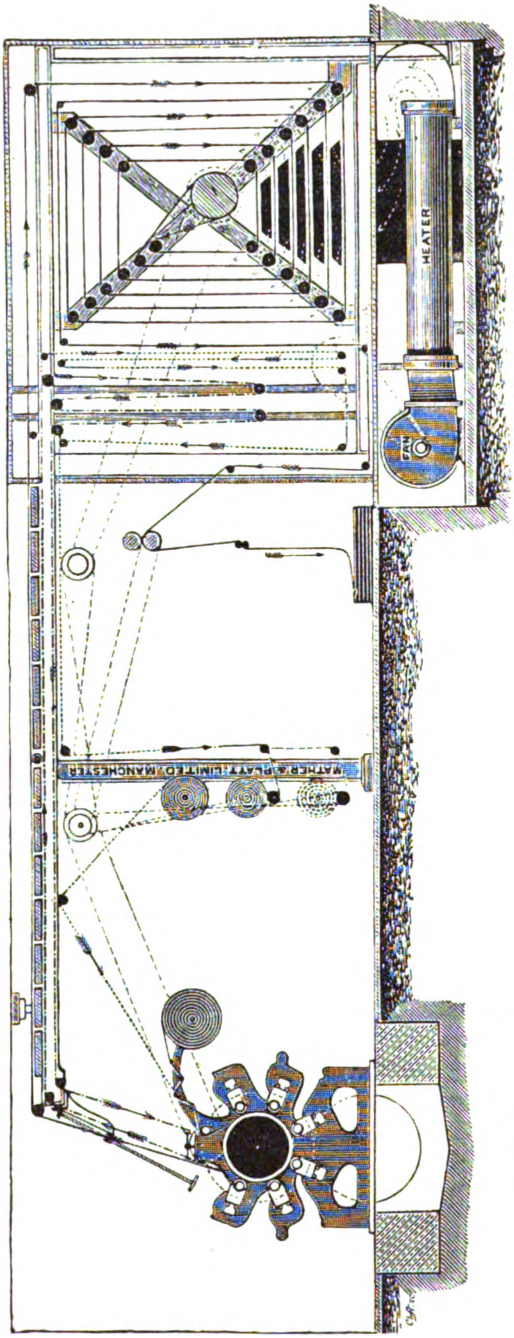


Fig. 25.—Six-colour printing machine, with drying apparatus on the same floor level as the printing machine (Mather & Platt).

In the other system the pieces are dried by hot air, or hot air combined with the use of a few steam chests, and this system is used for those colours that are liable to have their shade affected if over-heated or "baked." The manner in which the cloth is arranged is shown very clearly in Fig. 25. This represents a six-colour printing machine, complete with engine and drying apparatus, and shows the general arrangement of the back-grey and cloth for printing as they enter the printing machine; the latter, after printing and drying, is plaited down on the stillage, and the back-grey wound on to a wooden centre. The pieces are passed into a room, or portion of a room, which is heated with a supply of hot air, warmed with multitubular heaters, and propelled with a fan. The goods are passed over rollers in this room, so arranged that the pieces only touch the rollers on the face when they are almost dry, the number of rollers being such as to allow the goods to remain in the room for the time required to thoroughly dry them. The other details are similar to those used for chest drying.

Duplex Printing Machines.—Reversible prints, or prints showing the pattern on both sides of the cloth, are produced either by printing with deeply engraved rollers under a good pressure to force the colour through the cloth to the back; discharging upon a dyed cloth with strong discharges printed from strong pattern rollers; or by printing upon both sides of the cloth. The first two methods are done with the ordinary printing machine, and are used for simple patterns, such as small spot patterns on dark blotches or grounds, so largely used for making neckties. The two sides of the cloth, however, are never exactly the same shade, nor is the pattern quite the same size on the two sides; the back of the cloth can always be recognised by the bare or slightly thready appearance of the ground colour. By the use of the duplex printing machine the pieces can be printed either with the same pattern on both sides, or with two entirely different patterns on the face and back. When the patterns for back and front are the same they can be caused to fit accurately with each other. The duplex printing machine is similar in construction to the ordinary printing machine, but is provided with two bowls and two sets of engraved copper rollers, with their usual complement of colour boxes, doctors, &c. The cloth is printed on one side as it passes over the first bowl, and then the other side is printed on the other bowl.

An illustration of a two-colour duplex printing machine is shown in Fig. 26, from which the general construction of the machine will be readily understood. This machine can be used to print either similar or different patterns upon both sides of the cloth, or it can, when not required for duplex work, be used as an ordinary two-colour printing machine.

When the patterns on the two sides of the cloth are the same, and are required to fit properly, it is necessary to have the two sets of rollers engraved in pairs, and one set must be the reverse of the other; in other words, the pattern on one set of rollers must be engraved the opposite way, with regard to left and right, to that on the other set of rollers. The preparation of these pairs of rollers is done on special forms of engraving machines made expressly for the purpose.

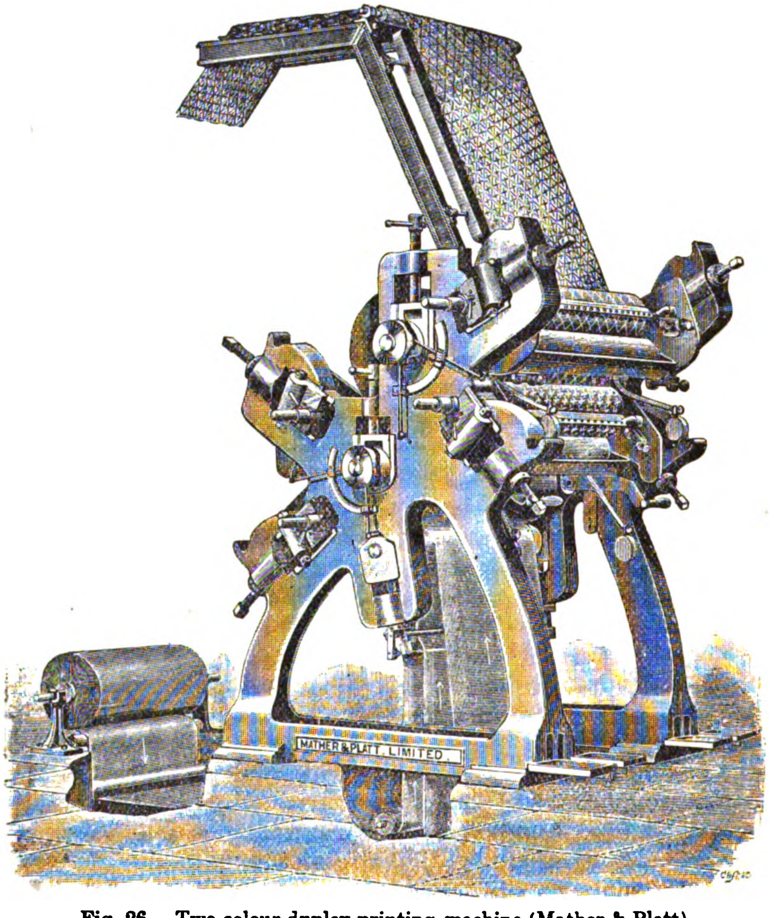


Fig. 26.—Two-colour duplex printing machine (Mather & Platt).

Cloth can also be printed on both sides on an ordinary printing machine where exactness of fitting is not essential. This is usually done by printing two fabrics at the same time, the back of one being then brought in contact with the face of the other, the latter being printed with colours of a more concentrated nature than the former. The reverse side of the piece is thus printed by taking some of the colour off the face of the other piece, it being simply a system of

marking off on the other piece, hence the necessity of using stronger printing colours.

Duplex printing machines are used only up to about four colours, requiring eight rollers, and a machine of this kind, when not required for duplex work, can be used as a four-colour ordinary machine. Ordinary printing machines are rarely required for more than twelve colours.

Yarn Printing Machines.—Yarn printing has lately become of considerable importance, and many machines have been introduced for this purpose. The application of the printing colours to the yarn was until recently applied by hand, the colour being taken up with blocks engraved in relief with a pattern consisting of stripes of various widths, and transferred to the yarn as described under *Block printing*.

In Fig. 27 a yarn printing machine is shown made by Messrs. Edmeston & Sons, of Salford. The hanks of yarn are stretched evenly over three fluted rollers, two of which only can be seen in the engraving. One of the rollers is loosely laid in the framework of the machine, a series of slots being arranged to allow the rollers to be placed in varying positions to accommodate different lengths of hanks. The printing roller is inside the hanks of yarn, and is furnished with an ordinary colour box and furnisher, while on the outside of the yarn is a pressure roller, and between these two rollers the yarn passes and is printed. The printing roller with its furnishing roller, &c., is carried on a swinging framework to enable the yarn to be readily put in and taken out of the machine. If the printing rollers were engraved with the lines of the engraving parallel with its length the yarn would, especially in coarse patterns, be beaten by the ridges of the engraving, and the jumping thus produced would cause the yarn to be unevenly printed; hence it is usual to engrave the roller with the pattern running spirally around it. The printing rollers are made either of wood or copper, the latter being preferable on account of its durability, but it is more expensive.

Roller Washing Room.—Situated as near as possible to the machine room, but in a separate apartment, washing tanks should be fitted for cleaning the printing rollers, doctors, and colour boxes after use. In various parts of this apartment there should be placed hot-water taps fitted with spray nozzles to rinse off the colour, the articles being properly cleaned in the tank by means of scrubbing brushes, and finally given a rinse under the hot-water rose tap. The water supplied to this room is generally heated with exhaust steam, one of the many forms of fuel economisers being used.

Block or Hand Printing.—Block printing is one of the earliest methods of applying figured designs to fabrics by printing, and, with the exception of its application to the printing of silk goods, has almost completely been displaced by the cylinder printing machine. The wooden blocks used in this method of printing are engraved with the pattern standing out in relief, similar in fact to the rubber name stamps used for commercial office purposes, the blocks varying in size in accordance with the size and continuity of the pattern. When the pattern is very long between each repeat, two or more blocks are required for each repeat. These blocks are provided with pins or points to guide the printer, and ensure each impression registering correctly with the last one done, and in a multiple colour pattern fitting accurately with the part of the pattern already printed. A separate block, engraved with a particular part of the complete pattern, is necessary for each separate colour. The method of printing is as follows:—The cloth is spread face upwards upon a long table, generally about 20 feet long and 4 feet wide, the surface of which is covered with a blanket to form a cushion upon which the printing is done. The printing colour is contained in a small colour box, fitted with wheels to enable it to be readily moved about the table, rails sometimes being fitted upon which it can travel. Inside the colour box, and resting on the surface of the colour, is a wooden frame covered with felt, and this acts as the furnisher, supplying colour to the surface of the wooden block. The colour in the box passes partially through the felt as it floats on the colour; and, by means of a spreader, the colour is caused to lay evenly on the upper surface of the felt. The block is now charged with colour by bringing it in contact with the colour-coated felt, after which it is applied to the cloth. When the block is exactly over the part of the cloth required to be printed, and which is indicated by the points on the block, the block is carefully applied, and the colour transferred to the cloth by giving the back of the block a tap with the hand, or, in the case of blocks of considerable size, by striking with a wooden mallet. This series of operations is repeated until the whole of the design has been completed and all the various colours put in, when the fabric is dried, and the subsequent operations of steaming, &c., are carried out in exactly the same way as would be done for machine work, as the difference between the operations is merely mechanical, and does not, of course, alter the chemical principles involved.

Ageing Rooms and Ageing Machine.—In some of the styles of calico printing, notably in the madder style, and when aniline black has been printed, the pieces after printing require ageing, either for the purpose of fixing the mordant on the cloth, or to allow the colour to be formed or developed. The ageing process may practically be regarded as a part of the madder style of calico printing, as it is in that method that it finds its principal application. In the *madder style*, or, as it is now more frequently termed, the *dyed style*, the cloth is printed with a colour composed merely of a mordant, suitably thickened to allow of it being printed on the machine, the mordants generally consisting of the acetates of the particular metal, or metals, required for the production of the shade wanted. These acetates are soluble salts, and before the piece can be dyed it is, of course, essential that the metallic compounds be fixed in and upon the fibre in an insoluble form, and in such a condition that it will have an affinity for the colouring-matter to be afterwards applied in the dye-beck. In the case of most of the mordants used in this style, this fixation is accomplished by submitting the printed piece to the action of moist and warm air, the process being completed when the operation known as dunging is performed. The chemical action taking place during the process of ageing is caused by the combined action of the affinity of the fibre for the metallic salt, the action of the oxygen contained in the atmosphere in the case of some mordants, like iron in particular, and the influence of the moisture contained in the air at the elevated temperature of the ager, all of which tend to liberate the acetic anhydride from its combination with the metal, or metals, with the formation of basic acetates that are insoluble in water; and these are further changed during the dunging process into compounds having the property of combining with the tinctorial substances used in dyeing, forming colours or lakes that are permanently fixed to the particular part of the fibre where the mordants were first printed.

The ageing chamber, machine, or room, as it is variously called, is a large chamber having wooden rollers fitted inside, one set of rollers being placed near the roof, and the other set about 18 inches from the floor. The cloth, after entering the chamber, passes first under the first bottom roller, then over the roller situated above, down again under the next bottom roller, and so on until it has traversed the entire series, when it passes out of the machine. The cloth is drawn through the machine by means of driven rollers, and all, or nearly all, of the guiding rollers inside the chamber are generally driven together at the same speed by the use of bevel wheels worked from a shaft. Placed near the floor, below the lower rollers, are steam pipes to enable the temperature of the chamber to be kept to the required point, and there are a number of small jets, fitted with taps, which enable any required amount of steam to be admitted into the apartment at will for the purpose of controlling the humidity of the atmosphere inside. In the top of the machine there is a ventilator that carries away the acetic acid vapour-charged air, allowing it to escape into the outside atmosphere. A wet and dry bulb hygrometer is usually kept inside the ageing chamber, and both the temperature and humidity of the atmosphere inside the chamber are judged from its indications. Should the temperature be too high or too low, more or less steam is admitted through the heating pipes, and the steam jets inside are adjusted in a similar manner.

After the pieces have been passed through the ageing machine they are usually hung up in the ageing room until the colours are developed to the proper stage, or until the mordant has been aged enough. These ageing rooms are usually extremely spacious apartments, capable of containing a large number of pieces hung loosely together, and form a very important part of a print works. The room is heated and the atmosphere moistened in the same manner as the ageing machine previously described, and the goods are hung upon a system of wooden rails, fixed generally from 20 to 30 feet from the floor, the pieces being hung from them in festoons. The goods are arranged on the hanging rails by boys who ascend a high pair of steps and pull the cloth over the several rails. The ladder is generally mounted on wheels so as to be easily moved from place to place, and the top step is provided with a railing on three sides to guard against accidents from falling. These hanging rooms, especially in the summer time, get extremely hot, especially near the roof, and at such times the operative will often be found working in an almost naked condition. In order to be able to regulate the temperature and dampness of the air a wet and dry bulb hygrometer should be fixed in such a position as to give the average temperature of the room, and in most cases the best position will generally be in the centre of the room and about 5 feet from the floor. The temperature of the hanging room is generally arranged to show about 102° Fahr. on the dry bulb of the hygrometer, and the humidity should be sufficient to cause the wet bulb of the hygrometer to register about 85° Fah. The length of time during which the pieces are allowed to remain in the hanging room depends upon the nature of the colours on the piece, and can only be found by experience, but two to three days is about the time usually required for properly ageing most of the ordinary mordants.

Mather's Patent Steam Aniline Ageing and Steaming Machine.—A form of rapid ageing machine which has been largely adopted by calico printers is shown in Fig. 28, and is ~~made~~ by ~~Messrs. Mather & Platt, of Salford~~. The principle of the machine is to submit the goods to the action of steam, without pressure, for a period of from one to three minutes, the pieces passing through the machine in a continuous manner. The general construction of the machine can be seen from the illustration. The steaming chamber itself is made of iron, and is usually encased in wood to prevent any unnecessary condensation taking place while in use. Inside the steaming chamber there are arranged two rows of copper rollers, one at the top and the other set at the bottom of the chamber, and the pieces in passing through the machine traverse these rollers, and remain in the steam for a sufficient length of time when the machine is delivering about 60 yards of cloth per minute. The steam enters the steaming chamber through perforated pipes placed in the bottom of the chamber, underneath the false bottom, blankets being placed on the latter to evenly distribute the steam and to prevent the cloth from being soiled from splashing. A blanket is also usually fixed above the top rollers to catch any drops of condensed water that would otherwise fall on and soil the goods. All necessary steam valves and driving gear are, of

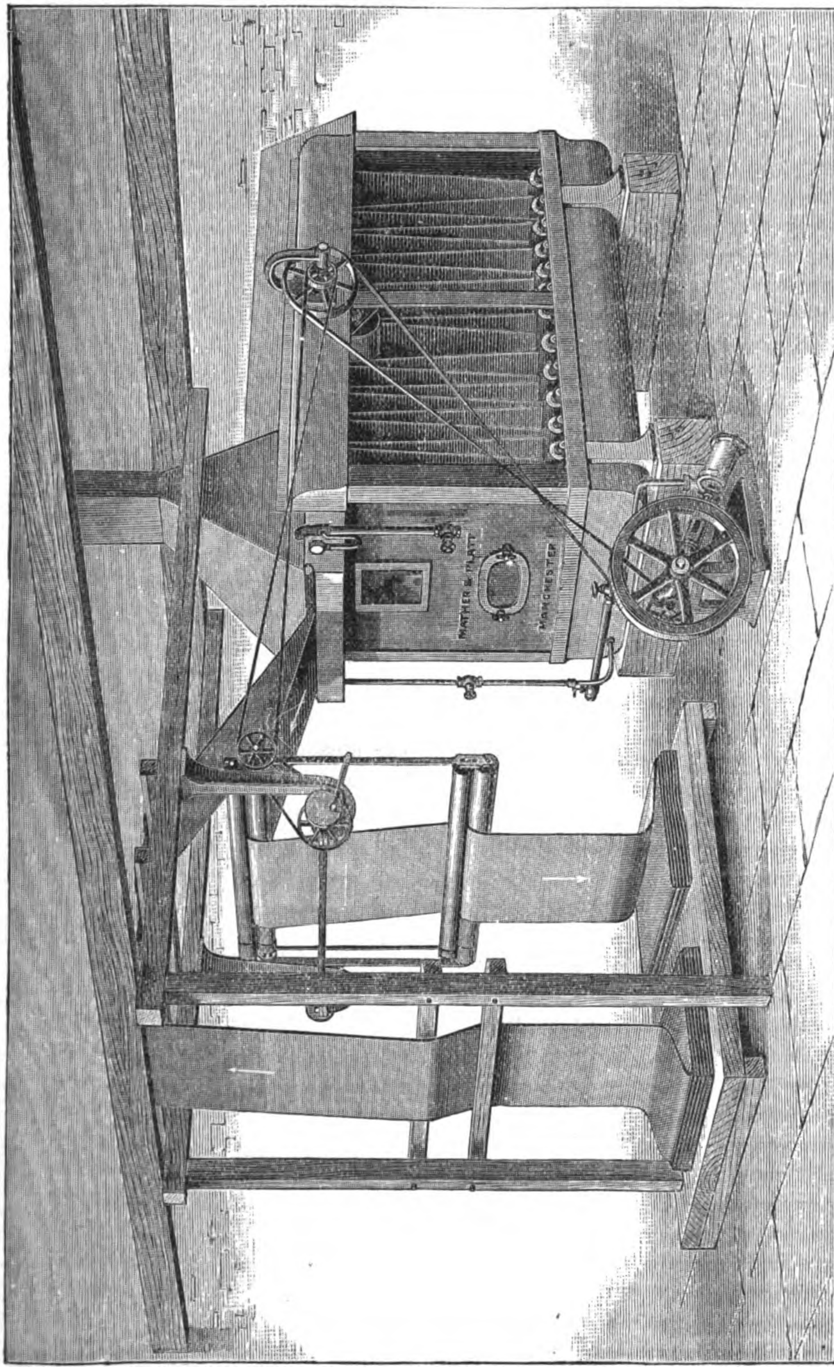


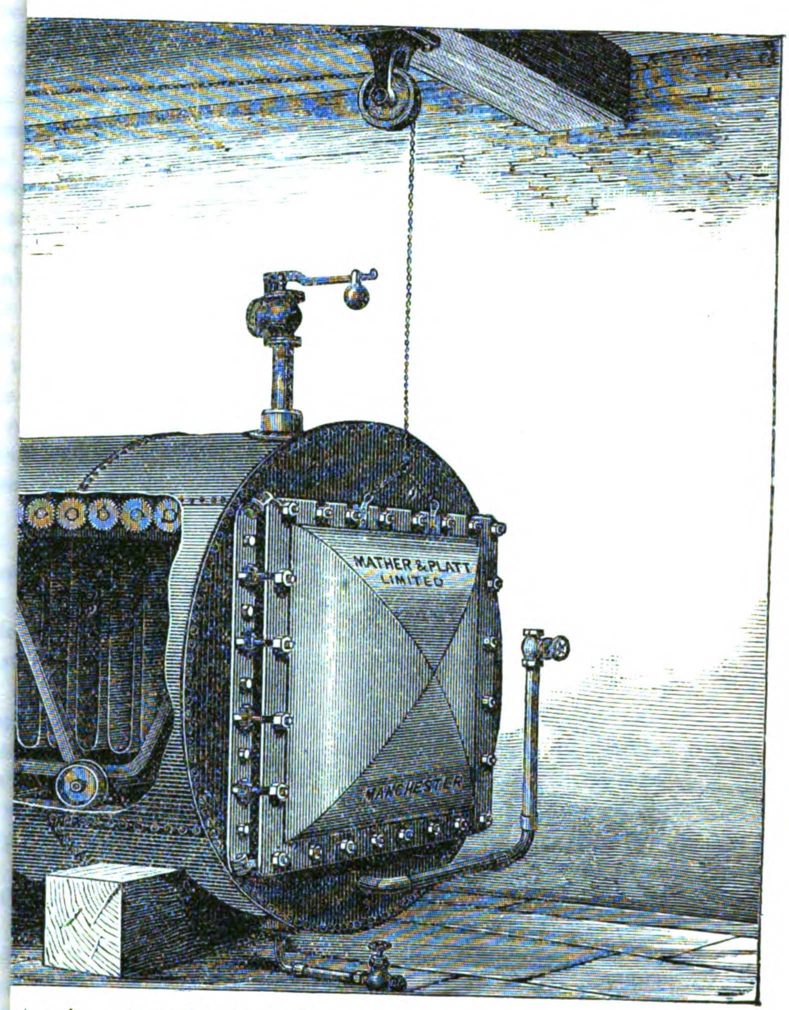
Fig. 28.—Steam aniline ageing machine (Mather & Platt).

course, fitted to the machine, in addition to the usual plaiting down mechanism, and the whole machine is driven, usually, by a separate single cylinder engine arranged to work at any speed required.

This machine is used for a large number of styles, but principally for ageing aniline and steam aniline blacks, and for reducing the indigo printed upon the glucose-prepared cloth in the Schlieper and Baum indigo process.

Steaming Machinery.—There are practically two systems of steaming printed pieces. In one system the pieces are placed in batches in a steaming chamber, and the steam admitted for the time required at any pressure found to be suitable; in the other system the pieces pass in a continuous manner through a long steaming chamber, the pieces being run through at such a speed as to enable them to remain long enough in the chamber. The first method is known as the *cottage steaming* system, and the latter as the *continuous* system of steaming. In the cottage system either high or low pressures can be used, but low pressure only can be obtained when using the continuous steamer. Woollen and silk goods, and several styles of calico prints, especially those that require steaming under high pressure, are generally steamed in the cottage steamer, while the continuous steamer is used for the vast bulk of the goods printed in the steam style on cotton.

Cottage Steamers.—The cottage steamer consists of a strong iron chamber somewhat similar in shape to a steam boiler, and is constructed in a similar manner. The front of the steamer is provided with a strong iron door which can be raised to allow the carriages containing the pieces to pass in and out of the steaming chamber, the operation being assisted by the help of the weights that balance the door shown in Fig. 29. The door is fastened by means of strong screws, so that when the door is closed and the screws screwed home, a perfectly steam-tight junction should result. The steam enters the chamber at the bottom, the pipes being placed underneath the false perforated bottom on which the carriage holding the pieces is standing, and a dead-weight safety valve is fitted to the top of the chamber and set to the pressure required. The goods are arranged before they enter the chamber on carriages, and each chamber is generally large enough to take two of them end to end. These carriages are merely iron frames supported on wheels to enable them to be easily moved from place to place, and provided with hollow bearings along the two top side rails, to receive the ends of the poles upon which the pieces are hung. Near the top of the inside of the steamer, close to the end of the poles that support the pieces, there are two iron gutters that receive the water which is condensed on the top of the steamer and convey it away, thus preventing it from dropping on the goods while they are being steamed. The steamer is generally sunk low enough to bring the false bottom on the



steaming cottage (Mather & Platt).

same level as the floor of the working room, and metal rails are frequently laid for the carriage to run on.

These steamers are made for pressures up to about 30 lbs. When it is required to steam without any pressure some of the plates on the top of the steamer are removed and the space thus formed covered with canvas or a blanket that allows the steam to pass freely through it; thus there is practically no pressure inside the steaming chamber. All cottage steamers should be placed in a well ventilated place to allow the steam to freely escape, otherwise considerable inconvenience will be experienced from the steam coming out of the steamer when the pieces are withdrawn.

Some makers fit mechanism that enables the poles carrying the pieces to be turned, while they are in the steamer, from the outside, for the purpose of preventing the rail marks from showing in the finished prints, but most printers divide the steaming operation into two parts, and arrange the pieces differently in each case, with the same object. The pieces as they are received from the printers are usually merely roughly plaited down, and before they can be put in the cottage steamer they must be wound to proper length so as to hang on the supporting poles. The winding machine consists of a wince made to fold up flat when required. The wince is driven by power from overhead or sunk gearing, a strap working on fixed and loose pulleys enabling it to be put in and out of gear. The pieces are wound on the wince while it is fully extended and the pieces are taken off by folding up the wince, which throws the cloth slack, when it can easily be removed.

The Continuous Steamer.—The continuous steamer marks one of the greatest improvements in the machinery used for textile printing of modern times, and on account of the advanced state of the steam style of calico printing, brought about by the introduction of the large number of useful artificial colouring-matters that are applied in this way, we believe that it is not too much to say that fully two-thirds of the calico prints that find their way to the warehouse are passed through this machine in those works where they have installed one.

The steaming chamber consists of a very large apartment, made partly of brickwork and partly of iron. At the bottom there are steam pipes that conduct and distribute the steam in the chamber, the steam coming from the boilers working under a pressure of about 50 lbs. The condensed water is taken out of the steamer by the use of steam traps placed at the bottom of the chamber. The steaming chamber is generally made to allow the cloth to hang from the rails to a depth of 50 feet, and the length of the chamber is usually about 60 to 70 feet. Inside the steaming chamber, situated near to the top and at both sides, there are two endless chains running from end to end of the steamer, and these chains are provided with catches or claws which engage with the ends of the poles that carry the pieces, and cause them to travel to the other end of the chamber, the whole of the poles being kept at an uniform distance from each other. The poles to carry the cloth are fed into the machine down a shoot, and the claws on the endless chains draw the poles into the steaming chamber as required, discharging them when they arrive at the other end of the chamber. As the poles are discharged from the machine they are returned to the entering end either by collecting them together and sending them down on a carriage running on lines, or by placing them upon an endless travelling band, running from end to end at the side of the steamer. The cloth is fed into the machine in a continuous manner through an aperature on the top of the steamer, a few inches in advance of the bottom of the shoot holding the poles, and, on account of the weight of the cloth, it forms a loop gradually increasing in length, which would eventually reach the bottom of the steamer were it allowed to do so; but, while the cloth is passing into the steamer, the endless chains are gradually advancing, and the speed of travel is so timed that when the cloth has formed a loop about 50 feet in length another pole is pushed against the cloth, taking it slightly beyond the point where the cloth is entering, and the cloth delivered after this falls on the other side of the pole forming an entirely new festoon. This procedure goes on all the time the steamer is being worked. When the cloth arrives at the extreme end of the machine it is drawn out of the chamber by means of ordinary lapped friction rollers, and when the chains turn over, the poles are released from the claws and run down an inclined plane out of the machine ready for use again. The cloth on leaving the steaming chamber passes over a series of steam chests, placed on the top of the machine, which dry the pieces before plaiting down. The machine is usually run at such a speed that the cloth remains in the steam about three-quarters of an hour, and for most styles the goods are sent twice through the machine. Four pieces, or rather four continuous lengths, of cloth can generally be passed through the steamer simultaneously.

Messrs. Mather & Platt, of Salford, have recently introduced a continuous steamer in which the poles carrying the cloth do not leave the inside of the steaming chamber at all, the poles travelling round inside the steamer in a continuous manner. The principal advantage that this new pattern of continuous steamer offers over the one generally used is that, as the poles are never allowed outside the steaming chamber, their temperature remains about the same as the steam inside, and, consequently, there is considerably less chance of the pieces being stained by steam condensing on the poles and causing the colours to run on the parts wetted. Another advantage is that a less number of hands are required to attend to the machine.

General Remarks on Steaming.—Perhaps one of the most common faults occurring during the steaming operation, both when using either the cottage or continuous steamer, is the local running of the colours, due generally to the goods being damped in parts during their passage through the steamer. This defect can usually be traced to condensed water dropping on the goods, or, in the continuous steamer, to condensation on the suspending poles. In all steamers special care is taken in the construction to guard against this occurring, and when it does happen to show itself, the cause must be searched for and remedied. The exact place where the stains are caused is often extremely difficult to locate.

With some styles the vapours evolved from the colours on the goods are liable to affect the shades, if the steam inside the chamber becomes heavily charged with them, and for such colours it is necessary that only a few pieces be steamed at one time; and, in the case of the continuous steamer, it is advisable that some pieces which do not evolve any hurtful vapours be passed through, in order to allow the steam inside the steaming chamber to be replaced before the next batch is steamed. This defect will be particularly noticed during the steaming of colours containing sulphocyanides, as, for example, alizarine pinks on cotton.

There are a few colours in use that are slightly volatilised during the steaming, and some that, especially in dark shades, evolve vapours that will condense upon and leave a stain on any other goods that may be near, or even on, the whites of the same piece. This *springing* of the colour, as it is termed, in these special cases is very difficult to avoid, and particular care is required to successfully steam the pieces printed with them.

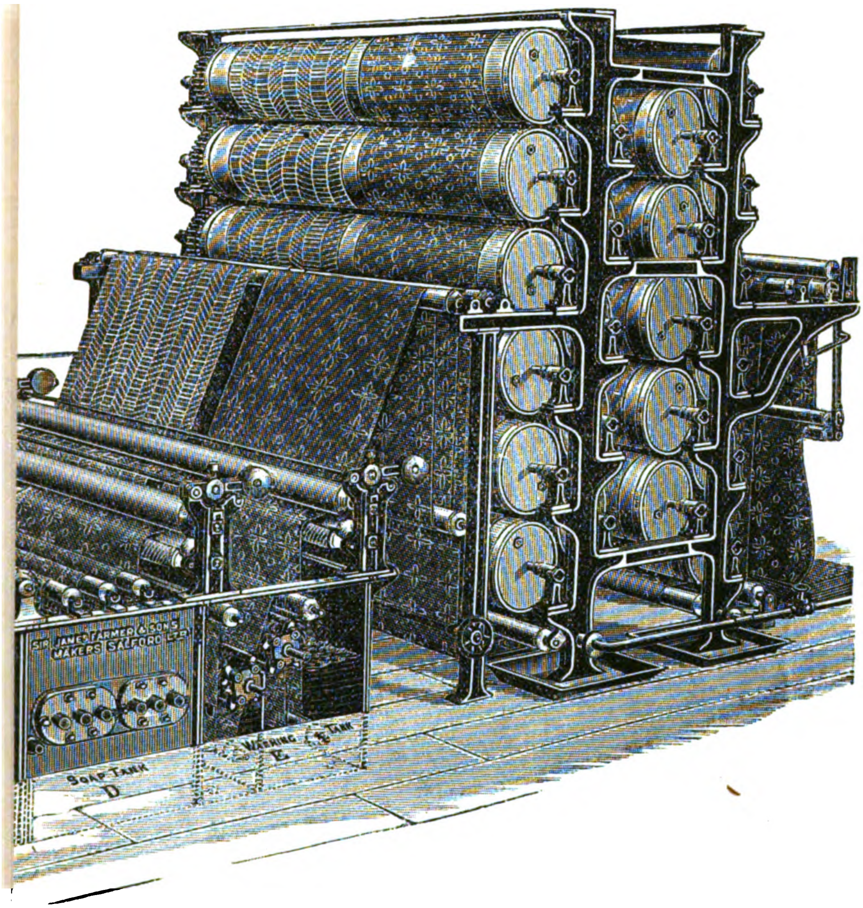
As mentioned above, rail marks that are not due to condensed water are usually avoided by dividing the operation into two parts, so that the position of the cloth is altered before the steaming is finished, or by turning the poles while the steaming is in progress, which can be done with certain makes of cottage steamers. Some shades are more liable to show the rail marks than others, and, as they are more susceptible during the early stages of the process, the duration of the first steaming is varied to suit the particular colour in hand.

The pieces after printing and drying are, as a rule, hard and stiff, and with some thickenings very brittle. If the film of thickening, before the pieces enter the steamer, should become fractured, the goods may show these marks when finished, consequently the pieces should be carefully handled before steaming, to guard against this. Colours like alizarine blue S and some of the other colours of the same class are extremely sensitive in this respect, particularly so when thickened with certain qualities of British gum.

Rosenstiehl, in an investigation into the conditions necessary for the proper fixation of the colours used in calico printing by steaming, found that the dampness of the steam in the steamer had a considerable influence upon the result. For the purpose of indicating both the temperature and the humidity of the steam, he employed a wet and dry bulb hygrometer; the drier the steam the greater would be the difference between the readings on the two scales, and *vice versâ*. The result was that when the dry bulb thermometer indicated a temperature of 114° C., and the wet bulb scale 74° C., the colours were not fixed at all, neither was albumen coagulated; while, when the steam was completely saturated with water, only the pigment colours printed with albumen were fixed. The best results were obtained when the thermometers stood at 108° and 95° C. respectively. He found that the coal consumption used for generating the steam for the steamers could be greatly reduced by heating the steam when it entered the steamer by means of steam pipes. The apparatus consisted of a number of steam pipes placed above the distributing blanket in the steamer, and heated with steam at 6 to 10 lbs. pressure. The steam entering the steamer underneath the blanket passes through the latter, and is warmed by passing between the heated pipes. The use of a hygrometer being inconvenient in practice, Rosenstiehl used two pieces of cretonne, one piece being dry and the other wet. If the steam was perfectly saturated with moisture the dry piece would gain in weight without the wet piece losing any appreciable weight of water, but when the steam was dry the wet piece would lose in weight and the dry piece would absorb a lesser proportion of moisture, corresponding to the amount of moisture in the steam. By this method he found that the best results were obtained when the wet cretonne lost more in weight than the dry piece gained.

Before entering the steamer some colours are passed through the vapour of liquor ammonia, in an apparatus similar to Mather's steam ager, in the bottom of which trays containing the liquor ammonia are placed, the machine being kept quite cold.

Soaping and Fixing Machinery— Open Soapers.—With the exception of calico printed with pigment colours, all the prints that are steamed are either soaped, washed, or fixed and washed, or fixed and soaped. These operations are in most cases done with the machine known as the open soaper (Fig. 30). The machine is generally constructed either in the form of one long tank divided into several compartments, or made up of several smaller tanks placed end to end with regard to each other. These tanks are filled with the soap solution or water required, which is kept at the proper temperature by means of steam pipes blowing the steam directly into the liquor in each compartment. Hollow copper rollers are placed along the top and near the bottom of all the tanks, and the cloth in travelling through the machine passes around these rollers. The cloth is drawn through the machine by means of nips or friction rollers, placed usually between each separate tank or compartment, driven by power; the rollers inside



es Farmer & Sons).

the tanks merely being revolved by the cloth passing around them. The number of rollers in an average sized open soaper is about 90, and as only a few of these are driven, the strain on the cloth in its passage through the machine is very great. The length of the machine is usually about 60 to 80 feet, and, when threaded with the cloth, contains from 100 to 120 yards in the machine at one time. The machine is commonly run at such a speed that it takes the cloth from $1\frac{1}{2}$ to 2 minutes to pass through.

The first tank is usually small, provided with seven rollers, three at the top and four at the bottom. This tank, when the pieces have been printed with tannic or basic colours, is filled with the tartar emetic fixing liquor, but when the goods require merely washing or soaping

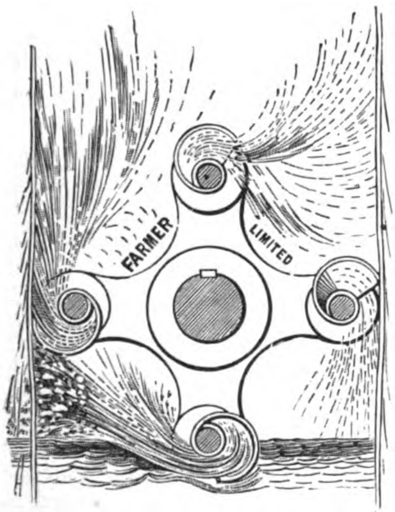


Fig. 31.—Beaters for open soaping machines.

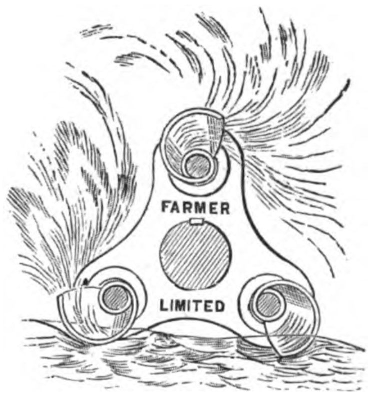


Fig. 32.—Beaters for open soaping machines.

it is filled with boiling water. The second compartment, or tank, is usually used for washing and beating the cloth with water only. In this tank the cloth, having had the thickening material softened during its passage through the first tank, is submitted to the action of sprays of water; or, better, to the action of mechanical beaters, which throw the water forcibly against the face of the cloth, and thus detach the loosened thickening material and colouring-matters from the piece. Figs. 31 and 32 show the manner in which the water is dashed against the cloth at both sides of the beaters. The illustrations represent the beaters made by Messrs. Sir James Farmer & Sons, of Salford. The construction of the beaters can best be seen from Fig. 33, showing the three beaters alongside each other, with the spur wheels at the ends. The beater is made in the form of a bent copper oscillating gutter, stiffened by having a steel rod soldered in it, and provided with brass ends. This method of construction makes the gutters very stiff, and the brass ends prevent the copper parts from coming into contact with the spider wheels. All the wearing parts are made of brass, and work brass on brass; they are easily detachable, and can readily be replaced when required. Beaters of the pattern shown in Fig. 31 are usually fitted to the washing tanks, and the beaters of this pattern are generally supplied in pairs, while of the pattern shown in Fig. 32 the beaters are supplied in sets of three arranged as in Fig. 33, and this pattern is fitted inside the soaping tank. These beaters can be fitted to nearly all existing open soapers, and are, we believe, the best form introduced so far for this purpose.

After passing through these tanks, the goods enter the third compartment, which is the largest one in the machine, and contains the boiling soap solution if the pieces are to be soaped, or boiling water when washing only is necessary. On leaving this part of the machine

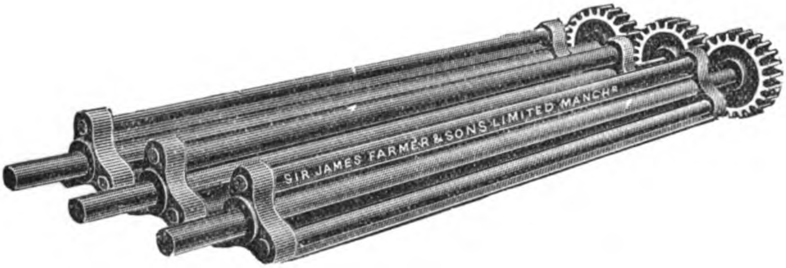


Fig. 33.—Set of three beaters for open soapers.

the goods are washed by means of spray pipes, the excess of water expelled by squeezing rollers, and the pieces dried by passing over the drying cylinders of a drying machine, which is always arranged to work in connection with the open soapers.

Messrs. Jackson & Hunt have patented a new form of beater, made of wood or metal, and triangular in section. These beaters are arranged in sets of three or more in a frame above the surface of the liquor in the tanks, and they shake the cloth by striking it outside the liquid. They also claim a new method of supplying the liquor to the tanks, which has the advantage of keeping the liquor much cleaner, and removing the scum that is liable to be produced on the surface of the liquor. This they accomplish by allowing the fresh liquor to flow into the tank from a pipe situated at the bottom of the tank, and allowing the liquor to overflow at the top. The matter detached from the goods which, with the soap, has a tendency to form substances that ascend in the liquor, is thus carried away more easily than when the liquor is fed from the top and allowed to escape from the bottom.

Hawthorn's improved patent continuous open soaking, soaping, and washing machine is very similar to those of other makers, but differs entirely from all others in the arrangement for soaking the cloth, and thus giving it a longer immersion in the liquor while running at the same speed. This is accomplished by the use of the patent cellular drum placed in the hot-water cistern.

The drum resembles in appearance a water wheel and is made with blades all round its circumference, placed about 6 inches apart, which form cells into which the cloth is loosely plaited by the action of a wince placed above it. As the cells are filled the drum slowly revolves and carries the cloth with it under the surface of the liquor. The liquor is heated with a steam pipe placed at the bottom of the tank, and covered over with an iron casing to prevent the cloth from being disturbed by the agitation of the liquor caused by the steam passing into it. The water or soap liquor flows from the cistern through the casing of the drum towards the centre, where it is discharged through the hollow shaft upon which the drum is mounted, and this, combined with the buoyancy of the cloth, prevents the latter from leaving the cells into which it is plaited. The drum makes one complete revolution in eight minutes when the pieces are passing through the machine at 60 yards per minute, and there are about 240 yards of cloth always immersed in the liquor. This soaking makes the thickening material so soft that it is easily removed by the action of the beaters in the next tank, and when the pieces are dried they are materially softer in handling than would otherwise be the case. The cloth is withdrawn from the cells at the opposite side to which it entered, by a wince, and then passes on to the other tanks similar to all other open soapers. There being a smaller number of rollers in this machine than in those of the ordinary pattern, the cloth is not subjected to the same strain that is put upon it by having to turn the larger number of rollers in the usual soaper.

All open soapers are fitted with scrimp rails and angular openers to keep the cloth in the open width, as all creases and turned edges generally show in the finished print, especially in light blotches. Jean and sateen cloths are extremely troublesome in this respect, and special care should be taken with them.

In the open soaper made by William Birch, of Manchester, the principle of forcing or flushing the liquor through the fabric while it is in the liquor is introduced. These flushing rollers are placed below the surface of the liquor, and the cloth passes around them in its transit through the machine. The flushing rollers are made with a series of recesses arranged longitudinally. In these recesses a series of plates work, the shape of the recesses being the same as that of the plates working in them. These plates or bars work in slotted plates at each end of the roller, and at each end there is a ring which holds all the bars together, but which allows them to move in the slots and thus preserves the regular eccentric motion which the fabric itself causes them to assume. The tension of the cloth forces the bars on the under side of the roller in and, consequently, out on the other side of the roller. When the cloth arrives at the roller, it is first caught by bars projecting from the roller, and a portion of the liquor is trapped between the fabric and the roller. As the cloth travels round the roller it forces the bars in, and at the same time the liquor between the cloth and the roller is forced through the fabric. These flushing rollers discharge about 5 gallons of liquor through the cloth per revolution. This soaper is made in skeleton form, the flushing rollers being in shallow tanks, and the plane rollers placed well above them outside the liquor. The advantages arising from this arrangement are that as the cloth comes from each flushing roller, the liquor in it is allowed time to stream from it, and is then better prepared to receive another flushing at the next roller; the liquor is oftener changed, and when the pieces arrive at the last tank they pass through perfectly clean liquor instead of soiled liquor as in the ordinary soaper. Should the pieces break asunder through faulty stitching, the locality of the break is easily perceived, and it can be remedied without emptying the tanks, or continuing the running with some rollers short.

Soaping Becks.—Certain styles require to be soaped for a very much longer time than the open soaper allows, and the goods are then soaped in soaping becks. These becks are generally arranged in series, the cloth passing through the whole set; and the number of becks working together is arranged to allow the cloth to remain in the liquor for the required length of time, and to deliver it at a sufficient rate properly soaped. Fig. 34 shows the general appearance and form of these becks. The whole series of becks is fed with soap solution from a large tank, placed at one end of the soap house, the liquor flowing from a pipe into the first beck and overflowing into the next one, and so on, until it reaches the last beck, when it is discharged into the drains. The cloth travels through the machine in the reverse direction to the flow of the soap liquor; hence the cloth comes in contact with gradually cleaner liquor as it progresses through the machine. This is done, as by far the bulk of the colour that will leave the cloth bleeds out in the first beck, and it is thus prevented from soiling the liquor in the whole of the becks. Working in connection with these soapers, there is a washing machine and squeezer which prepare the goods for the dryers.

A machine, which stands midway between the open soaper and the soaping beck, is made by Birch, of Manchester (Fig. 35), and is used in place of the former by such firms as have not enough room for the larger machine. It is also useful where it is required to soap the pieces, in the open width, longer than is possible with the open soaper; the soaping beck taking the cloth in the chain or rope form only. The machine is somewhat similar to the same maker's open soaper, but is made with a single tank only, and for the goods to

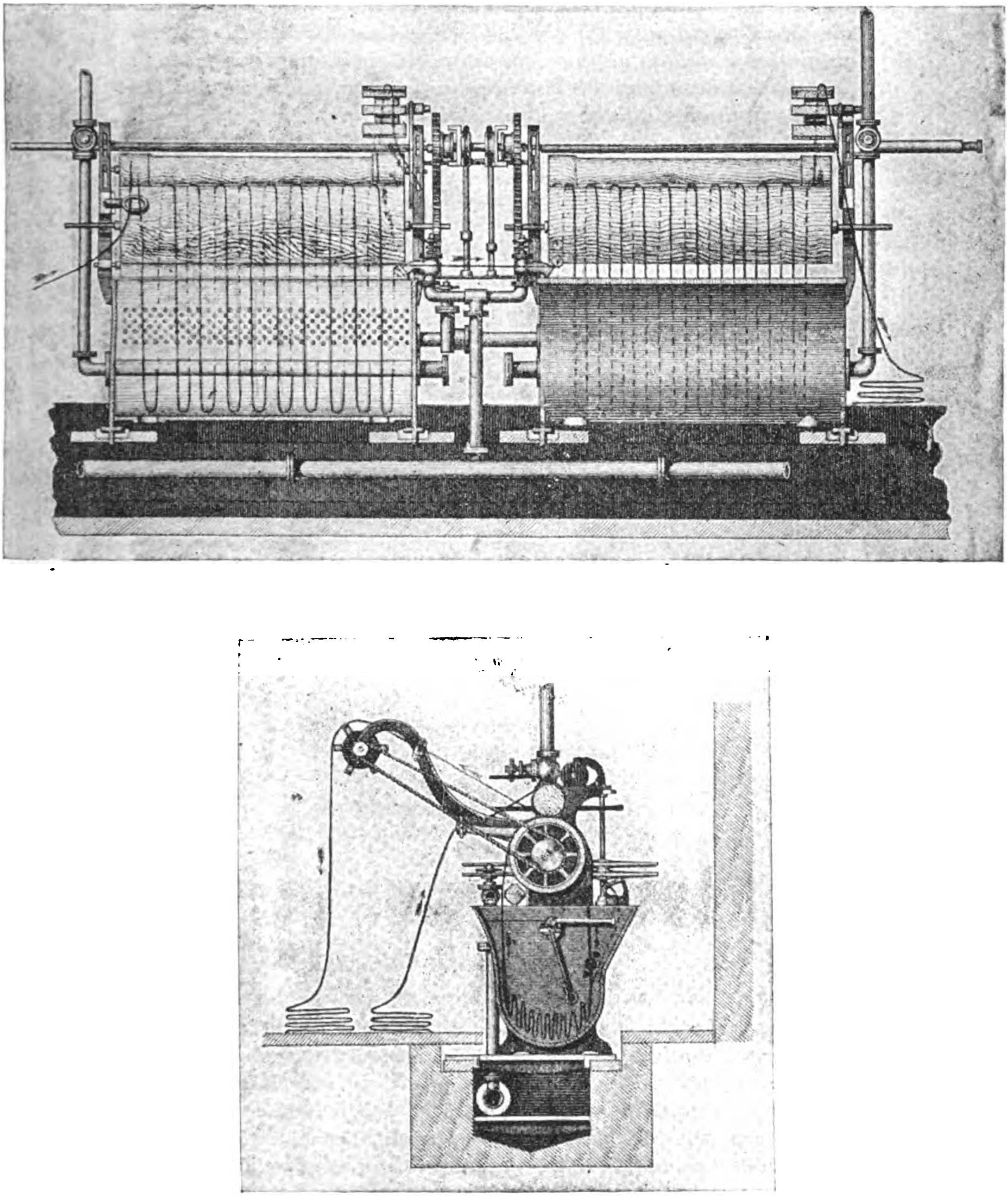


Fig. 34.—Soaping becks (Mather & Platt).

travel round and round in a continuous manner. Fig. 35 shows the machine charged with the cloth. The machine is charged with as many pieces of cloth as the slope shown will hold, and it is made to hold up to a dozen pieces. The ends are then sewn together, and the pieces run through the soap liquor until they are sufficiently soaped, when one of the ends is unsewn and the cloth drawn out of the machine between the squeezing rollers. The cloth can either be washed separately in a washing machine, or it can be run through

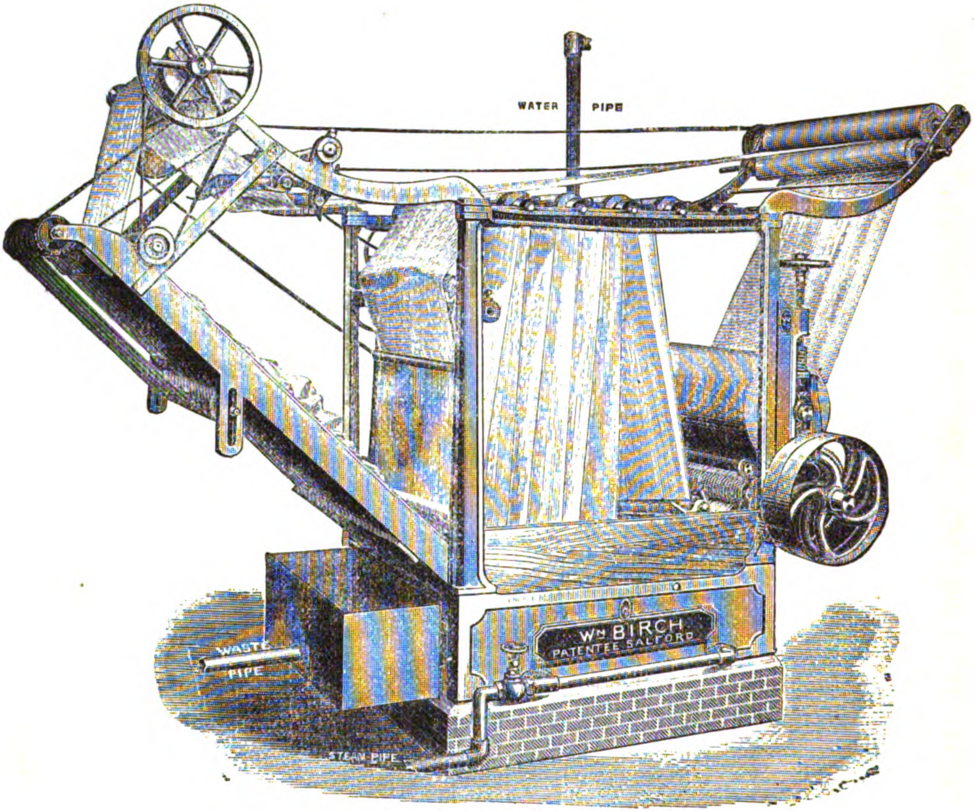


Fig. 35.—Single tank soaper.

clear water in the same machine before drawing it through the squeezer. The advantages of this machine are that the soaping can be timed to suit the particular kind of colours and cloth in hand; that only one man is required to work it; and that it effects a considerable saving in the amount of soap used. The machine takes out the creases that may be in the printed cloth quite as well as does the open soaper.

Dunging Machines.—In the dunging process the fixation of the mordant on the cloth, in the madder style of calico printing, is completed. The term *dunging* is applied to this process because formerly cow dung, alone or mixed with a certain proportion of chalk, was exclusively used for the purpose. At the present time arseniate and binarseniate of soda have to a considerable extent replaced the use of cow dung; but it is still found that, if the finest results are desired, the latter cannot altogether be replaced, and, consequently, a certain proportion of dung is nearly always used in the dunging cisterns. The mordants have, during the drying on the chests after printing and by the ageing which the pieces have already been through, been to a considerable extent fixed on the cloth; but there is also a large quantity of the total mordant printed, in such a condition that it would leave the cloth and cause the latter to dye a poor weak shade in the dye-beck, and this portion is, by dunging, fixed and rendered suitable to receive the colour on dyeing. Before the goods can be dyed the thickening material used in printing must be removed, and this is accomplished in this process. In addition to fixing the colour on the cloth, the dunging liquor must be so constituted that the mordant which leaves the cloth is transformed into substances that will have no affinity for the unprinted or white parts of the cloth, or the whites will be degraded during dyeing. The continuous system of dunging where the cloth is passed in the open width through the liquor, is the one now generally used by calico printers. The apparatus consists of a series of tanks (usually three) of large size, in each of which rollers are placed both at the top and bottom, around which the cloth passes after the manner used in the open soaper. The cloth is drawn slowly through these tanks by means of winces and drawing rollers, driven by power, clutches being fitted for putting them in and out of gear. After passing through these tanks, the cloth is often sent through two hot-water washing machines—similar in pattern to soaping becks—one containing a little of the dunging solution and the other charged with hot water only.

Tanks similar to those described above are frequently termed dollies, and we shall, when describing the processes used in printing, often have occasion to refer to them, as they are used for a large variety of purposes, and there are generally several of them fitted up in the dye-house attached to all printing establishments.

Slop-Padding Machine.—By the term *slop-padding* is meant the continuous and thorough saturation of a piece with the colour, mordant, or solution, allowing it to touch both sides of the fabric and thoroughly enter into it, the excess of liquor being expelled by pressure between rollers, the cloth being kept full width and free from creases, in order to ensure even application. The padding machine consists of a box holding the liquor to be applied, which is provided with three small rollers that take the piece under the liquor and increase the length of its travel in the box, to give time for the cloth to absorb the solution. The box is capable of containing from

10 to 15 gallons of liquor, and it is kept at a fairly constant level by occasionally adding more solution. Above the box a pair of copper-squeezing rollers are placed, which are very carefully covered with fine calico, the ends being so arranged that they leave no impression on the squeezed cloth, the cloth as it leaves the rollers appearing evenly wet. From the rollers the cloth is drawn, by a series of lapped drawing rollers, over a range of steam chests, generally encased in a wooden or brickwork shed. The chests in this room, or shed, are arranged in rows about 16 to 20 feet in length, and there are usually eight to ten lots placed one above the other. The pieces pass over, but do not come in contact with these chests, actual contact being prevented by the use of rollers between each pair of chests. The machine should be so governed that the cloth is delivered from the chests dry, but, in most cases, not overheated, especially when the pieces are required for discharges before the colour is raised.

Before the slop padding is commenced the machine should be carefully examined and a grey run over it, to ensure that all is in working order. The grey will also clean the rollers and prevent them soiling the pieces. If the machine is stopped while the cloth is over the drying chests, the latter is almost certain to be uneven when finished, owing to the uneven drying, some colours and mordants being much more sensitive in this respect than others. Of course, where the ground or blotch colour is considerably broken up by the design afterwards printed, slight differences in shade, due to overdrying, will not be easily observed.

Dye-Becks used in Print Works.—As we are more particularly concerned with the printing of textile fabrics, it will not be necessary for us to describe all the forms of dye-becks that are used in dyeing, but will restrict ourselves to that pattern which is principally used for dyeing the goods after having been printed with the mordants in the *madder style* of calico printing.

The dye-beck used for this purpose is shown in Fig. 36. The vessel, or beck, which contains the dye liquor, is usually constructed of iron, but when dyewares are used that are affected by the latter metal a copper-cased beck is employed. Inside the beck and reaching nearly to the bottom is a perforated plate, called a *mid-feather*, which prevents the pieces becoming entangled by the agitation of the liquor in the beck. The pieces pass gradually under this division up through the dye liquor and over the wince. In the framework of the machine, above the beck, a wince is placed driven by the cog-wheels shown, and each wince can be started or stopped independently of the others by means of a clutch. Just below the wince there is a rail provided with pegs projecting forward which keep the pieces in their proper position on the wince; this rail is called the *peg rail*. The liquor is heated by open steam pipes usually, but when colours are being dyed that require a special concentration of liquor, closed pipes are used so

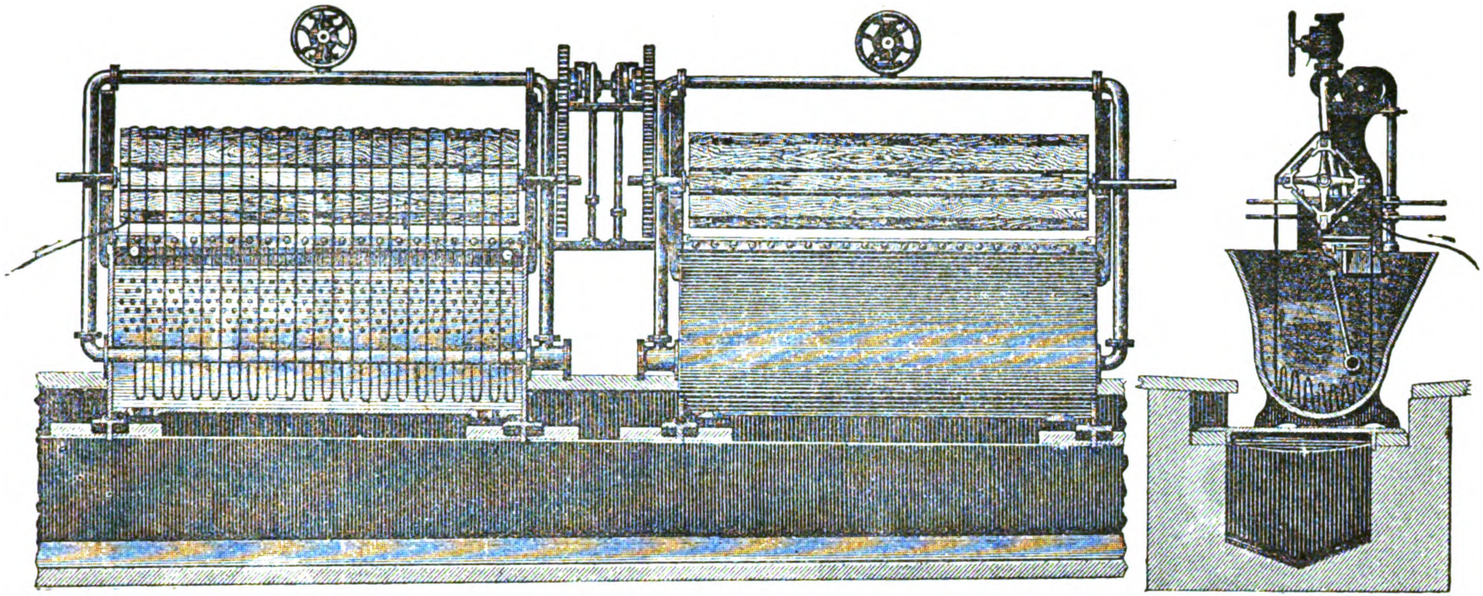


Fig. 36.—Dye-becks (Mather & Platt).

that the liquor will not be diluted by condensed steam. This is particularly important in dyeing goods printed with chrome mordants on calico. The pieces can be arranged on the wince either to work endlessly, or each piece can be placed separately on the wince and between the corresponding pegs.

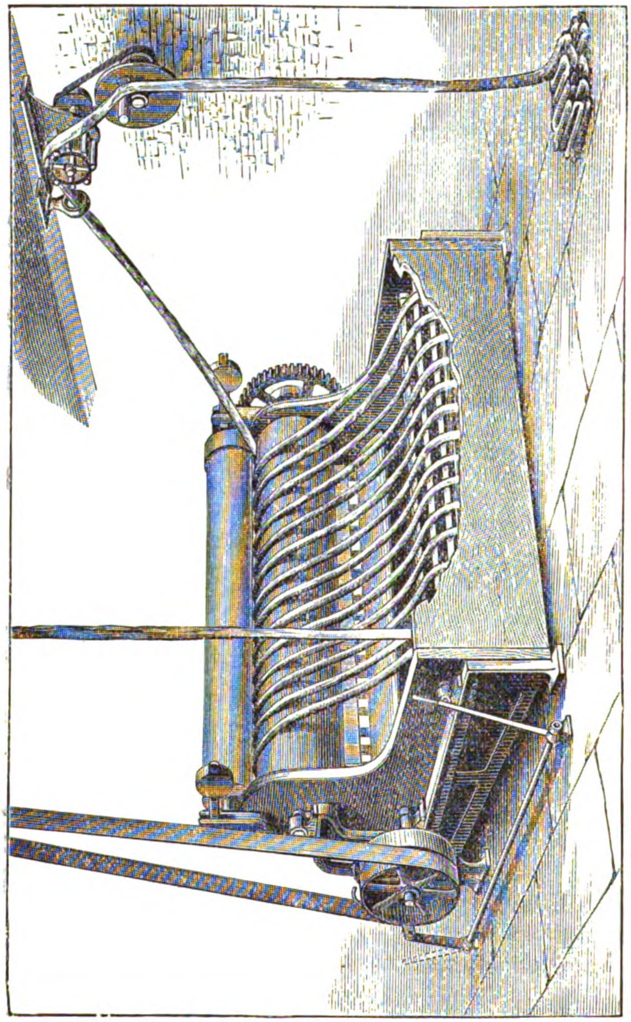


Fig. 37.—Dye-house washing machine (Mather & Platt).

Speaking generally, the following is the method of using these becks:—The beck is filled with the requisite quantity of water, and the pieces placed in, thrown over the wince, and their ends connected. The glue size, or other substance that may be used to preserve the purity of the whites, is then added, and the machine started, to thoroughly impregnate the cloth. After this, the steam is turned on, and then the dyestuffs, mixed with a certain proportion of water and carefully freed from lumps, are added. After this, the temperature is raised for dyeing, when the liquor is run off by the valve at the bottom of the beck. The pieces are, generally, before removal, run through hot water to clear away the dye liquor, and then washed in a washing machine before soaping or other treatment.

The waste liquor from the dye-becks is merely run into the drains, and finds its way to the nearest stream; the filthy condition of the streams having dye works on their banks is largely due to this system. In the near future dyers and printers will be compelled to purify their waste water before discharging it, as the Corporations, Local Boards, and Rivers Committees are now endeavouring to cope with this nuisance.

Dye-house Washing Machines.—A machine which is used for washing pieces after dyeing and many other processes—acting, in fact, as a general washer in the dye-house—is shown in Fig. 37.

The cloth is washed in a shallow trough of constantly changing water, and as it passes through the machine it is alternately beaten in the water, and then the excess of the latter squeezed out. The cloth enters the machine through a pot eye at one side, and, after passing through the machine in the manner shown in the figure, it is drawn off with a wince. The beater, which is made square in form, is placed under the squeezing rollers in the trough, and is driven directly by means of a strap; this opens the cloth out to nearly full width in the water, and ensures the thorough cleansing of every part of the cloth. Sometimes two of these washers are worked together, the pieces first passing through one and then through the other. When they are worked in this manner it is necessary that a certain quantity of the cloth should lie slack between the two machines.

Preparing, Chemicking, and Buffing Machines. — Cotton fabrics are prepared with oleine, &c., for printing, chemicked, and, when required, tinted with the direct cotton dyes (buffed) on a machine somewhat similar to a slop-padding machine. The liquor is contained in a box, exactly like the slop-pad machine liquor box, the squeezing rollers, however, being made of sycamore. From the rollers the piece passes over the drying cylinders of an ordinary drying machine. Goods prepared with prepare containing caustic alkalies, as, for example, the prepare used for naphthol colours, are done on the slop-padding machine, as the caustic would act on the wood, and it could not be dried on the tins. Although a large number of the pieces are chemicked or cleared on this machine there are special machines made for this purpose. In these machines the cloth is passed first through the chemic liquor and the excess removed by passing between rollers. The cloth now impregnated with the bleaching liquor is submitted to a short steaming, by passing it through a small steaming chamber, where the hypochlorite of lime or soda is decomposed and the whites of the cloth are cleared thereby. If required the cloth before drying can be passed through a box filled with water and provided with squeezing rollers to remove the chemicals now in the cloth. This washing box is placed between the drying cylinders and the steaming box, and the piece passes through the whole series at one operation. When the pieces are to be *buffed* or tinted, with the direct cotton dyeing colours, and soap is used along with the dye, this washing is absolutely necessary, as the lime salts remaining in the cloth will form insoluble soaps, rendering the cloth disagreeable to the feel, and, eventually, curdling the soap in the liquor. For this reason, hypochlorite of soda is sometimes substituted for the lime salt. Even then it is advisable to wash the pieces before buffing, a comparatively easy matter with soda salts.

PART II.

THICKENERS AND MORDANTS.

SECTION I.

THICKENING MATERIALS USED IN PRINTING.

Before a mordant or solution of a colouring-matter can be printed by means of an engraved roller on the calico-printing machine to yield a clear impression of the engraved design, it must be "thickened," or its viscosity increased, to such a degree that the colour will not flow from the roller, out of the engraved portions, before it reaches the cloth, and the viscosity must be such that the colour will not spread or run by the capillary action of the fibres of the cloth before the colour is dry. This is the practical use of the thickening material.

The thickening material must be of such a nature as will allow the colour (1) to completely combine with the mordants used, and (2), during the processes of fixation, to enter into the fibres of the cloth. In most cases the material used for thickening should be soluble, so as to be removable by the processes of washing or soaping which the pieces pass through; otherwise, the printed parts will be stiffened, which is generally undesirable. In some cases, as, for example, with the pigment colours, the same material is used for thickening the colour and fixing it to the fibre, and in this case it is, of course, not removed by washing

Generally speaking, all the ordinary thickeners prevent, in varying degrees, the combination of the colour lake with the fibre; so that colours containing the same proportions per gallon of colouring-matter and mordant, but thickened with various kinds of thickeners, will, when printed under identical conditions, yield shades of varying intensities; the intensity of the shade apparently depends upon the quantity of thickening material required per gallon to thicken the colour. For example, gum tragacanth, which is used in the proportion of only about 5 to 6 ozs. per gallon for thickening, will yield a darker shade than starch (of which from 1 to $1\frac{1}{4}$ lbs. are required); starch yields a darker shade than is given by British gum (3 lbs. per gallon); and this again a darker shade than dextrine (4 to 5 lbs per gallon). Besides this effect in altering the intensity of the shade, the various thickening materials give different results with regard to the evenness or "solidity" of the colour on the piece, the more soluble, as distinct from the "pasty" or "starchy" thickeners, yielding the more level shades. The character of the engraving, area of covering, and intensity or depth of shade required very often influence the kind of thickening used for any particular pattern. As no rule is used, none can be given.

The principal thickening materials used for printing are starch, British gum, dextrine, gum tragacanth, flour, tapioca flour, gum Senegal, and gum Arabic. In addition to these there are other substances which serve both as thickeners and as fixing agents—viz., albumen and caseine—a description of which will be found in the chapter on *Pigment Colours*. We will now notice each of the above-named thickeners from a practical, rather than a chemical, point of view, as the chemical consideration of these bodies will be found very completely given in all books on organic chemistry.*

Starches.—In calico printing there are only two starches used for thickening to any extent—viz., wheat starch and Indian-corn starch. To produce a paste of sufficient viscosity, or thickness, for a printing colour, about 16 to 20 ozs. per gallon of water are required with either of the starches named. Although a paste made from starch alone is frequently used, it will be found of advantage to employ about a quarter the weight of tapioca flour along with the starch, as the resulting paste will then be much more homogeneous and will be less liable to separate into a rough paste. For many purposes the thickening is composed of a mixture of starch paste and a paste made from gum tragacanth; such a mixture is largely used for reducing starch colours, as it keeps very much longer than starch paste alone.

When a colour containing a large proportion of acetic acid is being made, it will be found necessary to employ a rather larger quantity of starch per gallon of finished colour than is given above; because, when starch is boiled with acetic acid, some of the thickening property of the starch is destroyed, and an extra quantity must be employed in order to make up for this loss. The same remarks apply to colours containing citric, tartaric, or oxalic acid, but it is usual in these cases to add the acids, especially when oxalic acid is used, after the colour has been boiled to thicken the starch, and has been cooled to a temperature of 100° F. or less.

Starch is precipitated by a solution of tannic acid, but this precipitation does not take place if acetic acid in sufficient quantity—usually

* See *A Dictionary of Chemistry*, edited by H. Watts; and *Bleaching and Calico Printing*, by George Duerr.

about 2° to 4° Tw.—is present, hence when starch is used for thickening tannic or basic colours, a large proportion of acetic acid must be used. The proportion of acetic acid must also be preserved when the colour is reduced, and hence an acetic acid starch thickening—containing also some tannin generally—must be used as the reducing paste.

Starch, especially when used in combination with gum tragacanth, is largely used for dark colours, but the shades obtained, although darker, are not so even or "solid" as those produced with British gum, or, better still, the finer qualities of the natural gums, Senegal or Arabic.

The colours which have been printed with starch, as the thickening material, always have rather a harsh feel after passing through the ordinary operations of washing and soaping in the open soaper, more especially if they are tannic colours, as the before-mentioned starch-tannin compound is formed on the cloth when the acetic acid is expelled during the drying and steaming of the goods. As a general rule, this harshness of feel of the cloth is of no consequence, as it will, in most cases, be unobservable when the pieces are stiffened and finished; but where an exceptionally soft feel or supple print is required, it is necessary either to employ other thickening materials for the printing colours, or, what is the more usual custom, to treat the prints with a weak infusion of malt, which will convert the starch adhering to the pieces into more soluble products by the action of the diastase contained in the malt liquor.

Starch paste will mix with most of the other thickening materials, but the mixture with gum tragacanth is the most used.

British Gum.—British gum, also called calcined farina, is made by calcining various starches or mixtures of starches, and is sold in three grades—viz., light British gum, medium or ordinary British gum, and dark British gum. These grades indicate the degree to which the calcination of the starch has been carried, the colour of the resulting gums varying from pale straw, through dark cream, to quite a dark-brown colour. With the exception of dark British gum, all the grades probably contain more or less unaltered, or only partially converted, starch, light British gum containing the larger quantity. Various makes of gum vary very largely in their properties, even although, judging by sight, they may appear to be the same, which is due partly to the fact that they may contain varying quantities of unaltered starch, and partly to the particular methods used in their manufacture, especially with regard to the temperature at which the starch was calcined and the kind of starch or starches used.

Light British gum is principally used as the thickening material for the caustic colours containing indigo used for printing indigo by the Schlieper and Baum process. The gum contains starch in a fairly large proportion, and a very small quantity is required to thicken these colours, as, under the influence of the concentrated caustic soda, the starch is converted into a glutinous substance having exceptionally great thickening properties.

The medium, or ordinary, British gum is by far the most largely used grade, and is the thickening material used for, practically, all the "gum colours" made in the colour shop. About 3 lbs. of British gum per gallon are required to properly thicken a colour; hence it is generally kept as a solution of this strength in the colour shop; but a solution or paste made with 10 lbs. per gallon is also stored for use in preparing colours that must be made cold.

The dark British gum is only used for special work, the intensity or depth of its colour being such as to render it unsuitable for general use.

Solutions of light and ordinary British gum always become pasty after keeping for a few days, some makes changing much more rapidly than others; but, unless kept for a considerable time, this does not seem to have much influence upon the printing colours made from it.

Dextrine.—Dextrine occurs in commerce as white and brown dextrine, the latter being the kind chiefly used for thickening colours, and the former for preparing finishes. It is made by several processes, the principle of which is that starch, by the action of acids, is transformed into dextrine.

Commercial dextrine is practically completely soluble in water, and although steps are taken to neutralise any free acid used in manufacture, still the finished product is always slightly acid.

Occasionally, when printing pale bright shades, a mixture of white and brown dextrine is used to produce a thickening, having a paler shade and thus to increase the brightness of the resulting shade, because some of the colouring-matter contained in the thickening is always fixed upon the cloth.

Dextrine yields very "solid" or even shades, and the cloth, when finished, is particularly soft to the touch, due to the complete removal of the dextrine by the processes of washing and soaping, owing to its ready solubility in water. On this account, it is very largely used as a thickening for printing colours used for wool, union, silk, and half silk.

The shades obtained from a colour thickened with dextrine are paler than those obtained from a corresponding printing colour thickened with British gum; when the colours are dried upon the cloth they are very brittle and liable to show marks after steaming should the film of colour become broken. The same thing occurs with British gum, but in a less degree.

Gum Tragacanth.—Gum tragacanth, commonly called "Gum Dragon," occurs in the form of yellowish-white leaves. It is not actually soluble in water, but when soaked for some hours it swells considerably and forms a nearly transparent pasty mass. It possesses very great thickening powers, 5 ozs. per gallon usually being sufficient.

The actual method of preparing this thickening is to soak the gum over-night in cold water, and then to boil the mixture for one to two hours to make the mass uniform.

Gum tragacanth is only used by itself for thickening very pale pad shades, as the shades produced by its use lack evenness or solidity. It is very largely used along with starch paste for thickening all classes of "starch" colours and, occasionally, for increasing the viscosity of slop-padding liquors.

Flour.—Flour is now used, practically, only for the mordant dyeing colours—or "dyed style" colours—for which purpose it is found to answer better than any of the other thickeners. It varies considerably in quality; hence care should be taken to obtain a good sample.

Gum Senegal and Arabic.—These natural soluble gums are not used very largely as thickeners, but for special colours they are very useful. They are soluble in water, and will stand the action of strong acid solutions without losing their thickening power better than any of the other thickeners.

Colours thickened with gum Senegal give very solid shades, and are thus particularly suited for blotches, especially light ones; but its cost is against its more general use.

Gum Arabic is largely used for thickening reserve or resist colours, because the necessary presence of large quantities of free acids would render other thickeners useless. The thickness or viscosity of the colours is usually augmented by the addition of China clay, which also acts as a mechanical reserve protecting the fibre from the colour. Occasionally, when a colour is made with tartaric acid and gum Arabic is used to thicken it, small hard crystals of tartrate of lime may form on standing and these may scratch the engraved printing roller. In this case, partial substitution of tartaric acid by citric acid may remedy the defect, which is due to the action of the lime contained in the natural gum. The entire use of citric acid in place of tartaric acid will prevent this occurring, but, for various reasons, this is not always allowable.

A small quantity of Senegal or Arabic thickening added to a printing colour made with a starch thickening will immediately render it much thinner; this is occasionally done when it is found that a starch printing colour, after being tried on the printing machine, is too thick to work well with the pattern on hand.

SECTION II.

MORDANTS USED IN CALICO PRINTING.

In this section we shall confine ourselves to the preparation of the various solutions, used as mordants and assistants in the practice of calico printing, which are usually prepared in the works by the printer. For fuller information upon the chemical action of mordants in general, and the preparation of those mordants that are generally purchased ready prepared, some of the manuals more concerned with the science of printing and dyeing should be consulted.*

Acetate of Alumina.—A solution of acetate of alumina for use in printing is prepared by the double decomposition of sulphate of alumina and acetate of lead.

Instead of sulphate of alumina, alum is, and was formerly very largely, used; but it is now easy to obtain sulphate of alumina quite free from iron, and there is no advantage arising from the presence of potash or ammonia salts contained in the alum.

Acetate of lead, also called sugar of lead, is sold in two forms—viz., white and brown; the white being of the greatest purity. For preparing the liquor for printing, the white sugar of lead should be used, and care should be taken that it is free from iron. Acetate of lime is also used, instead of the lead salt, for the same purpose.

The acetate of alumina mentioned in the recipes for the colours used in calico printing is prepared as follows:—

Acetate of Alumina.

90 lbs. sulphate of alumina (patent alum),
14½ gallons water,
½ gallon acetic acid, 8° Tw.,
90 lbs. white sugar of lead.

Dissolve the sulphate of alumina in the mixture of water and acetic acid, then add, very gradually, the sugar of lead in the form of powder, stirring well all the time. After the whole of the lead salt has been added, the mixture should be stirred until the acetate of lead has been completely decomposed, when it should be filtered through a cloth filter, and the precipitate washed twice with water, allowing the washings to mix with the liquor. The liquor should then be tested with the Twaddle hydrometer, and, if necessary, water added until it stands at 24°.

Nitrate of Alumina.—Nitrate of alumina is occasionally used as a mordant in certain alizarine reds of a yellowish shade, and in scarlets, as it produces shades more yellow in tone than any of the

* See *A Manual of Dyeing*, by Knecht, Rawson, and Löwenthal.

other alumina mordants, possibly due to the formation of a small quantity of nitro-alizarine during the steaming of the printed pieces. Nitrate of alumina is generally prepared in the works from nitrate of lead and alum, and care should be taken to use these salts quite free from iron.

Nitrate of Alumina.

6 lbs. nitrate of lead,
6 lbs. alum,
1 gallon water.

Dissolve each of the ingredients in a portion of the water, mix together, stir for some time, allow to settle, decant off the top clear liquor, and filter the rest. The clear liquor is then diluted with water until it stands at 14° Tw.

Sulphocyanide of Alumina.—Sulphocyanide of alumina is now very largely used, in conjunction with alizarine, for the production of pink, salmon, and red shades. Unlike the other alumina mordants it is not affected by traces of iron, which are always contained in the thickening or other ingredients of the printing colour, and, consequently, much brighter shades are generally obtained than from the other alumina mordants. Notwithstanding this property, it is advisable to prevent, as far as possible, the introduction of iron in any form into the colour, unless it is put in with the definite object of modifying the shade; in that case, it is preferable to use the acetate of alumina instead of the sulphocyanide.

Sulphocyanide (called also Rhodanate) of alumina is usually purchased ready made as a solution of such a density that it shows from 28° to 30° on the Twaddle scale; it can be made by the printer in the colour shop, but there is very little saving in cost by so doing.

It is prepared by mixing sulphocyanide of barium with sulphate of alumina in the presence of water, when a heavy precipitate of barium sulphate is formed, which settles to the bottom of the vessel, while the sulphocyanide of alumina (with, generally, the slight excess of sulphate of alumina) passes into solution.

The following recipe illustrates the method used for making this mordant in the colour shop:—

Sulphocyanide of Alumina.

15¾ lbs. solid barium sulphocyanide,
18¼ lbs. sulphate of alumina,
3 gallons water.

The sulphocyanide of barium is placed in a cask, and the sulphate of alumina, previously dissolved in the water given, is poured upon it. The whole is then well stirred at intervals during the day, allowed to settle, and the clear liquor decanted off. The precipitate is then poured on to a filter, the liquor allowed to drain into a tub, and the precipitate washed twice with water. The drainings and washings from the precipitate are mixed with the liquor, and the latter set to 28° Tw.

A ready test for the presence of iron in a solution of sulphocyanide of alumina has been published by G. Stein, which depends upon the solubility of sulphocyanide of iron in ether. To carry out this test, place in a 100 cc. cylinder about 50 cc. of the sample of sulphocyanide of alumina to be tested, add 20 cc. of ether, shake well together, and then allow to stand until the ether has separated from the solution, forming a layer of liquid at the top of the tube. The quantity of iron contained in the sample can be judged from the depth of colour of the layer of ether, which becomes red from the iron contained in it. This test is very useful for rapidly comparing several samples to ascertain the relative proportion of iron in each.

Acetate of Chrome.—Acetate of chrome is the most largely used metallic mordant in the steam style. It may be prepared from chrome alum and acetate of lead in a similar manner to that described for the preparation of the alumina salt, but it is generally made by reducing a solution of bichromate of potash in acetic acid with sugar or starch; preferably the former.

The following is a good practical method for its preparation on the large scale required in the works:—

Acetate of Chrome.

½ cwt. bichromate of potash,
61 gallons acetic acid, 8° Tw.,
28 lbs. brown sugar.

The bichromate of potash and acetic acid should be placed in a pan and heated nearly to boiling. The pan should be considerably larger than what is actually required to hold the solution, as the liquor froths and boils up in the pan when the sugar is added. The sugar is now very gradually added to the liquor, care being taken to allow the violent action caused by the addition of the sugar to completely subside before adding more. When all the sugar has been put into the pan, the liquor should be occasionally stirred during the day and then allowed to remain overnight for the reducing action to become complete and the liquor to cool.

In the morning the acetate of chrome should be cooled, if not cool already, and diluted with water until it marks 28° Tw. The liquor is now put into stock for use.

Alkaline Chrome Mordant.—This mordant is sometimes used for slop-padding cloth intended for printing with a colour which will remove the chrome from the parts printed, and thus produce a white pattern upon a coloured ground. It is, however, not much used for this purpose at the present time, as superior results can be obtained, and with greater certainty, by using the more recently introduced bisulphite of chrome, either alone or mixed with some bisulphite of alumina.

Alkaline chrome mordant is prepared by adding a solution of caustic soda to acetate of chrome in the presence of glycerine, and as it is rather unstable, especially in the summer time, it is better to make it up each time just before use. The following is an example of a chrome-padding liquor for medium shades :—

Alkaline Chrome Mordant.

3 gallons water,
10 lbs. acetate of chrome, 32° Tw.,
½ lb. glycerine.

3½ gallons water,
26 lbs. caustic soda liquor, 67° Tw.

Gradually mix the two solutions and keep in a cool place until required.

Bisulphite of Chrome.—This salt of chrome has lately been much employed as a mordant in certain padding styles and steam colours. It is easily decomposed on the fibre into hydrated oxide of chrome and sulphurous acid, which escapes into the atmosphere, and the chrome is left on the fibre in a condition suitable for its easy discharge, if required.

Bisulphite of chrome is sold as a solution of about 32° Tw. strength, and most printers purchase it ready made. It can be prepared by the printer by mixing solutions of chrome alum and bisulphite of lime.

Chlorate of Chrome.—Chlorate of chrome is only occasionally used in a print works, sometimes for oxidising aniline blacks, and sometimes in certain special steam colours. When required, it is usually prepared by mixing solutions of chrome alum and chlorate of barium, and using the clear liquor.

Sulphocyanide of Chrome.—Sulphocyanide of chrome is only used to a very limited extent, and is usually purchased as a solution standing at 35° Tw. Should the printer desire to prepare it, the same method can be used as described for sulphocyanide of alumina, using chrome alum instead of the alumina salt. It will, however, be found to be cheaper to purchase it ready made from firms making a speciality of this article.

Tartrate of Chrome.—Tartrate of chrome is used for a resist. It is prepared in exactly the same way as acetate of chrome, using the following ingredients and proportions :—

Tartrate of Chrome.

3 lbs. bichromate of potash,
1½ gallons water,
4½ lbs. tartaric acid.

Acetate of Tin.—This solution is very unstable, and should be prepared shortly before use. It is used very largely as a discharge for cloth dyed with substantive colours. The acetate of tin is often made by using a mixture of tin crystals and acetate of soda in the printing colour itself, but the acetate is also prepared directly in the colour shop by warming a mixture of acetic acid and tin pulp containing an excess of the latter, the solution being set at about 28° Tw.

Double Muriate of Tin.—This is merely a strong solution of stannous chloride acidulated with hydrochloric acid. It generally stands at 120° Tw. A weaker solution than the above is frequently termed "single muriate of tin." The following proportions are used in all the recipes in this work:—

Double Muriate of Tin.

40 lbs. tin crystals,
2 gallons water,
1½ gallons hydrochloric acid, 32° Tw.
Dissolve, and set to 120° Tw.

Oxide of Tin Pulp.—This is prepared by precipitating a solution of stannous chloride, or tin crystals, with ammonia. The following proportions should be used:—

Oxide of Tin Pulp.

15 lbs. tin crystals,
6 gallons water.

Place the above in a cask, and add very slowly (stirring the whole of the time) the diluted ammonia solution, as below—

1 gallon 1 pint ammonia,
3 gallons water.

The ammonia solution should be added very slowly, especially when, say, three-quarters of the whole has been added, and then it must be added very cautiously, testing each time with a piece of litmus paper.

The ammonia solution should be added until the blue litmus paper only very slowly turns red, showing that the solution is only faintly acid. Should too much ammonia have been added, and the solution show an alkaline reaction, some hydrochloric acid must be slowly added to render the liquor just acid. If the solution were allowed to remain in the alkaline condition, the resulting paste would be liable to turn black when kept for a little time, the change commencing with a few black specks making their appearance, and gradually extending to the whole of the paste. When these particles make their appearance the paste is absolutely useless for the printer. When sufficient ammonia has been added the whole mixture is filtered, the resulting paste washed three times with water, allowed to drain, and stored.

Oxalate of Tin.—This preparation is employed principally as an ingredient in colours prepared from alizarine and an alumina mordant, the object being to brighten the shade. It has also the property of making the resulting shade yellower in tone.

It is prepared by dissolving, or heating, the oxide of tin paste just described with oxalic acid to 90° or 100° F. The following is the method of preparing it:—3 gallons of the oxide of tin paste, prepared as described above, are warmed to between 90° and 100° F., and 1¼ lbs. of oxalic acid in crystals are gradually added. After remaining at 100° F. for some time, the mixture is cooled, and stored for use.

Oleine.—Oleine is used for preparing the tissue previous to printing, as an ingredient in several printing colours, and for brightening the colours of alizarine-dyed goods. It is prepared by the action of sulphuric acid on either olive or castor oil, the resulting fatty and sulpho-fatty acids, after the removal of the excess of sulphuric acid, being neutralised or converted into the alkali salts by the addition of caustic alkalies in solution. Caustic soda-lye is usually selected as the alkali to neutralise these fatty acids, as it is comparatively cheap; but there is said to be some advantage arising from the use of liquor ammonia for this purpose, the ammonia salts formed being more easily decomposed during steaming and thus enabling the colour lake to more readily take up the fatty acids. Many manufacturers combine, to some extent, these two alkalies, adding ammonia until most of the fatty acids are neutralised, and finishing the operation with soda-lye.

Oleine, as supplied to printers, is a yellow, oily liquid, practically miscible with water in all proportions, forming, however, when largely diluted, a milky emulsion, which, on standing for some days, partially separates from the water, the surface of the liquor becoming more or less covered with an oily liquid. The opalescence of the diluted liquid depends upon the degree of dilution and also upon the quantity of alkali contained in it; an oleine containing an excess of alkali forms a nearly clear aqueous solution, even when largely reduced with water. As usually sold, it contains from 37 to 40 per cent. of free fatty acids and about 50 per cent. of total fatty matter.

To prepare oleine on the large scale in the works the following process is employed:—The castor oil and sulphuric acid are mixed together in large wooden tanks. These tanks are lined with lead, fitted with stirring gear, and arranged so that the contents can be cooled by the circulation of cold water. Into such a tank place 50 gallons of castor oil, stir and add very slowly, to avoid over heating, 12½ gallons of sulphuric acid at 169° to 170° Tw. The mixture of oil and acid is then allowed to stand for about fourteen hours. After standing the length of time specified, the mixture is run into a solution of common salt at 8° Tw., well mixed, and then allowed to stand. The fatty acids will gather to the top of the liquor in the tub, the salt solution settling below. The aqueous liquor, lying under the oily liquid in the tub, is then drawn off by means of a tap placed near the bottom. Some more brine is then added to the oily liquid in the cask, the whole well mixed, allowed to settle, and the salt solution drawn off as before. The excess of sulphuric acid should now have been removed and all that remains to be done is to neutralise the oil, and make it up to strength. If the alkali chosen is soda, the neutralisation should be done with a solution of white caustic soda at 10° Tw., the soda being added until, when a small quantity of the oleine is taken out and mixed with water, the liquor appears of the usual opacity. This should be done by always taking a uniform quantity of water and oleine. The proper degree of opacity or turbidity will soon be found by experience; if too much soda has been used, the oleine, when mixed with water, will be quite clear; while, if too little has been added, the mixture will be very turbid. Before sufficient experience has been gained in making oleine, it is well to procure a sample of well-made oleine, and to mix this with, say, six times its bulk of water; all new batches should be compared with this standard sample. A fresh quantity of the sample of oleine must be mixed with water each time a new batch is made, as it will not be safe to use it as a guide if it is kept.

When it is desired to use ammonia to neutralise the fatty acids, the operation is done in the same way, using liquor ammonia instead of the soda-lye.

Olive oil is also used for the preparation of oleine, but not to the same extent as was formerly the case; the mode of preparation is exactly the same as with castor oil oleine. For use in brightening the shade of dyed alizarine reds, olive oil is to be preferred to that made from castor oil; and, if intended to be used for this purpose, the fatty acids should be neutralised with ammonia in preference to soda.

When the fatty acids have been neutralised with the alkali, the oleine should be reduced to the standard strength by slowly adding water until the bulk of the liquid is increased to the gauge mark, the usual strength being an oleine containing 50 per cent. of fatty matter, as tested in the laboratory.

Gallipoli Olive Oil.—This oil is often added to various colours, sometimes to cause the colour to work better in the printing machine; and, at other times, to assist in the fixation or brightening of the shade. The oil is often termed merely "Gallipoli oil," and is an olive oil containing a large quantity of free fatty acids.

Cottonseed Oil.—This oil, which is considerably lower in price than Gallipoli oil, has, to a large extent, replaced the latter for the larger number of colours made in the colour shop. It is often sold to calico printers under the name of "colour oil," and, with the exception of a few colours, can be used where the addition of an oil is necessary.

Chlor Oil or **Chlorinated Oil.**—This preparation is now largely used as an addition to steam alizarine reds, and consists of a mixture or emulsion of colour oil with a solution of hypochlorite of lime or "chemic." The following recipe yields good results :—

Chlor Oil.

11 gallons Gallipoli, lard, or cottonseed oil,
1 gallon chemic liquor, 27° Tw.

Soluble Oil—Castor-oil Soap.—Soluble oil is more largely used in the finishing room than in any other part of the works, but occasionally finds employment in "prepare" and a few printing colours. It is usually purchased, but can easily be prepared in the works by boiling together castor oil and a solution of caustic soda, the following proportions being suitable :—

Soluble Oil.

1¾ gallons castor oil,
1 gallon caustic-soda lye, 40° Tw.
Boil for thirty or forty minutes ; then add
6 gallons hot water.

The soluble oil should be free from an excess of alkali, which is best indicated by moistening a piece of wool dyed with malachite green with the solution and drying it. If free alkali is present, the colour will be discharged. An excess of alkali should be neutralised, either by boiling with some more castor oil, or by adding a sufficient quantity of acetic acid to the hot solution.

PART III.

THE PRINTING OF COTTON GOODS.

CHAPTER I.—SECTION I.

THE BLEACHING OF COTTON PIECE GOODS FOR PRINTING.

The cloth received at a calico print works is generally of widely varying qualities, differing considerably, not only in the nature of the fibres themselves, but also in the composition of the sizing materials used by the various manufacturers of the cloth.

Goods purchased by the printer himself, from manufacturers who make a speciality of the weaving of piece goods for calico printers, only occasionally give the printer trouble, the cloth manufacturer having found by experience the materials he may and may not use in the composition of his size; trouble from this source is generally traced either to the manufacturer using materials of an impure nature, to accidental stains produced during manufacture, or to the practice of some of the many dodges, known to weavers, for assisting the working of certain kinds of cotton in the loom. Cotton manufacturers usually endeavour to check the use of these dodges on the part of the weaver, but they are, nevertheless, often resorted to.

Printers have the most trouble and annoyance in the printing of the various batches of goods sent to them by shippers, &c., from manufacturers absolutely unknown to them; these goods are often found to contain sizing materials most difficult to remove, and sometimes of such a nature as to utterly unfit them for the production of certain kinds of prints.

Before the cloth is printed, it is necessary to remove all the natural impurities originally in the cotton before manufacture, all the sizing materials applied to it to assist in the fabrication of the piece, and the dirt, grease, &c., with which the goods always become contaminated during weaving. As some of the cloth while in the grey condition has to be used in the process of printing other pieces, as a backing material, the *back-grey*, to prevent the colour from passing through and over the edges of the piece being printed and thus soiling the blanket lapped round the bowl of the printing machine, the process of bleaching should be capable of removing not only the natural and accidental impurities above mentioned, but also any printing colour that may be deposited on the back of the cloth. The bleaching of the cloth for printing must be of the most complete character; the piece must not only be completely freed from colour, but all impurities, even should they be colourless, must be removed, or the white parts of the print may, in any after dyeing process, become soiled. The cloth, in fact, should be chemically, as well as visibly, clean.

The most thorough process for bleaching is that known as the *madder bleach*, and the greater part of the cloth is bleached by this method, including the pieces which have been used as back-greys during the printing of other pieces. The following is a description of this process as practised at the present time by some of the calico printing firms who have not yet adopted the more recent process requiring the use of the Mather kier :—

The pieces, on arrival at the print works, are conveyed to the "grey room," where they are stamped, at one end of each lump, with the order number, and any other number or sign for the purpose of recognising them in the works, or to guide the work people with regard to their special treatment. The stamping is generally done with brass stamps let into wooden blocks, using gas tar or aniline black mixture for the ink, as these resist the action of the bleaching process. When the goods have been stamped, they are sewn together, end to end, and are then ready for the operation known as *singeing*.

Singeing.—After the pieces have been sewn together, they are arranged in a pile on a waggon, or truck, and are taken into the singeing house. If the surface of the piece, before it is singed, is carefully examined, it will be found that it is covered with small hairy fibres, projecting from the surface of the piece, technically known as a *nap*. If these fibres were allowed to remain on the face of the piece the colours printed upon the cloth would, when the print was finished, be very uneven, and the whole surface of the print would be covered with white specks. These specks are caused by the loose fibres preventing the printing colour coming into contact with the surface of the cloth on which they are lying; as their position is altered during the processes to which the piece is afterwards subjected, the place where they were formerly lying shows up perfectly white, or considerably lighter in shade; the fibres, in fact, act as mechanical resists. Singeing has for its object the removal of these loose or projecting fibres; this is accomplished by passing the piece over, and in contact with, a red-hot plate or roller, at such a speed that the nap is burned away without the piece itself being scorched. Generally, the goods for printing are only singed on one surface; but for some special styles, and usually for dyed goods, they are singed on both sides of the cloth by passing them twice through the singeing machine.

There are two forms of singeing machines in general use at the present time, the best and most popular being that known as the **roller singeing machine,** shown in Fig. 38. The singeing roller consists of a copper, or cast-iron, hollow roller, mounted so that the

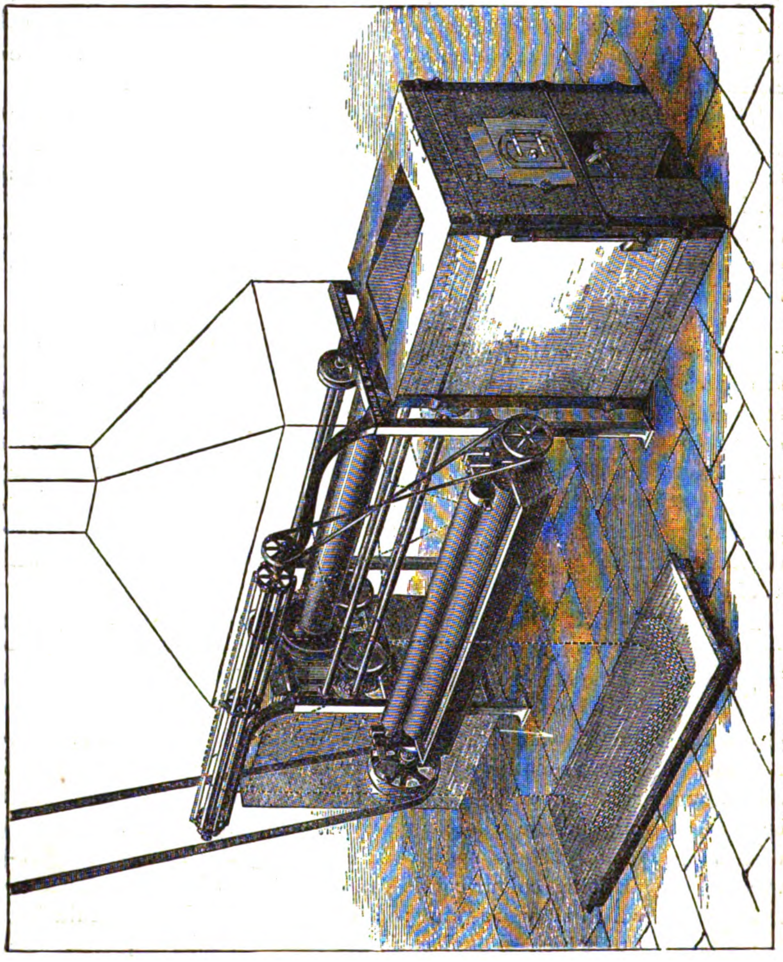


Fig. 38.—Singeing machine, with hollow revolving roller (Mather & Platt).

flames from the furnace, shown at the right-hand side of the figure, pass directly through the roller into the flue, and, consequently, keep the cylinder at a red heat. The hollow roller is connected with gearing so arranged that the cylinder slowly revolves as the cloth passes over its surface. The cloth is drawn into the machine by means of the drawing rollers shown in the figure, passes under the friction rollers and rods which depress the surface of the piece against the singeing roller, after which the piece passes through a steam box, where all sparks are extinguished. On coming out of the steaming box, the goods are drawn through a porcelain ring or "pot-eye" into the bleaching croft, thus taking the form of a rope, in which form they remain until they are dried after bleaching. The pressure of the piece on the face of the red-hot cylinder is regulated by threading the cloth under a higher or lower rod; the lower the rod the greater the pull on the singeing roller and the larger the surface of contact with the piece. The machine is usually driven with a small engine, placed in a position convenient for adjusting the speed. The speed at which the cloth is passed through the machine, in order to ensure perfect singeing, can only be found by experience, as it varies with the weight of the cloth per piece, and to some extent with each machine, even when of the same design; but, as a rough guide, we may mention that in the case of one machine we have used, and singeing a medium quality of cloth, the speed required in this special case was about equal to 160 pieces of 25 yards length per hour. When the machine has been for some time in use, the interior of the singeing cylinder will be found to be coated with a crust, somewhat resembling the scale formed in the inside of steam boilers; this crust, being a very bad conductor of heat, prevents the heat of the furnace from reaching the outside of the roller, and causes a vast waste of fuel, as also, sometimes, uneven singeing. This scale is deposited and fused on to the inside of the cylinder by the flames passing through it; it is easily removed by chipping with a hammer when the roller is quite cold and out of the machine. In order to prevent a stoppage of the work while the cylinders are being scaled, two or more rollers are commonly supplied to each machine. The principal advantage of the roller singer over the older plate-singeing machine is that the cooling effect of the cloth is not felt to the same extent, as, on account of the movement of the revolving roller, a fresh red-hot surface of the singeing roller is continually presented to the cloth, which ensures even singeing. The parts of the cylinder which the cloth has just touched are lowered in temperature, but by the time the same portion again reaches the piece it has had time to become heated to the temperature necessary for the proper combustion of the nap.

In the roller-singeing machine made by Messrs. Downham & Co., of Bury, the gearing connected with the singeing roller is arranged to enable the operator to have complete control over the speed at which the singeing roller revolves, irrespective of the velocity of the piece, so that the roller can be revolved either at a greater or lesser speed than that at which the piece is travelling.

A very good pattern of plate singer is shown in Fig. 39. In general construction it is very similar to the roller singeing machine, but instead of the roller, two copper plates are used heated from one furnace. The plates are so placed that one attains a higher temperature than the other; the cloth first passes over the cooler plate, and the singeing is completed on passing over the second plate. The preliminary heating of the piece with the first plate prevents the cloth from reducing the temperature of the second plate below the singeing heat, and thus perfect singeing is effected with a comparatively small

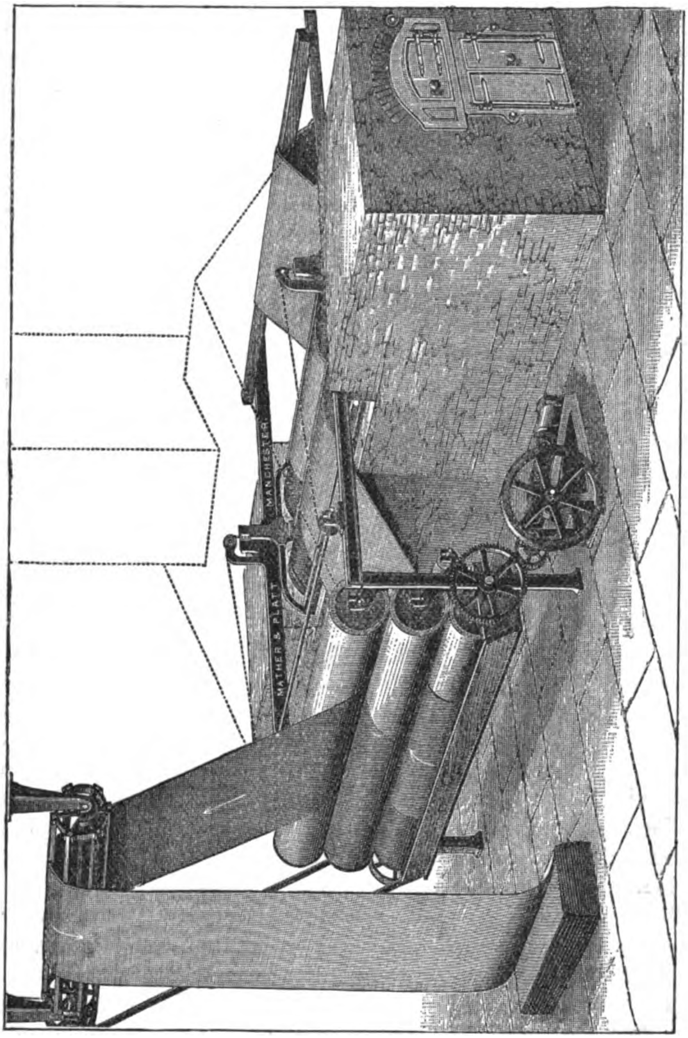


Fig. 39.—Plate singeing machine (Mather & Platt).

expenditure of fuel. In this special machine there is an arrangement for quickly withdrawing the cloth from the red-hot plates should the machine be stopped accidentally or otherwise, thus preventing the piece from catching fire. The same system for extinguishing sparks can be employed as mentioned when describing the roller singer, or the piece may be passed through a water box, but we prefer the former method.

Gas singeing machines resemble, in principle, the machines just noticed, but instead of the piece passing over a red-hot roller or plate, it passes through the flames of a row of atmospheric gas burners, the piece passing round a very small metal roller which guides it into the flames. In most gas machines there are two rows of burners, the piece passing first through one set and then through the other row, situated at a short distance from each other. Should the machine stop, the burners automatically move away from the cloth. The gas singer is rarely used for anything but very light fabrics.

Singeing machines are always covered with a ventilating hood (shown in the illustrations) to carry away the gaseous products of combustion.

Washing after Singeing.—The pieces, after singeing, are run through cold water in a washing machine of the ordinary pattern (Fig. 44), and then plaited down in a pile and allowed to remain in the wet condition, covered up with coarse sacking, for a few hours, or overnight. The object of this washing is to remove those constituents of the size and impurities that are soluble in water alone, and to render the starchy matters easier to remove in the following treatments.

Lime Boil.—When the pieces have laid in pile for a sufficient length of time, they are passed through milk of lime of such a strength that the goods take up about 4 to 6 per cent. of their weight of lime. The milk of lime should be strained before use, and it is applied to the cloth by passing the pieces through a machine exactly like the one used for treating with chemic. A good quality of lime, as free from iron as possible, and recently burnt, should be employed. From the liming machine the pieces pass through pot-eyes and over winces directly into the kier.

Bleaching Kiers.—~~There are three kinds of kiers~~ used by calico printers for the lime boil, the most popular being the injector kier; the others are known as the Barlow and Pendlebury kiers.

Injector Kier.—An exterior view is shown in Fig. 40, and a sectional one in Fig. 41. All kiers are made of strong wrought iron, strong enough to stand a pressure much greater than will ever occur in practice, and are generally supported on four iron pillars, clear of the ground, so that all the parts can easily be reached for cleaning and repair. The kiers are usually placed all together in a one-storey part of the bleaching croft, the roof of which is provided with efficient ventilators. The whole series of kiers should be surrounded with thick brick walls to prevent loss of heat by radiation. The proper working floor is shown in the diagrams, and is about 2 feet from the top of the kier. The kier is filled through a manhole in the top of the kier. A boy enters the kier through the manhole, and stands on the pile of stones or on the perforated false bottom of the kier. The cloth, in the rope form, coming direct from the liming machine, is sent into the kier by the revolving winces over which it passes, and the boy packs it evenly and firmly in the kier, using a stick to direct the cloth, and treading upon it to press it down. These boys are provided with clogs without the usual clog irons, which they should never be allowed

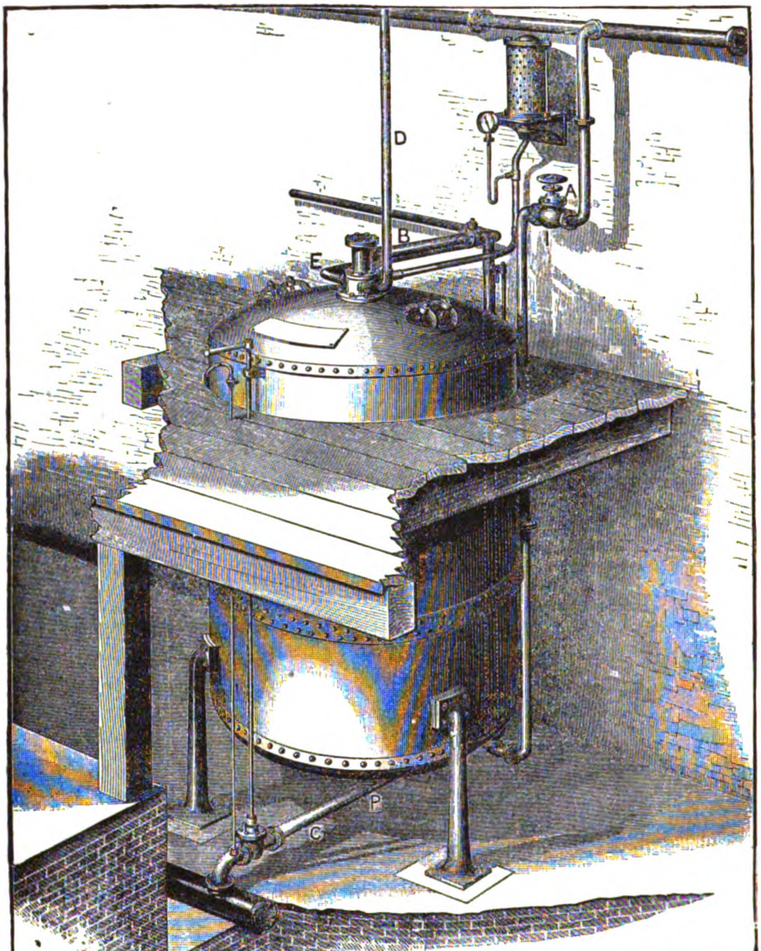


Fig. 40.—Injector bleaching kier (Mather & Platt).

to take out of the croft. When the kier has been filled, the requisite quantity of water is added, and steam blown through the kier until all the air is expelled from the kier and, consequently, from the interstices of the cloth. The door is then placed over the manhole, and securely bolted down with the screws provided for this purpose. The kier is now ready for the actual boiling.

The liquor is caused to circulate in this form of kier by the use of a steam injector, hence its name, the action of which will readily be understood from the diagram showing the kier in section. The steam from the boiler is admitted by turning on the steam cock, marked A, which passes along the pipe shown to the steam injector at the bottom of the kier. The injector meets the liquor in the kier at J, and forces

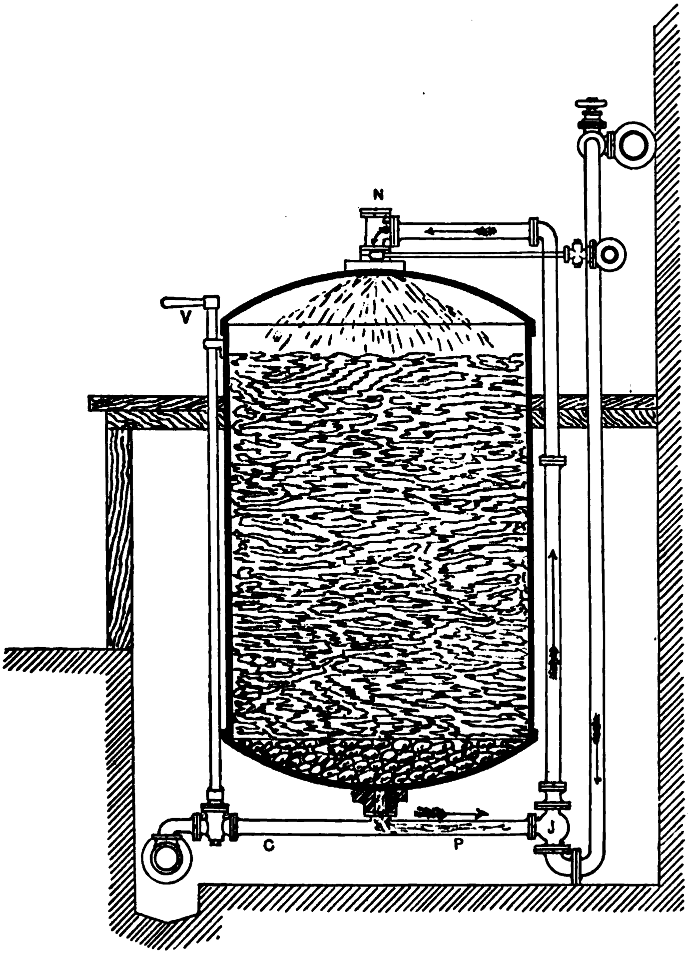


Fig. 41.—Section of injector kier.

it up the pipe B to the top of the kier, where it again enters the kier through the connection N. This process goes on continually for a period varying from four to eight hours. The waste liquor, after the boiling is completed, is run off at the cock C, arranged, as shown, to be turned on or off when the operator is standing on the working floor above. The pipe D, shown in the outside view of the kier, is connected with the tanks holding the liquor for the ley boil. The pipe B is the cold-water pipe used for running in the necessary water for boiling, and for cooling the goods after the completion of the boiling.

In the **Barlow system** two kiers are worked together, as shown in Fig. 42. The general construction of the kiers will be seen from the diagram. This system differs from that just described in that the liquor circulates from the one kier to the other. In working with the Barlow kiers, both kiers are filled with cloth, the necessary quantity of liquor admitted, and steam blown through both kiers to expel the air,

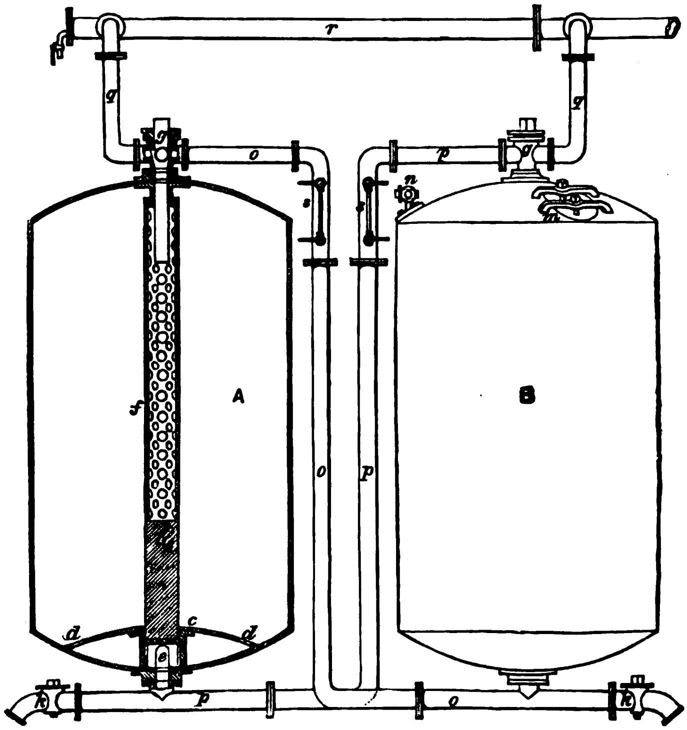


Fig. 42.—Barlow's high-pressure bleaching kiers.

the manholes being left open. The steam is then turned off, the manholes fastened down, and the two-way cocks so arranged that the boiling occurs in one of the kiers only. The two-way steam cocks are now reversed, and the steam drives the liquor from the one kier up the pipe, shown at the side of the kier, into the other, showering it over the cloth from the top. This reversing process is continued until the cloth has boiled the necessary length of time, when the liquor is run off, and the cloth cooled and finished as usual.

Pendlebury's system resembles, to some extent, Barlow's in principle, but instead of using two kiers of equal size, and both filled with cloth, only one is charged with goods, and the other, and smaller, one contains the liquor, which is caused to circulate from the small kier to the larger one, and back again, in the same manner as in Barlow's method (see Fig. 43).

Kiers are made of various sizes, up to about 7 feet in diameter.

As mentioned above, the injector kier is the most popular with modern calico printers, especially when used in connection with the Mather steamer kier, for the ley boil, but both the other systems are largely used, and have many advocates who claim important advantages

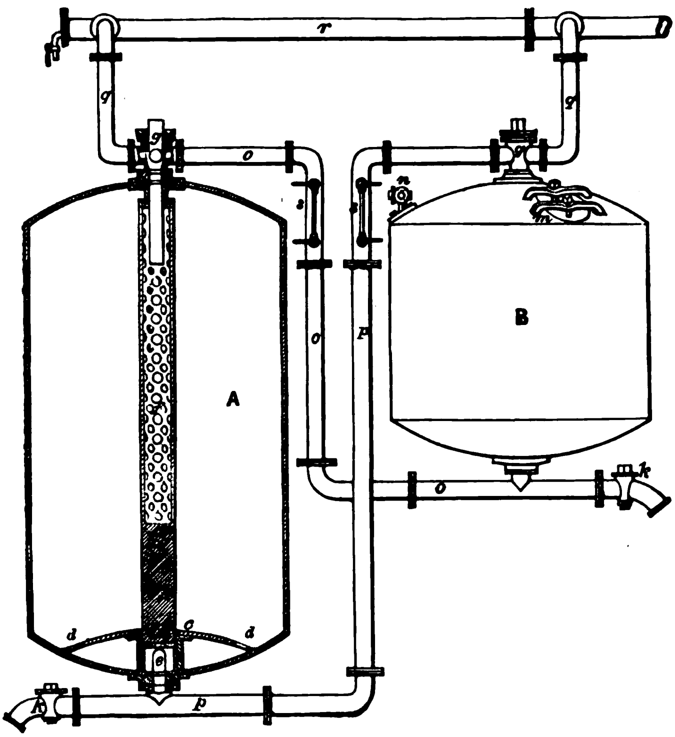


Fig. 43.—Pendlebury's high-pressure bleaching kiers.

arising from their use. Barlow's system is said to be rather more economical in soda when used for the ley boil, and both systems are claimed to be better than the injector kier, because in the former the cloth is drained dry between the various circulations, so that when the liquor returns it comes in contact with hot and almost dry cloth, and is thus better able to permeate the thicker, twisted or more closely woven parts of the fabric. On the other hand, the Barlow system has the disadvantage that the two kiers take a long time to fill and get ready for boiling, which is very inconvenient when small batches are being worked.

The inside of the kiers should be occasionally whitewashed, when it is found that the interior begins to show any signs of rust coming through; neglect of this precaution is a frequent cause of the pieces showing patchy stains of iron rust, which the after-treatment may fail to remove. If the goods are not thoroughly covered with the water, and the goods well cooled before they are taken out of the kier, the action of the hot lime on the piece may cause it to become tender or rotten in places.

During the boiling with milk of lime most of the size remaining in the cloth is removed, and the oily matters, originally contained in the cotton itself, together with that used in sizing and that accidentally deposited on the goods during weaving, are decomposed, but still remain on the fibre as lime soaps, which are, however, easily removed by the acid and soda treatment afterwards applied. For the most thorough bleaching, particular attention should be given to the lime boil, as upon its proper application the thorough removal of the more refractory impurities depends.

Wash after Lime Boil.—The pieces are now drawn out of the kier over winces driven by power, and are sent through two washing machines like the one shown in Fig. 44. In this process (and all the subsequent ones), the pieces are worked in duplicate, as seen in the diagram of the washing machine, where the two pieces are shown passing through the pot-eyes at each side of the machine; after having passed several times through the constantly changing water contained in the water-box, and received several squeezings between the weighted rollers, each piece leaves the machine from the centre of the rollers (as shown), and passes through a second and similar machine in the same manner.

Grey Sour.—From the washing machine the pieces are passed through a solution of sulphuric acid of a strength of 2° Tw., contained in a machine similar to that used for applying the chemic liquor, and the pieces are then plaited down on the stone floor to form a large pile, covered up with coarse sackcloth, and allowed to remain for five to forty-eight hours. During this treatment the lime soaps contained on the fibres are decomposed, and the metallic impurities, which have been changed by the lime boil into hydrates or easily soluble oxides of the metals, are converted into such a condition that they, with the sulphate of lime formed, are removed when the goods are afterwards washed with water, leaving practically only the fatty matter and the natural colouring-matter on the fabric. When the goods have laid in pile for a sufficient length of time, they are well washed by being passed through two washing machines; they are then ready for the

First Ley Boil.—The goods are put into the kiers direct from the washing machines, or they may be first run through a solution of soda ash contained in the last washing machine before entering the kiers. When they are packed in the kiers and the air expelled, as before described, a solution of soda ash mixed with rosin soap, or gum thus, is run in, and the goods boiled for six to eight hours. The quantity of soda ash generally used is about 5 per cent. of the weight of the goods; and about 2 per cent. of rosin, previously saponified by boiling with caustic soda, is added. Ammonia-soda ash is the best for this purpose, being free from iron and containing very little matter insoluble in water. Sometimes a small proportion of caustic soda is mixed with the other ingredients of the ley, and this is much to be preferred to the use of the so-called caustic-soda ash, as there is more control over the relative proportions of the two substances.

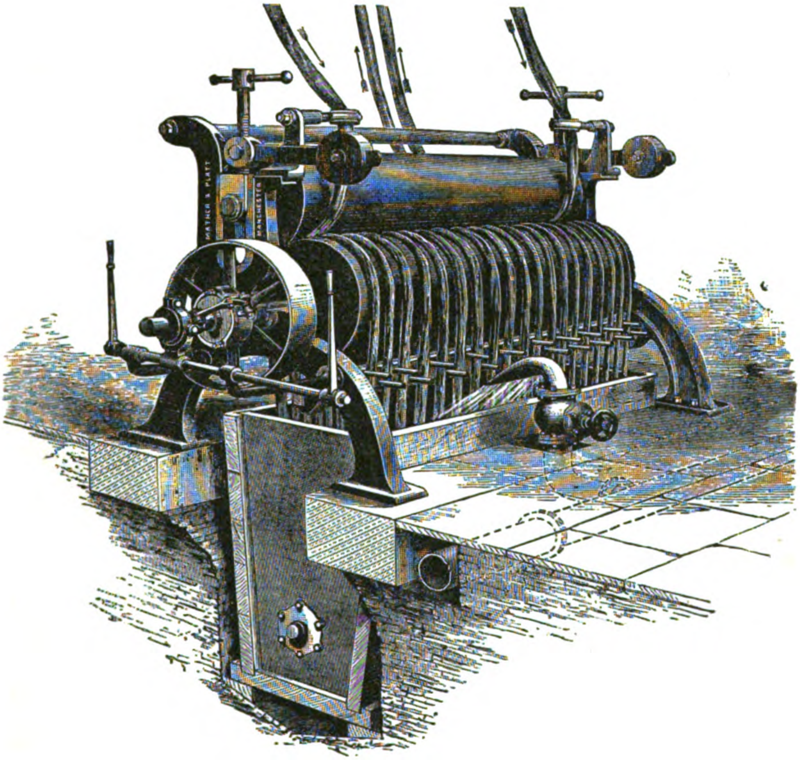


Fig. 44.—Bleach-house washing machine (Mather & Platt).

After the expiration of the time specified the liquor is run off, and the goods boiled again with a solution of soda ash only, using about half as much as was required in the first ley boil.

The use of rosin soap is of great importance in bleaching for printing and dyeing in the madder or dyed style, the whiteness and purity of the white parts of the print after dyeing depending upon its proper use. The whole of the fatty impurities contained in the cloth should, in the two ley boils, be converted into soaps soluble in the boiling liquor; any small quantity of mineral oil that may have been present in the cloth should be removed by emulsification with the soapy liquor, and, after the cloth is washed, there should be nothing left on it but the colouring-matter, which the chemic will remove.

From the kiers the pieces now pass through a washing machine, and are then ready for chemicking.

Chemicking.—The bleaching proper is accomplished by treatment with a solution of bleaching powder, or chemic, of about 1° to 2° Tw.

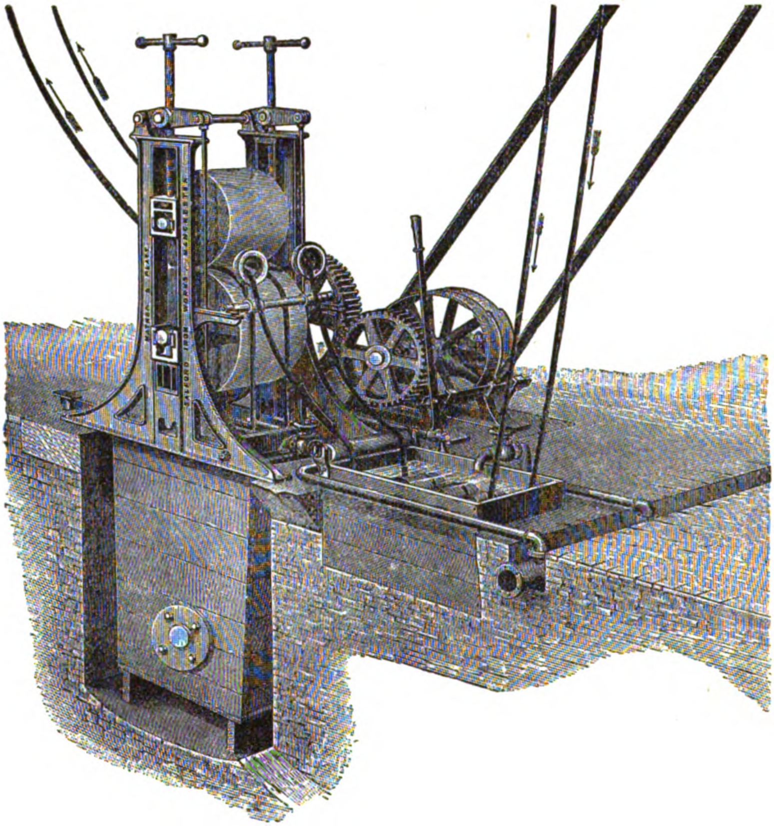


Fig. 45.—Squeezing machine (Mather & Platt).

in strength, applied to the pieces in the apparatus shown in Fig. 44. The bleaching powder should be mixed with some of the water to be used for its solution and allowed to settle, and the clear liquor diluted until it is of the proper strength, as tested by the hydrometer. If there are any solid particles in the liquor and they get on the pieces, the cloth is likely to be tendered, or the place may show up during printing or dyeing, as the cloth may be oxidised into oxycellulose, which has a greater affinity for some dyestuffs than ordinary cotton.

The cloth, after being impregnated with the chemic, is plaited down on the stone floor in a pile, covered up with cloth and allowed to remain over night, care being taken that none of the exposed parts of the cloth are allowed to dry; for this reason they are generally piled in a part of the croft where it is cool, and where the sun will not shine on them. The cloth is liable to become tender if the chemic dries on the piece. The bleaching action of the chemic takes place chiefly while the cloth is in the pile, and is completed when it is passed through the white sour.

Next morning the goods are run through (1) a washing machine; (2) a solution of sulphuric or, preferably, hydrochloric acid, standing at 2° Tw.; (3) two washing machines; (4) the water tank of the squeezer, Fig. 45, through which a stream of water is constantly passing in a direction the reverse of that in which the piece is going; (5) the squeezer itself; (6) the water again; and (7) the excess of the water is taken out by again passing them through the bowls. The cloth is then finished so far as its treatment in the croft is concerned, the final drying being done in another room.

Bleaching by the Use of the Mather Steamer Kier.—The Mather kier is gradually finding its way into all calico printing works; nearly all the larger works and the more enterprising firms are using it at the present time. The chief advantage arising from its employment is greater speed combined with economical working.

The principle upon which the kier is designed is to subject the cloth, saturated with the scouring liquor, to the action of steam under pressure, the cloth being kept wet with the liquor by causing the latter to be constantly showered over the cloth, the circulation being effected by the employment of a centrifugal pump. The liquor falling on the top of the cloth gradually percolates through the cloth, and finds its way to the bottom of the kier, when it is again lifted by the pump and showered over the goods. This process goes on continually while the boiling is taking place and the pump working. This kier is shown in Fig. 46. The kier is made in the form of a large boiler with curved ends, and is constructed of wrought iron. One end, which serves as the door, is made wedge-shape in section, and can be raised to clear the front opening of the kier by means of a chain passing over pulleys situated above and worked by hydraulic power. The grooves in the framework of the kier into which the door slides are also made to taper towards the bottom, so that when the door is completely lowered it is jammed tight against the front of the kier, and is further secured with bolts, forming a steam-tight junction with the body of the kier. The pieces are packed into waggons made of iron, and having perforated bottoms. These waggons run on rails laid in the places required about the croft, and connected with rails fixed on the false bottom of the kier. The waggons are moved from place to place by means of a chain, which is twisted round revolving capstans placed in convenient parts of the bleach-house. The kier is generally made long enough to take two of these waggons, end to end. A steam gauge is fitted to the top of the kier to indicate the actual pressure in the kier at the time of working. Pipes connected with the liquor tank and water tank are provided so that either can be turned on at will. The other details of its construction can be seen from the figure, where P is the pump

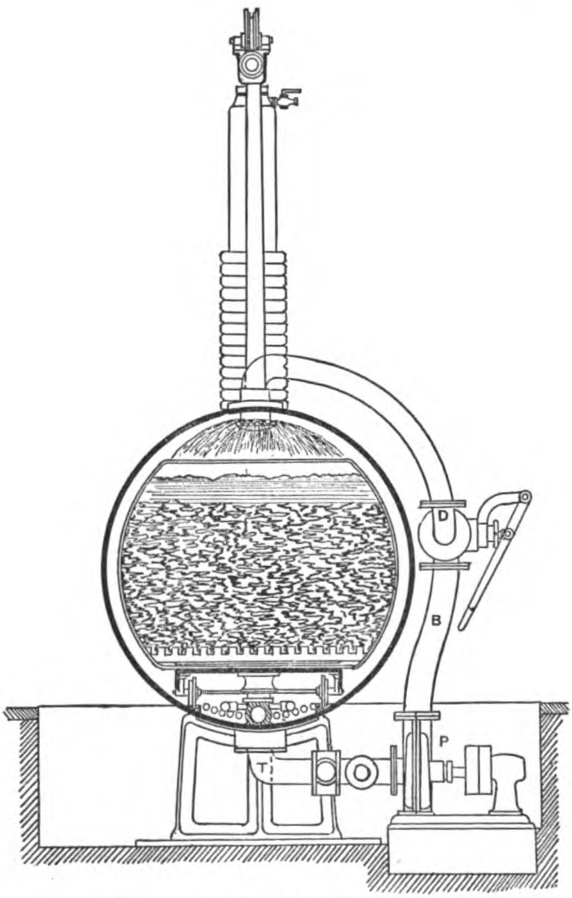


Fig. 46.—Section of the Mather kier.

which lifts the liquor that has drained to the bottom of the kier up the pipe B, and showers it over the cloth in the waggons, the liquor collecting at the bottom of the kier being kept at the proper heat, either with a closed or open steam pipe.

The following method of bleaching may be taken as a good example of the process in use on the large scale as practised at the present time in works using the Mather kier :—

1. Singe.
2. Wash through one washing machine.
3. Sour through sulphuric acid at 2° Tw., and allow to lie in pile for a period not shorter than five hours and not longer than forty-eight hours.
4. Wash through two washing machines.
5. Squeeze.
6. Run through caustic soda at 2° Tw. and fill into waggons.
7. The waggons having been filled with cloth, the goods are carefully covered over the top with covering cloth, which acts as a filter for the liquor each time it is showered over the goods and prevents the top layers from becoming stained. They are then run into the kier, the door lowered, and the air expelled by the admission of steam. The necessary quantity of scouring liquor is allowed to enter the kier from the liquor tank and the boiling, or rather steaming, and circulating commenced and continued for a period of about eight hours. The scouring liquor is generally composed of a mixture of soda ash, caustic soda, and rosin soap, a good proportion being—

Liquor for Mather Kier.

Soda ash,	90 lbs.
White caustic soda, 70 per cent.,	120 ,,
Rosin soap,	220 ,,
Water,	1,300 gallons.

After the treatment with the soda ley the liquor is run off, and the goods, while still in the kier, scalded with boiling water, in the same manner as the soda was applied, for one to two hours.

8. The goods are now cooled, the waggons withdrawn from the kier, and the pieces sent through one washing machine.
9. From the washing machine they pass direct over winces to the chemic machine, are impregnated with chemic at 1° to 2° Tw., and are laid in pile over night.
10. Next morning, or after the expiration of at least twelve hours, the pieces are passed through one washing machine, through the souring machine, then through two washing machines, squeezed, and are then sent for drying.

The above process answers perfectly well for cloth intended to be printed and treated in the steam style, or for topical colours generally, and which has not been used for back-greys in printing; but for the latter and for all goods intended for dyed styles it is usual to treat the goods, in the ordinary form of kier, with milk of lime as in the old process, using it between the operations marked 2 and 3, and washing through two machines before souring.

The machine used for opening out the cloth to the full width and drying it will be found described in Part I.

An entirely new departure in the methods of bleaching cotton piece goods has been introduced by Messrs. Bentz, Edmeston, and Grether, the apparatus being made by Messrs. Edmeston & Sons, Salford.

The principle upon which this process is based is that the detergent action of the scouring liquors used in bleaching is increased by submitting the piece saturated with the scouring liquor to the action of steam under more or less pressure. The chief difficulty in effecting this in practice is that the fibre is liable to become more or less oxidised, and there is also the liability of the cloth becoming dried in places while in the steam, producing tender places, and, in some cases, "mercerised" cotton. All these objections appear to have been over-

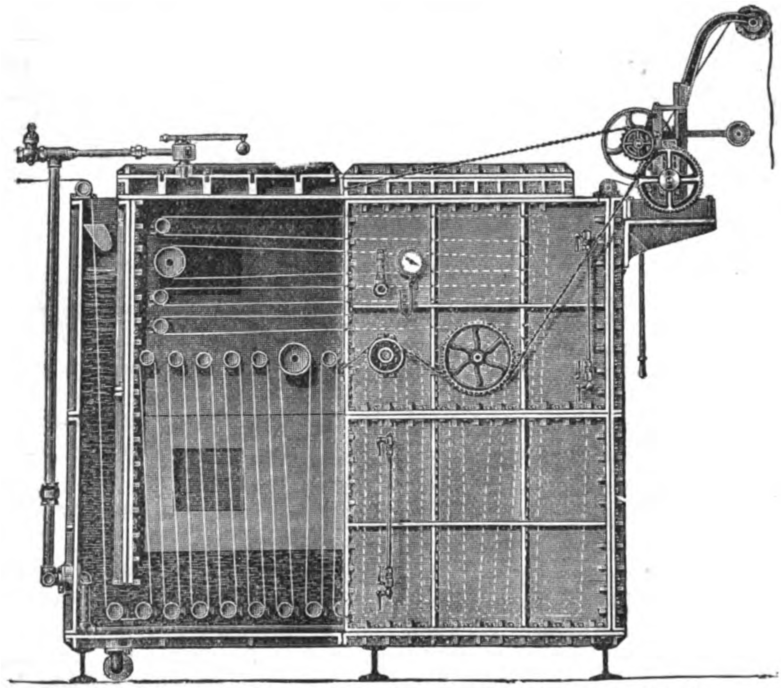


Fig. 47.—Bentz-Edmeston bleaching kier (A. Edmeston & Sons.)

come by the system now under consideration. The saturating and steaming kier is shown in Fig. 47, and we extract the following description from *The Textile Manufacturer*, vol. xvii., p. 43, as we have had no practical experience in the use of the kier:—

"From the illustration it will be seen that the kier is rectangular in shape, and divided by two partitions which reach to within 9 inches of the bottom into three compartments, the first being the entrance chamber, the second the steaming and saturating chamber, and the last the exit chamber. The two latter chambers are fitted with metal rollers for squeezing the cloth in its passage.

"The second, or saturating and steaming chamber, is fitted with a steam boiling arrangement in the bottom where the liquor is retained, and a steam supply pipe to the upper or steaming part of the chamber. The action is as follows:—When the liquor is boiled and the steam turned on through the upper pipe into the chamber, the pressure rises and the liquor is forced to a higher level in the entrance and exit chambers, according to the pressure desired. The height and pressure are regulated by an escape and reducing valve, and when the liquor is boiled and the steam turned on, the cloth is run through the kier continuously without a stop.

"The kier is supplied with the liquor from two cisterns placed at a higher level than the kier; as the cloth passes from the final squeezing rollers the liquor is discharged into a receiving trough and conveyed, by a pipe, back to the entrance part of the chamber. The saturating and steaming chamber proper is divided into two compartments by a partition rising from the bottom, up above the liquor level; thus the fresh liquor is worked up in the exit end of the chamber, and the expressed liquor passed to the entrance end of the same.

"There is also an arrangement for receiving the let-off liquor, and this can be precipitated and the top liquor used again as long as practicable.

"The principle here adopted of saturating and steaming has been shown to give the best result for rapidity, and being exposed to a low pressure only, the best results also are obtained as regards the strength of the cloth bleached. The method has the further very important advantage of being continuous, and the cloth being presented to the action of the alkaline reagents and the steam in the open form, there is thus ensured a greater regularity and intensity of action which is not attained when the cloth is treated in bulk.

"In connection with the kier a very complete form of plaiting down apparatus, which places the cloth evenly into storage boxes, is used.

"We have had an opportunity of inspecting one of these machines which has now been continuously at work at Messrs. Peter Reid & Sons, Pendleton, for some months, running four pieces at a minimum speed of 30 yards per minute each piece, and the results are such as to leave no doubt whatever as to the efficacy and economy of the system. The goods we examined in the making-up room were equal to the highest class of work in their respective styles. Amongst others we were shown samples of calico-printers back-greys bleached by this method for the dyed style. This difficult operation had been accomplished as successfully as by the old process. Another marked feature of the new process is the entire absence of stains, a defect of frequent occurrence when boiling is done in the bulk."

There are other processes, such as the Mather-Thompson process, which are used to a very limited extent on the large scale at present; as also others of a more or less experimental nature, which will be found described in the recent books treating specially of bleaching and in the technical press devoted to dyeing.

CHAPTER II.—SECTION I.

THE STEAM STYLE: THE PIGMENT COLOURS.

The shades printed in this style are obtained from insoluble pigments or lakes, which are mixed with the thickening material to allow of them being printed on the machine; this thickening is generally of such a nature as to fix or cement the particles of the pigment to the face of the cloth. The actual fixing is usually accomplished by submitting the printed and dried pieces to the action of steam, which renders part, or the whole, of the thickening material insoluble in water, thus binding the pigment to the fibre and rendering it incapable of being washed away by water.

This style is the simplest of all, as the colours are already prepared for the printer and their application is merely a mechanical operation, so far as the printer is concerned, the fixation of the colours depending on the physical properties of the thickening and binding material employed. There is, therefore, no necessity for any preparation of the cloth before printing, beyond the usual bleaching necessary to obtain a pure white ground; hence, for this style, any system of bleaching which ensures the latter condition may be used, because the shades are not influenced by the presence of invisible metallic or other impurities which would totally unfit it for the "Madder style."

The thickening and binding agent generally employed for the ordinary pigment colours and lakes is albumen, either in the form of blood or egg albumen, the former being principally used on account of its low price, the latter only for very pale and bright shades.

Blood albumen is sold in the form of dark brown flakes or scales, which emit a disagreeable odour. Some samples are almost wholly insoluble in water, and are, therefore, useless to the printer; nearly all samples contain more or less insoluble albumen, often the result of drying at too great a heat; consequently, before purchasing, the blood albumen should be tested for insoluble matter in the following manner:—One ounce of each sample should be placed in a test tube, capable of containing about 100 cubic centimetres and 70 cubic centimetres of cold water added. The contents of each tube should be occasionally stirred with a wooden rod (not a glass rod, as it is liable to break the tube) during about twelve hours, or until it is judged that all the soluble matter has passed into solution, after which, the whole set of tubes should be allowed to stand over night for the insoluble matter to subside. Next morning it will be noticed that the various samples show very different quantities of insoluble matter, and that the clear liquors in the upper part of the tubes vary considerably in viscosity. From the comparative proportion of insoluble matter, as regards both weight and bulk, and from the viscosity or thickness of the clear liquor, a very good idea of the value of the various samples can be obtained.

A solution of blood albumen is generally of such a dark colour that were it used alone the brilliancy of many of the colours would be considerably reduced; on this account, egg albumen was formerly largely used for bright shades. Printers have, however, of late years adopted a process for the partial bleaching of blood albumen which renders it capable of being used for a far larger number of colours than formerly, and at the present time the more expensive egg albumen is used only to a very limited extent.

The bleaching of blood albumen is generally done in the colour shop when the stock albumen thickening is prepared, the bleaching agent employed being either turpentine or rosin spirit, preferably the latter, on account of its price. To accomplish the bleaching, all that is necessary is to add the rosin spirit or turpentine to the dissolved blood albumen, and allow the mixture to stand for some hours. The following is an example of a bleached stock solution of albumen from which many of the pigment printing colours are prepared :—

Albumen Thickening.

2 gallons water,
8 lbs. blood albumen.
Dissolve, and add gradually, stirring the whole of the time,
1 gallon of turpentine or rosin spirit.

The turpentine or rosin spirit not only bleaches the albumen, but prevents that frothing of the colour in the colour box of the printing machine to which all pigment colours are liable, giving rise to bare or "unsolid" printing.

The above stock solution of blood albumen is used for the preparation of the dark shades of the printing colours, from which all the paler shades are prepared by reducing the strength with more thickening. On account of the expense, and further, on account of the fact that the strong stock solution still possesses some colour, and that where there is a less proportion of pigment in the printing colour a smaller quantity of albumen will serve for its fixation, the reduction is generally made with a thickening prepared from a mixture of the bleached blood albumen and a solution, or rather paste, made from gum tragacanth or dragon as follows :—

Reduction for Pigment Colours.

1 gallon blood albumen stock solution,
1 gallon gum dragon thickening (5 ozs. per gallon).

The gum dragon thickening is added in order to preserve the necessary viscosity of the printing colour demanded by the conditions required for its application on the printing machine.

In those few cases where it is necessary to use egg albumen, the same method can be employed as described for blood albumen, using only sufficient rosin spirit to prevent the colours frothing in the colour box.

Caseine, the chief nitrogenous constituent of milk, is now very little used for fixing pigments on calico, its chief use in this connection being when silver and gold prints are printed with the various bronze powders and precipitated tin, and are afterwards calendered to bring up the lustre. The caseine is dissolved in a solution of borax before mixing it with the pigments.

The pigments used for printing are comparatively few in number, the various shades of ultramarine, lampblack, ground indigo, vermilion, chrome orange, chrome yellow, pigment brown, chrome green, and the various lakes prepared by the printer himself, or sold for the purpose, being chiefly employed.

Ultramarine is obtainable in a large number of shades varying from a pure blue, through violet to pink or rose shades. As a general rule, the intensity or covering power of the ultramarine depends upon the shade; the bluer shades being the most intense, the pink and rose shades being the most deficient in covering power. The ultramarine supplied to printers is usually so well ground or levigated as to cause no inconvenience from scratching of the printing rollers, but, before a fresh lot is purchased, it should always be tested for grit by working some of the ultramarine into a paste with water, placing a little of the paste on a glass plate, and then rubbing with another glass plate in a circular manner. If there is any grit between the glass plates, and, consequently, in the colour, its presence will be indicated by the scratching which will be felt to occur between the plates; and if the latter are afterwards washed and dried, the scratches will be shown on the surfaces of the two plates. All pigments should be tested, before purchase, for grit in the above manner.

Before the powdered ultramarine is mixed with the blood albumen it should be well mixed, or ground up, with some crude glycerine, so as to form a thin paste, in which condition it will the more readily mix with the albumen thickening. Sometimes the pigment is ground into a paste with Gallipoli oil, and afterwards the paste thinned with rosin spirit before mixing with the albumen solution; this method is said to yield shades having more "bloom."

Lampblack is sold both in the paste and powder form. If it is in the dry condition, it should be prepared for printing by mixing it with glycerine until it forms a thin paste; after which the thickening can be added.

Ground indigo paste, as used for preparing either the indigo vat or indigo for printing, serves as a pigment in the preparation of slate shades, &c. The indigo should be ground in "the roller indigo grinding machine," as the high speed of "the ball indigo grinding machine" is liable to contaminate the resulting paste with particles of metal, detached from the grinding balls, which scratch the engraved copper printing roller. The shade of the indigo paste depends upon the quality and kind of indigo used, the low qualities being of a duller and blacker shade than those containing a larger percentage of indigotine. The paste is generally stocked for use of 25 per cent. strength —*i.e.*, it contains 25 per cent. of solid matter.

Vermilion is a sulphide of mercury; it varies to some extent in shade, some samples being brighter than others. It is liable to adulteration with cheaper substitutes, but these can easily be detected by ignition; vermilion, if pure, should volatilise entirely or leave merely a trace of ash, while most of the adulterants are not volatilised by heating. Vermilion is an expensive colour, very heavy, and requires about 10 lbs. per gallon of printing colour to give a good full shade; consequently, it is used only for small parts of patterns.

Chrome yellow is sold or prepared for printing in the form of a stiff paste, and is made in several shades, from a lemon to a full yellow colour. The deeper shades consist of chromate of lead, while those of a paler hue often contain both chromate and sulphate of lead. The colour is mixed with albumen, for printing, along with a small quantity of cadmium nitrate. The cadmium nitrate is added to the printing colour to prevent the chrome yellow from darkening, thus preserving the purity of its colour. The action of the cadmium salt is easily explained. During the steaming, to which the pieces are subjected after printing, the albumen on the cloth is not only coagulated, but partially decomposed, the decomposition being accompanied with the liberation of some sulphuretted hydrogen gas. If the cadmium salt were not present, some of the sulphuretted hydrogen gas would combine with chromate of lead and form a black sulphide of lead; this, mixed in small proportions with the colour in the piece, would destroy the brilliancy of the shade. The cadmium salt has, as it were, a selective influence, combining with sulphuretted hydrogen before it has time to affect the lead on the piece, and the sulphide of cadmium formed, being of a yellow colour, does not affect the shade of the chrome yellow to any appreciable extent.

Chrome orange is a basic chromate of lead, and is generally sold in the form of a paste. It is used in the same way as chrome yellow, cadmium nitrate being added to the colour to prevent darkening during steaming.

Pigment brown, pigment buff, and chrome green are usually met with in the form of very thick pastes, and are ready for mixing with the albumen solution for printing.

There are many other pigments that are more or less used in this style; for, in fact, any pigment that can be ground or levigated into a fine state of division can be employed, but the above are those principally used.

In addition to the ordinary pigments there are, in commerce, many lakes, prepared from colouring-matters of both natural and artificial origin, which are sold under various names and generally in the pasty condition. Some of these, especially the pink and vermilion shades, are very fugitive to light, as they are prepared from the resorcine dyes. There are, however, several dull red and claret shades that are quite fast to light, these are prepared by mixing solutions of β-naphthol with solutions of various diazotised amines.

Many of the basic coal-tar colours may be used for the preparation of lakes for pigment printing; they yield some useful and practically fast colours. These colours are precipitated by means of solutions of tannic acid and tartar emetic, the proportions of the various ingredients being found by practical trial, as they vary with each particular colouring-matter. Perhaps one of the most useful lakes is the yellow one obtained from auramine, as it is free from any tendency to darken on steaming, and is of a more primrose shade than chrome yellow. This lake can be prepared in the following manner; it will serve as an example for the preparation of other lakes from the various basic colouring-matters :—

Auramine Lake.

Auramine,	1 lb.
Tannic acid,	1½ lbs.
Tartar emetic,	1 lb.

Dissolve each of the above separately in water, then mix the auramine and tannic acid solutions together, and add gradually, stirring all the time, the solution of tartar emetic. After standing for a short time the mixture should be poured on to a fine cloth filter and the paste washed twice with cold water, after which it should be allowed to drain until of the standard consistency.

We will now give some practical recipes for printing the pigment colours, merely drawing attention to the fact that many of the shades used in the print works are obtained by mixing several pigments together, as it would only unnecessarily multiply the number of recipes were we to give examples of these mixtures. In this connection it is useful to note that colours prepared with the ultramarines are extremely sensitive to acids, which discharge the colour; hence it is impossible to mix them with colours that are of an acid nature, or contain acid salts in their composition. Ultramarine should also never be printed on the same piece alongside a colour which will evolve acid fumes during steaming, or the ultramarine adjacent to this colour will probably be partially or wholly discharged.

Vermilion.

10 lbs. vermilion, ground to a paste with crude glycerine, and mixed with
1 gallon blood albumen thickening.

Orange.

1 gallon chrome orange paste,
3 gallons blood albumen thickening,
4 ozs. cadmium nitrate.

Yellow.

1 gallon chrome yellow paste,
3 gallons blood albumen thickening,
4 ozs. cadmium nitrate.

The cadmium nitrate in the last two recipes should be dissolved in a small quantity of water before adding it to the colour.

Primrose Yellow.

1 gallon auramine lake paste,
3 gallons blood albumen thickening.

Ultramarine Blues and Violets, and China Blues.

6 lbs. pigment in powder; work into a paste with glycerine, and add, gradually,
1 gallon blood albumen thickening.

Buff.

1 gallon yellow ochre paste (buff paste),
4 gallons blood albumen thickening.

Green.

1 gallon chrome or Guignet's green paste,
6 gallons blood albumen thickening.

Brown.

1 gallon pigment brown,
6 gallons blood albumen thickening.

Black.

6 lbs. pigment black paste,
1 gallon blood albumen thickening.

Grey.

4 lbs. lampblack, worked into a paste with brown glycerine, then add
1 gallon of blood albumen thickening.

In preparing these colours the pigment, made or bought ready prepared in the form of a paste, should first be placed in a colour tub and stirred with a wooden paddle until quite homogeneous. The thickening should then be added in small portions at a time, stirring between each addition, and not adding more thickening until the last portion has been thoroughly mixed, and the colour appears quite smooth and even in consistency. When the pigment paste is very stiff the thickening must be added in very small quantities at first, otherwise the finished colour will be lumpy or rough and a large portion of the pigment will remain in the straining cloth when the colour is strained. As the paste becomes thinner in consistency the thickening can be added in larger quantities at a time.

Paler shades than those given above are prepared from these stock or standard colours by mixing them with more or less of the reduction given on p. 95.

The colour is generally supplied to the engraved copper roller on the printing machine by means of a brush furnisher, and as these colours contain large quantities of suspended matter there is some difficulty in forcing the colour into the deeper parts of the engraving; for this reason the furnishing brush roller is revolved against, or in the reverse direction to, the printing roller. This causes the colours to froth in the box; any inconvenience from this cause is avoided, in practice, only by the liberal use of resin spirit in the printing colour. If the frothing of the colour in the colour box becomes excessive the result is shown in the print obtained from the roller, the impression being weak or bare.

The cloth requires no preparation to develop the colours with this style, and when pigment colours only are to be printed it is used just as received from the bleach-house; but it very often occurs that other steam colours, requiring the cloth to be prepared with oleine, are required on the same piece, and as this does not affect the pigment colours, they may be printed on cloth so prepared. Where it is possible to do so, and in those cases where the piece is chiefly printed with pigment colours, the requisite quantity of oleine is added to the printing colour to save the trouble and expense of preparing the whole of the cloth. An example of this method may be seen in some recipes for steam alizarine red, but colours so prepared usually have the disadvantage of spoiling when stocked for a few days.

The pieces are usually steamed twice through the continuous steamer, or for an hour in the cottage steamer under low pressure. Pieces printed with ultramarines should not be steamed along with pieces evolving acid vapours, which will decolorise ultramarine; should any pieces of this description have passed through the steamer, sufficient time should be allowed for the steam inside the chamber to be renewed before they are allowed to enter. Similarly, pieces printed with lead salts, or colours liable to be soiled by sulphuretted hydrogen, should never be allowed to immediately follow pieces printed with albumen, as some of this gas is given off from the pieces when they are steamed.

After steaming, the pieces are often finished straight away, but in other cases they are washed or soaped by passing them through the open soaper. While the goods are running through the open soaper care should be taken that they pass through in the open or full width; if creased or turned at the edges the goods will show these places when delivered off the drying cylinders.

Goods printed with pigment colours always have a harsh feel, because the whole of the thickening—or rather the albumen contained in it—remains on the cloth when the print is finished. On this account the pigment colours are used generally for patterns of small size.

SECTION II.

STEAM STYLE: MINERAL COLOURS FORMED DURING STEAMING.

THESE colours, formed upon the fibre during the processes of steaming, do not differ from the pigment colours in composition, but in the fact that they are produced *in situ* on the tissue; they do not exist before printing.

Steam Colours—Prussian Blue.—Formerly the blue colour produced by the decomposition of ferrocyanides or ferricyanides, or mixtures of these two salts, under the influence of steaming in the presence of acid or acid salts, was largely used for obtaining blue shades upon cotton piece goods; but owing to the superior fastness, especially to soaping, of the newer colours, their use is now extremely limited; this property of these salts being used now chiefly as a means of altering the shade of other colours—*e.g.*, brown or chocolate shades are often obtained by the admixture of the Prussian blue so produced with the shades obtained from alizarine.

The following recipe will illustrate the method of preparing a printing colour to obtain a blue shade in this way:—

Steam Prussian Blue.

1 gallon water,
¼ lb. oxalic acid,
¼ lb. powdered alum,
1½ lbs. ferrocyanide of potash (in fine powder),
1 gallon thick British gum thickening.

The cloth requires no preparation previous to printing, and the colour is developed by steaming.

The shade can be altered by adding a little oxide of tin paste to the printing colour.

When it is desirable to change the shade of an alizarine steam colour, the ferrocyanide of potash (yellow prussiate) is added to the printing colour and the decomposition, and formation of the Prussian blue, occurs in the process of steaming by the action of the acid bodies in the colour or liberated in the steamer. Colours so produced are, however, not fast to soaping, and are not to be recommended.

Steam Yellow—Chrome Yellow.—Chrome yellow can be applied as a colour of this class, the chromate of lead being produced by the double decomposition which occurs between a mixture of chromate of barium and nitrate of lead when steamed.

The following recipe is given by Sansone in his book on printing:—

Steam Chrome Yellow.

5 lbs. gum tragacanth paste,
4 lbs. lead nitrate; dissolve; cool; and add
10 lbs. chromate of barium paste, 50 per cent.

Chrome Orange.—Chrome orange can also be produced in the same manner by altering the ingredients of the colour, as shown in the following recipe, which we take from the same source:—

Steam Chrome Orange.

5 lbs. thickening,
5 lbs. nitrate of lead,
7½ lbs. acetate of lead,
15 lbs. chromate of barium, 50 per cent.

SECTION III.

THE STEAM STYLE: THE MORDANT COLOURS.

THIS style is very often termed the "extract style," because, before the introduction, or, at any rate, the universal use of artificial alizarine and the various other allied colouring-matters, the extracts or decoctions of the various natural colouring-matters, dyewoods, and preparations were chiefly used in this process.

The colours used for printing the cloth are composed of the colouring-matters and the mordants, along with, in many cases, other chemicals that are used either to assist in the combination of the colouring-matter with the mordant, increase the brilliancy of the resulting shade, or prevent the immediate combination of the colouring-matter with the mordant. This latter condition is necessary because, if the insoluble colour lake is formed in the printing colour before it is printed, all the insoluble portion so formed will detach itself when the pieces are washed, and the shade will be flat and deficient in depth.

The colouring-matters used are generally possessed of little colour themselves, but yield insoluble colour lakes when in combination with metals, and the shade obtained generally varies with the particular mordant employed—for example, alizarine printed with an alumina mordant yields a red shade; with a chrome mordant a claret shade; and with iron a purple or purple-black shade.

In addition to the extracts of the natural dyewoods, tannins, &c., there is a large range of anthracene and alizarine colours which, used with alumina, chrome, and iron mordants, and modified in tone by the addition of tin and other metallic and organic bodies, yield a very large number of shades, which are further extended by combining several of the mordants and colouring-matters in the same printing colour.

Previous to the cloth being printed, but after bleaching, it is prepared with a weak solution of oleine. The oleine prepare is made in vats fitted with stirrers working in a similar manner to the stirrers fitted to colour pans. To prepare 100 gallons of oleine prepare, 7½ gallons of oleine are put into the empty vat, the stirrers started, and water from a tap above allowed to run, very slowly indeed, into the oleine, until the vat is filled to the 100 gallon mark. It is necessary to run in the water very gradually or it will not mix thoroughly with the oleine, and this would cause the pieces to be unevenly prepared.

The oleine used should contain 40 per cent. of fatty acids, and when the prepare is finished it should stand at $\frac{1}{2}°$ Tw.

The cloth having been bleached and dried, is passed through the oleine prepare, squeezed and dried on the machine described on p. 61; after which it is sheared and wound on centres ready for printing.

In some works the goods are passed, immediately after bleaching and before drying, through the oleine prepare; but this method is not to be recommended, as it is liable to cause the cloth to become unevenly prepared, the liquor in the box generally increasing in bulk and being diluted by the water expelled from the pieces as they pass between the squeezing rollers.

We will now deal with the most important colouring-matters used in this style, and show (1) how they are used, and (2) the colours they yield when printed with the various mordants that yield shades of practical utility.

Logwood.—Logwood is purchased by the calico printer in three forms—viz., in chips; in the form of a thick liquid, called "logwood extract;" and as a thin liquid called "logwood liquor." Sometimes it is purchased in the form of a solid extract of a dark brown colour having a peculiar lustre. The chips are used for dyeing the "dyed styles;" and the other forms are used for printing.

For the purpose of preparing printing colours for steam work, the liquor is by far the most suitable form to use; so that, if the printer has the necessary space and convenience, it is better to prepare it from the chips in the works, as it is then in a purer condition than when purchased ready made.

Logwood liquor gives much better shades than the extracts in the more concentrated forms, as a considerable amount of the colouring-matter is oxidised and rendered thereby more or less useless to the printer during the process of concentration, even when done in vacuum pans. The thick extract will always be found to contain a large quantity of a dark tarry substance, which separates out when the extract is diluted; if this finds its way into the printing colour, it will show up as dark stains, unless the shade is so dark as to hide them.

The liquor should be stocked of such a strength as to show 12° on the Twaddle scale.

When logwood is used for printing in the steam style, the mordant used with it in the printing colour is generally chrome, along with a substance which, on steaming, has an oxidising action. The iron mordant is chiefly used in the dyed style, but occasionally in the steam style. The oxidising agent is generally chlorate of soda, sometimes mixed with ferricyanide of potassium or red prussiate of potash.

Logwood is rarely used alone, the shade given being of too blue a tone; on this account it is generally mixed with some bark liquor to produce a more neutral shade of black or slate.

We give below two recipes for blacks, and one recipe for a slate shade, which will illustrate the remarks just made:—

Logwood Black.

10 lbs. Indian corn starch,
2 lbs. tapioca flour,
1½ gallons acetic acid, 12° Tw.,
7 gallons logwood liquor, 12° Tw.,
1 gallon bark liquor, 12° Tw.,
3 pints Gallipoli oil.
Boil well; cool; and add
42 ozs. chlorate of potash.
Cool; and then add
2 gallons acetate of chrome.

The acetate of chrome in this recipe may be replaced by sulphocyanide of chrome, or, better, with a mixture of equal parts of the acetate and sulphocyanide of chrome.

Logwood Black.

Another black of a slightly different shade is obtained by the addition of
2¾ lbs. red prussiate of potash
to the above colour.

Logwood Slate.

2 gallons acetic acid, 12° Tw.,
2 gallons logwood liquor, 12° Tw.,
½ gallon bark liquor, 18° Tw.,
5 lbs. starch.
Boil; then add
6 ozs. chlorate soda.
Cool; and add
½ gallon acetate of chrome.

For very many styles where logwood black was formerly used it has been replaced to a very large extent by aniline black.

Quercitron Bark.—Quercitron bark generally finds its way into the print works in the form of a thick extract, which, however, varies considerably in quality, according to the maker. Generally, the shade given is rather dull, but there is at least one brand which gives remarkably bright and pure shades, being prepared by a process apparently known only to one or two firms. The process seems to be one of purification, or a method of extraction which enables the useful colouring principle to be obtained without extracting those bodies which have the effect of dulling the shade. From these two varieties of bark extract we can, by the same method of application, obtain two different shades, one being considerably brighter than the other. We shall refer to these two varieties as *refined* and *common* bark extract in the recipes which follow.

Quercitron bark is used chiefly with acetate of chrome as the mordant, and yields dull yellow to gold shades. It is extensively used, along with alizarine orange and acetate of chrome, to produce several shades of brown and for mixing with many other colours used with the chrome mordant; in fact, this is its chief use. To allow of the bark colour being added to both starch colours and colours made with British gum, it is usual to make up two standard colours with each kind of bark extract, thickened with starch paste and British gum respectively. The standard colours keep well and are used for making up a very large number of shades.

In addition to the bark extract, thickening and acetate of chrome, a certain proportion of acetic acid is nearly always added to the printing colour, to increase the length of time which the colour will keep in good condition.

The following are examples of some colours and standards, to which reference will be made when recipes for colours made from mixed colouring matters are given :—

Gold.

1½ gallons water,
25 lbs. British gum,
4½ gallons refined bark liquor, 12° Tw.,
Boil well; cool; and add
1 gallon acetate of chrome.

Bark Standard No. 1.

1½ gallons common bark liquor, 12° Tw.,
1½ gallons British gum thickening, 10 lbs. per gallon.
Mix well, cold, in a tub, and add
½ gallon acetic acid, 12° Tw.,
½ gallon acetate of chrome.

Bark Standard No. 2.

This is prepared in the same way as No. 1, but the refined bark liquor is used instead of the common kind, and thus it yields a brighter shade.

The two standard colours just given are both gum colours, or colours thickened with British gum, and these are used for mixing with colours thickened with the same thickening material. In addition to the above, two standard colours thickened with starch are required, to use along with starch colours.

The two following recipes show how the bark is used with a starch thickening :—

Bark Standard No. 3.

3 gallons water,
½ gallon acetic acid, 8° Tw.,
6 lbs. Indian corn starch,
1½ lbs. tapioca flour,
3 gallons common bark liquor, 12° Tw.
Boil; cool; and add (when quite cold)
½ gallon acetate of chrome.

Bark Standard No. 4.

This is made according to the recipe given for No. 3, using refined bark liquor instead of the common liquor.

Quercitron bark can also be printed with other mordants, but the shades produced are of little practical utility. Perhaps the most useful are those produced with a tin mordant; but they are fugitive and not so bright as those obtained from Persian berries.

Persian Berries.—Persian berries are, like quercitron bark, usually sold to the printer in the extract forms, made in two qualities, common and best quality, the latter giving the brighter shades. The quality of the various samples, even of the same description of extract, varies considerably, and all samples should be tested before purchase against those in use. This testing is best done by preparing two small batches of printing colour, using chrome as the mordant in one colour and tin in the other, following, on the small scale, the recipes given below. The colours should also be reduced with thickening to give several shades from each sample, as slight differences are more readily perceived in light shades than in dark ones. The colours are then printed on the same fent off the doctor of the printing machine, steamed in the usual way, and run through the open soaper, treating them, in fact, exactly as the pieces will be produced on the large scale. If there are too many samples for all of them to be printed on the one fent, several fents can be used, but care should be taken that the corresponding colour from each sample is printed on the same fent, otherwise no fair comparison could be made.

The most useful shades are obtained by the use of acetate of chrome as the mordant, giving yellow and gold shades rather brighter than those obtained from the corresponding qualities of bark extract. The chrome berry colours are also used in the preparation of a large number of shades by admixture with other colours.

With alumina and tin, or a mixture of these two mordants, a very bright and pure yellow is produced, which is unfortunately very fugitive. This colour is largely used, solely on account of its shade, but it should be used as sparingly as possible (or only when compelled to do so, and then for small portions of the pattern) if it is desired to produce prints that may be considered fast.

The following recipes are for dark yellow shades prepared with acetate of chrome, and thickened with starch and gum respectively:—

Berry Yellow No. 1.

3¾ gallons common berry liquor, 16° Tw.,
¾ gallon acetic acid, 8° Tw.,
½ gallon cottonseed oil,
7¼ lbs. wheat starch.
Boil well; and, while hot, add
¼ gallon gum tragacanth thickening.
Cool; and add
¼ gallon acetate of chrome.

Berry Yellow No. 2.

3 gallons common berry liquor, 16° Tw.,
3 gallons British gum thickening.
Mix thoroughly, and add
1 gallon acetic acid, 8° Tw.,
and add, finally,
1 gallon acetate of chrome.

The British gum thickening used in this colour is made by dissolving 10 lbs. of British gum in 1 gallon of water.

If the shades given by the above two colours are not quite bright enough, brighter shades can be produced by using the better quality of berry extract.

Bright Berry Yellow.

10 lbs. British gum,
5 gallons best berry liquor, 20° Tw.
Boil; and add
6 lbs. alum previously dissolved in
2¼ gallons hot water.
Cool, and, when quite cold, stir in
4 noggins tin pulp.

Galls, Sumach, &c.—These astringents are used, along with a chrome mordant, to produce various shades by mixing them with other colouring-matters, the chrome serving to fix a dyestuff of the mordant class, while the tannic acid contained in them enables them to be used along with the tannic, or basic, colours.

Used with chrome alone the shades given are very pale, and are of a fawn or holland shade. Printed with an iron mordant, slate shades are produced of rather a brownish tone.

Examples, showing their application to the production of compound shades, will be found amongst the "Practical Recipes."

Alizarine.—Commercial alizarine is sold in the form of a yellow paste, nearly all the various manufacturers sending it out of 20 per cent. strength—that is, containing 20 per cent. of its weight of solid matter. There are several shades obtainable, varying from an alizarine yielding with an alumina mordant a bluish-red to a yellowish shade of red. The various manufacturers affix various letters to the alizarine to denote the shade, the bluer shades generally being marked B or V., and those of a yellower tone G or Y. It is, however, hardly safe to rely on these marks, and it is better to test each new sample for shade and strength against those in use. The paste should appear quite homogeneous in consistency, and should be so finely divided as to enable a colour of a very pale shade to be prepared without any tendency to form specks due to particles of alizarine. Various makes of alizarine vary considerably in the degree of fineness in which the particles of alizarine exist in the paste, and those should be selected in which the alizarine is in the finest condition. The tub or cask containing the stock of alizarine should be kept well covered up when not in use, so as to prevent the paste drying on the top, as it will be found that if the alizarine once becomes dry on the surface there will be a tendency for the colours prepared from it to be uneven, and, when in light shades, to show up in the form of specks, particularly if the colour is prepared by mixing together cold thickenings and mordants with the alizarine. This difficulty is due to the fact that when the alizarine has once become dry it is nearly impossible to restore it to the same degree of fineness of division that it had originally. The same difficulty will also be experienced in the winter time when the temperature is very low; the casks often arrive at the works in a partially frozen state, and when the ice has been melted it will be observed that the alizarine has a tendency to separate from the water in which it is suspended.

In the steam style, alizarine is principally used with mordants of alumina or chrome, salts of tin, lime, and other materials, like oleine, often being added to influence the resulting shade either in brilliancy or tone.

As will be noticed from the recipes appended, the mordants named, together with the various shades of alizarine and other dyestuffs, are mixed together to give various shades, and thus a very large range of shades are obtainable.

The bluer shades of alizarine are used for reds and pinks, the yellower shades being employed for reds and salmon shades when alumina is used as the mordant.

Chrome yields with alizarine various shades of claret, rather dull in tone, the shade depending upon the particular shade of alizarine used.

The colours given with iron mordants are purple, varying in tone according to the kind of alizarine used. Alizarine is, however, used only to a limited extent with an iron mordant in this style, but it is very largely employed in the madder style, the mordant being printed on the cloth first and the alizarine applied afterwards.

Alizarine red is produced by printing a mixture of alizarine with an alumina mordant, the sulphocyanide, or a mixture of sulphocyanide and nitrate, being generally used. In addition to the substances just named a certain proportion of acetate of lime is always employed. In many recipes for alizarine red, either olive oil or oleine will be found as one of the ingredients, being added to supply the necessary quantity of fatty acid to form the colour lake, in addition to that on the cloth before printing, and, like the latter, it has the effect of making the resulting shade both brighter and faster. The shade of red obtained varies with the kind of alizarine used, the yellower shades, often mixed with certain proportions of blue shade alizarine, being chiefly employed. For very bright yellow-toned reds the mixture of sulphocyanide and nitrate of alumina is generally used, as it is found that the presence of nitrate of alumina yields a more fiery red than any of the other alumina mordants. The presence of tin also has a remarkable effect in increasing the brilliancy of the shade; this metal is usually introduced in the colour in the form of oxalate of tin (see p. 72). Formerly acetate of alumina was very largely used for the preparation of steam alizarine red printing colours, but now the sulphocyanide is almost exclusively used, one great advantage arising from its employment being that it is not so sensitive to the presence of small quantities of iron that may find their way into the colour, either in preparation or during the printing, the presence of the merest trace of iron completely spoiling the reds made with the acetate of alumina mordant. The printing colours, in addition to the chemicals just mentioned, should also contain a certain quantity of an organic acid, acetic acid being the one usually selected, but it will be found far better to use a little tartaric acid, as this acid (not being volatile) remains on the piece during its passage through the steamer.

The following recipes are examples of colours prepared on the lines indicated :—

Alizarine Red.

11 gallons starch thickening,
4 gallons alizarine, 20 per cent.,
2 gallons oxalate of tin,
3 gallons acetate of lime, 30° Tw.,
2 gallons oleine,
1 lb. tartaric acid,
1 gallon water.

The above should be prepared and kept in stock. When required for printing, the sulphocyanide of alumina should be added in the following proportions :—

12 gallons stock colour,
1 gallon sulphocyanide of alumina.

Alizarine Red.

24 gallons starch thickening,
4 gallons alizarine, 20 per cent.,
3 gallons sulphocyanide of alumina,
1 gallon nitrate of alumina, 15° Tw.,
½ gallon acetate of lime, 30° Tw.

These two colours are made up both with starch and British gum as the thickening for use along with colours, and for patterns requiring gum or starch colours respectively; the gum colours print more solid or even, but much lighter in shade, than those made from starch; hence they are used in open blotch patterns.

Alizarine pink is made with the blue shade of alizarine, using sulphocyanide of alumina as the mordant, the following being a good recipe:—

Alizarine Pink.

23 gallons British gum thickening,
3½ gallons alizarine, blue shade, 20 per cent.,
1½ gallons oleine,
4 gallons oxalate of tin,
2½ gallons acetate of lime,
1¼ lbs. tartaric acid,
1 gallon water.

Instead of the tartaric acid, 1 gallon of acetic acid, 8° Tw., may be used.

For printing take—

12 gallons alizarine pink (as above),
1 gallon sulphocyanide of alumina.

A starch colour should also be made, using the same recipe, and be kept in the colour shop.

The lighter shades of pink are prepared from the above strong colours by adding more thickening, special care being taken to ensure perfect mixing of the colour with the thickening, adding the latter very gradually, stirring the whole of the time, and continuing for some time after the whole of the thickening has been added.

If the thickening used for reducing the shade of the pink is mixed with a little sulphocyanide of alumina, the shades obtained are considerably brighter, but there is a tendency for them to yield an uneven shade on steaming, the pieces often showing yellow patches. This increased brilliancy of shade is no doubt due to the increased proportion of sulphocyanide preventing the iron contained in the thickening from influencing the shade, and the difference is more noticeable when British gum is used for reducing the colour.

The claret shades produced with the blue shades of alizarine, with acetate of chrome as the mordant, are very largely used, not only as self colours, but also for mixing with the extremely large variety of other dyestuffs that are fixed in the same manner. When the shades are required for use in mixing, a standard colour is generally prepared, using alizarine, thickening, and acetate of chrome only. Two stock colours should be made up, one thickened with British gum and the other thickened with a mixture of starch and dragon, and these are used with other colours thickened with similar substances.

Chrome Alizarine Standard No. 1.

3 gallons British gum thickening,
1 gallon blue shade alizarine,
½ gallon acetate of chrome.

The starch colour is prepared in a similar way, using 4 gallons of a thickening prepared with a mixture of starch and gum tragacanth.

Alizarine, printed along with acetates of chrome and lime, yields a fine dark claret shade, the colour prepared with a starch thickening being the darker in shade. The following is an example of a colour made up in this way :—

Alizarine Claret.

3 gallons British gum thickening,
1 gallon alizarine blue shade,
½ gallon acetic acid,
½ gallon acetate of lime,
1 gallon acetate of chrome.

The starch colour is made up in a similar manner to the above gum colour.

When brighter shades of claret are required than those given by the use of the above recipes, a mixture of the above colours, and the alizarine red printing colour given on p. 109 is used; by varying the proportions of the two colours a variety of shades can be obtained.

The violet shade produced by using iron along with alizarine is also sometimes useful, and with this colour it is better, if possible, to print it on cloth that has not been prepared with oleine. This, however, is rarely possible if there are any other colours on the same piece which require oleine-prepared cloth.

Alizarine Violet.

8 gallons starch thickening,
1 gallon alizarine,
½ gallon acetic acid, 8° Tw.,
¾ gallon iron liquor,
½ gallon acetate of lime.

The violet produced with alizarine and an iron mordant can be brightened in shade by the addition of some methyl violet solution.

Orange Alizarine—Nitro-Alizarine.—Orange alizarine occurs in commerce in the form of a yellow paste, much lighter in colour, and considerably thinner in consistency than ordinary alizarine. It is usually sold containing 15 per cent. of solid matter.

In calico printing orange alizarine is used to a very large extent, both as a self colour along with either alumina or chrome mordants, and in a very large number of mixed shades.

With alumina, orange alizarine yields fine bright orange shades, and with a chrome mordant fine orange brown shades. The printing colours prepared with orange alizarine, especially those prepared with an alumina mordant, do not keep well when made; consequently, they should be prepared as required for use.

The following colours are generally used, thickened with starch and gum respectively, according to the character of the pattern:—

Alizarine Orange.

4 gallons starch paste,
1 gallon orange alizarine,
½ gallon sulphocyanide of alumina,
½ gallon acetate of lime.

Alizarine Brown.

8 gallons British gum thickening,
6 gallons orange alizarine,
3½ gallons acetate of chrome,
1½ gallons acetate of lime.

The shade can also be varied by the use of both alumina and chrome with the orange alizarine in the same printing colour.

Alizarine Blue S.—Alizarine blue is used by the printer as the soluble compound sold as alizarine blue S. It gives with acetate of chrome fine dark blues; when reduced in shade the blue is fairly bright and of rather a reddish tone. The chrome mordant colour is also used for making several shades of grey, the shade of the alizarine blue being turned by the addition of other colours. Alizarine blue S, when mixed with acetate of chrome in the printing colour, will not keep for many days, the colour lake being formed in the colour, and the shade when printed becoming gradually paler; hence it is the custom to prepare the stock colours without any acetate of chrome, and to add the latter just previous to use. The colour can be thickened either with gum or starch; it is advisable to add some Gallipoli or castor oil to the colour.

In preparing the colour the thickenings must be boiled and well cooled before the alizarine blue S is added; the latter should be first dissolved in cold water and the solution sieved into the thickening and well mixed. The colour so prepared is then put into stock, and when actually required the proper quantity of acetate of chrome is added to the colour and then strained.

Alizarine blue S is also printed with a zinc mordant; the sulphite being the salt generally used. The shade obtained with a zinc mordant is brighter, but not quite so fast as that obtained with chrome.

Below we give recipes for alizarine blue S with chrome and zinc mordants, and the thickenings used for these colours when either a gum or starch colour is required:—

Starch Thickening for Alizarine Blue.

30 gallons water,
50 lbs. Indian corn starch,
20 lbs. tapioca flour,
2½ gallons colour oil.
Boil well, and cool.

Gum Thickening for Alizarine Blue.

6 gallons water,
60 lbs. British gum.
Boil; cool; and add
1 gallon castor oil.

Alizarine Blue Stock Colour.

1 gallon thickening,
1 gallon water,
1½ lbs. alizarine blue S.

The thickening in the recipe just given may be either the gum or starch thickening named above. The alizarine blue should be dissolved in the water cold, then strained, and gradually mixed with the thickening. The colour so far prepared is then put into stock. Both the starch and gum stock colour should be prepared ready for the addition of the mordant.

When required for printing the mordant is mixed with the stock colour and the colour brought to the required shade by the addition of ordinary gum or starch thickening. The following proportions of stock colour and mordant should be taken:—

Alizarine Blue Printing Colour.

8 gallons alizarine blue stock colour,
½ gallon acetate of chrome.

To prepare a colour with a zinc mordant, the following proportion of stock colour and mordant should be employed:—

Bright Alizarine Blue Printing Colour.

8 gallons alizarine blue stock colour,
1 gallon sulphite of zinc.

Brilliant Alizarine Blue (F. B. & Co.) is a dyestuff extremely useful to the printer. By mixing it with some of the yellow printing colours that are fixed with chrome, very fine bright green and olive shades are produced. The chrome lake is quite fast to light.

Brilliant Alizarine Blue.

10 lbs. brilliant alizarine blue S P,
1½ gallons hot water,
8½ gallons acetic starch thickening,
3½ lbs. acetate of chrome, 28° Tw.

Dissolve the blue in the hot water, then gradually add it to the thickening, after which add the acetate of chrome. The colour is then ready for printing.

Brilliant alizarine blue may be printed on cloth prepared with oleine or unprepared cloth, and is treated in exactly the same way as the other chrome mordant colours.

Alizarine Indigo Blue.—Alizarine indigo blue is sold in the liquid state, which merely requires the addition of the thickening and the mordant to prepare it for printing. The shade given by alizarine blue indigo is much purer or bluer than alizarine blue S, and is quite satisfactory in its fastness to the action of light and soap. The following is an example of a dark shade prepared with this colour, the mordant being acetate of chrome with which the colour is usually printed:—

Alizarine Indigo Blue.

½ gallon alizarine indigo blue,
4 gallons thickening,
½ gallon acetate of chrome.

Alizarine Green S is used in exactly the same way as alizarine indigo blue, acetate of chrome being the mordant generally used. The colour is much greener in tone than alizarine indigo blue, and, like the latter, is practically fast to soap and light. The same proportions of colour, thickening, and mordant can be employed for a fairly deep shade. The colour is rather a blue having a green shade than a green colour.

Alizarine Cyanine (F. B. & Co.).—The alizarine cyanines are made in several shades, and are printed either with chrome or alumina, different shades being obtained according to the mordant used.

Alizarine Cyanine R (F. B. & Co.).—This colouring-matter is sold in the form of a paste. It yields blue shades with acetate of chrome and violet with an alumina mordant. The shade obtained with acetate of chrome is rendered redder in tone if acetate of lime is added to the colour.

Chrome Colours with Alizarine Cyanine R.—The colour with which all our trials have been made was prepared as below:—

Alizarine Cyanine R.

4 gallons British gum thickening,
1 gallon alizarine cyanine R,
¾ gallon acetic acid, 8° Tw.,
1 gallon acetate of chrome.

The pieces were printed on oleine-prepared cloth, steamed for one and a quarter hours in the continuous steamer, and passed through the open soaper.

The shade given by the above printing colour is a dull blue with a rather greenish tone, which is practically fast to soaping and light. Reduced in strength by the addition of eight times its bulk of thickening the shade is a bluish-grey, which is also fast to light and to the action of a boiling soap solution. Steamed under 12 lbs. pressure the shade is slightly purer in tone.

The above colour may be made to give a redder shade by the addition of ½ gallon acetate of lime to the quantity of colour given.

Alumina Colour with Alizarine Cyanine R.—The alumina colour is printed with the following recipe:—

Alizarine Cyanine R.

1 gallon thickening,
¼ gallon alizarine cyanine R,
¼ gallon acetate of alumina, 12° Tw.,
1 noggin acetic acid, 8° Tw.

The shade of the alumina colour is a dull violet, which is fast to light, but only moderately so to soap. The addition of acetate of lime to the printing colour makes the colour looser to soap than without this addition. Steaming under 12 lbs. pressure makes the shade very much redder in tone and increases its fastness to soaping.

Alizarine Cyanine R R R is redder in shade than the R R mark, and behaves in the same way with regard to the action of light and soap. The printing colour is prepared in a similar manner to that used for the R R shade.

Alizarine Cyanine G is considerably greener in shade than the other marks of this colouring-matter, is equally fast, and is applied in the same way. The colour containing acetate of chrome yields a greenish-blue shade and the alumina colour a blue.

Alizarine Cyanine Black G (F. B. & Co.).—This colouring-matter is shown in pattern No. 3. The pattern has been printed with the following colour:—

The thickening was first prepared from the materials named:—

Thickening for Alizarine Cyanine.

145 parts wheat starch,
20 parts light British gum,
105 parts gum dragon thickening (6½ ozs. per gallon),
105 parts acetic acid, 9° Tw.,
25 parts olive oil,
600 parts water.

These ingredients are well boiled together in a colour pan and cooled. The printing colour was made up as below:—

Alizarine Cyanine Black.

30 parts alizarine cyanine black G
dissolved in
5 parts ammonia
were added to
240 parts thickening,
13 parts acetic acid,
5 parts acetate of chrome,
2 parts acetate of lime, 23° Tw.

The above will yield a very dark shade. The pattern was printed with the above prepared colour reduced with gum solution, as below :—

Printing Colour.

3 gallons above colour,
2 gallons thickening.

Alizarine cyanine black G is fast to both light and soaping.

Alizarine Bordeaux (F. B. & Co.).—Alizarine bordeaux is sold in two shades marked B and G. They can be used either with sulphocyanide of alumina or acetate of chrome as mordants. With alumina they yield very fine claret shades, the G mark being the brighter and yellower of the two shades. With acetate of chrome very dark black blues of rather a rusty tone are produced, which, when reduced in shade, are much redder than the dark colour. The alumina shades are by far the most useful, both for use alone and along with other colours.

Both marks are best used as directed below :—

Thickening for Alizarine Bordeaux.

18 lbs. Indian corn starch,
6 lbs. tapioca flour,
1¾ gallons acetic acid, 8° Tw.,
¾ gallon colour oil,
3 gallons gum tragacanth thickening,
12 gallons water.
Boil well together and cool.

Alizarine Bordeaux.

3¼ gallons thickening,
¾ gallon alizarine bordeaux, B or G,
½ gallon sulphocyanide of alumina,
3 pints acetate of lime,
¼ gallon oleine,
2¾ noggins oxalate of tin.

Alizarine bordeaux should be printed upon oleine-prepared cloth. If it can be arranged, it is advisable, after steaming, to pass the pieces through a chalk bath and to soap afterwards.

The shades produced with the alizarine bordeaux are quite fast to light and soap, the shade being turned only very slightly redder when chemicked. They are particularly useful for preparing bright salmon and claret shades.

Alizarine Yellow (B. A. & S. F.).—The alizarine yellows made by the Badische Co., and sold in the form of pastes under the names of alizarine yellow and alizarine yellow A, give bright yellow shades inclining to a maize shade in tone with alumina. The colours should be made up with sulphocyanide of alumina, with the addition of acetic acid and acetate of lime. The shades are quite fast to soap and light, and it is a very useful colour for mixing with alizarine to produce fast and bright scarlet shades, and for all purposes where the addition of a bright and fast yellow is required to turn the shade of other colours containing sulphocyanide of alumina. It is rarely used alone, as there are other colours giving practically the same shade with other mordants which are cheaper.

Alizarine Yellow C of the same firm is applied in the same way as the other alizarine yellows, using an alumina mordant. It is greener, but duller in shade, than the A mark, and is equally fast to light, soap, and the action of chemic.

Alizarine Yellow G G (M., L. & B.).—Alizarine yellow G G is one of the brightest and purest yellows we have at the present time, fixed with a chrome mordant. It is quite fast to soaping and light, and it is used, on account of its fastness, for the preparation of mixed shades.

Gambines (R. H. & S.).—The colours made by this firm, and sold under the name of gambine, are made in several shades. They are printed with acetate of chrome as a mordant, and yield a series of shades varying from yellow to brown. These shades are quite fast to the action of light, and practically so to boiling soap solutions. They are largely employed in the production of mode shades.

Anthracene Yellow B N (Cassella).—This colouring-matter, which is shown in pattern No. 1, is very useful to the calico printer on account of its fastness to light and soap; it yields a fairly bright yellow shade with a chrome mordant, and is a very useful colour for producing compound shades.

Anthracene yellow is printed with acetate of chrome, and can be thickened with either gum or starch paste.

Anthracene Yellow B N.

1 part anthracene yellow,
5 parts water,
12 parts thickening.
Mix well, and add
2½ parts acetate of chrome.

Anthracene Yellow G G is much greener in tone than the B N mark, is equally fast to light and soap, and is fixed with acetate of chrome.

Anthracene Brown is useful for modifying the shade of other chrome mordant printing colours, and occasionally as a self colour. The following recipe may be used to prepare a dark shade, from which the paler shades can be prepared by the addition of more thickening:—

Anthracene Brown.

15 lbs. anthracene brown R paste (F. B. & Co.),
8 gallons thickening,
1 gallon acetate of chrome, 28° Tw.

The colour can be printed either on ordinary or prepared cloth, but the best results are obtained on the pure tissue.

Chrome Orange (F. B. & Co.).—This colour gives a bright orange with a chrome mordant; hence, we suppose, its name. We consider that it is, nevertheless, a mistake to call a new colour by a name already in use for a well-known pigment. It is likely to cause some little annoyance in the store-room where the colours are kept; due to the man in charge, who is rarely more than a mere storekeeper, sending the wrong colour to the colour shop. Chrome orange is extremely useful on account of its bright orange shade when used with a chrome mordant, which enables many mixed shades to be prepared with the other chrome mordanted colouring-matters. It will be remembered that alizarine orange yields with chrome an orange brown shade; consequently, chrome orange is one of the brightest orange colouring-matters which can be fixed with a chrome mordant. The shade corresponding to that given by chrome orange is obtained by the use of alizarine orange with an alumina mordant, and this, in common with all the colours requiring alumina mordants, is very liable to show specks on the finished prints. Many of these specks are due to the iron, &c., contained in the dust which will settle on the pieces however careful one may be during the many processes which the cloth passes through before it is finished. Alumina-mordanted colours, especially in such bright shades as that under consideration, are also more liable to become soiled in soaping, should the soap in the open soaper become soiled with the other colours that are printed on the same piece, than chrome-mordanted colours.

The colour is shown in pattern No. 4, and has been printed with the following recipe :—

Chrome Orange.

30 parts chrome orange,
62 parts thickening,
8 parts acetate of chrome.

The colour is not quite so fast to soaping as the alizarine colours generally are. It withstands the action of light rather better than soaping, but still it is not up to the standard of fastness possessed by similar shades made with the colours containing alumina as the mordant. The shade is quite unaltered when passed through the chemic solution at 2° Tw. on the chemicking machine.

Indian Blue, Direct Blue, &c.—There are on the market at the present time a range of dark blue colours which are sold under a great variety of names, such as the above, and which are used very largely for the production of dark blue colours. They are probably prepared from logwood which has first been oxidised with bichromate of potash and then dissolved in a solution of bisulphite of soda; the colour so produced, which yields a dark grey or black, is shaded by the addition of methyl violet and brilliant green. At any rate the shade, yielded by such a preparation, matches in appearance and shade the preparations sold under these names. These colours require merely the addition of thickening to prepare them for printing. They are used both as self colours and for darkening other blues. The colour is cheap and is fast in dark shades, but when reduced to yield a pale shade it is not satisfactory in its fastness to light.

Opal or Coerulein Blue.—The blues, obtained from rosaniline, are sold to printers in the form of pastes and yield some very bright shades of blue, which, however, are very loose to light. They are used when an extremely bright shade is required, brighter than could be obtained with any of the faster shades.

These blues can be printed, we can hardly say fixed, with either acetate of chrome or with a mixture of alumina and arsenic, the latter mordants yielding the brighter shades.

The following is an example of a colour prepared with a chrome mordant:—

Bright Blue.

1 gallon opal blue paste,
20 gallons thickening,
1 gallon acetate of chrome.

The alumina arsenic thickening used for preparing the bright shade is prepared as follows :—

Alumina-Arsenic Thickening.

1 gallon starch paste,
1 gallon acetate of alumina,
1 pint arsenic solution.

The starch paste should be made much thicker than usual to allow of the addition of the acetate of alumina without making the mixture too thin. The arsenic solution is prepared by dissolving 4 lbs. of white arsenic (arsenious oxide) in 1 gallon of crude glycerine, the latter solution being kept in stock for this purpose.

The printing colour is simply prepared by reducing the colour paste with the prepared thickening, using quantities in accordance with the depth of the shade required. The following proportions yield a medium shade of blue from which the pale shades can be prepared by the addition of more thickening :—

Opal Blue.

1 gallon opal blue,
3 gallons arsenic-alumina thickening.

In some countries the import of prints containing arsenic is prohibited ; consequently, a colour prepared as above should not be used for such markets.

Chrome Blue (F. B. & Co.).—Chrome blue is a useful colour for brightening other colours fixed in the same way, and is employed in preference to the blue made from methylene blue for printing along with (in two colour patterns) alizarine red, as it does not bleed off the cloth during soaping and dull the shade of the red. It does not, however, withstand the action of chemic so well, so that care must be taken not to chemic too strongly.

Chrome Blue.

3 lbs. chrome blue paste,
10 gallons starch thickening,
1 gallon acetate of chrome, 28° Tw.,
¾ gallon water.

The colour should be printed on oiled cloth, steamed, and soaped as usual.

Coerulein.—Coerulein occurs in commerce as a dark paste, almost insoluble in water. By the action of bisulphite of soda upon the coerulein paste, the coerulein is converted into the bisulphite compound, and thus rendered soluble, in which state it exists in the printing colour. Coerulein yields dark dull green or myrtle shades on cotton, and is used with a chrome mordant.

For a dark green shade the following proportions should be used :—

Coerulein.

3 gallons starch thickening,
1 gallon coerulein paste,
¼ gallon acetate of chrome.

The above mixture can be kept in stock, and the coerulein contained in it converted into the bisulphite compound when actually required for use. The latter operation is performed by carefully mixing the colour in a tub with bisulphite of soda solution, and allowing it to stand, with occasional stirring, for two hours for the combination to take place. The following proportions answer this purpose well in practice :—

15 gallons of the coerulein mixture,
2 gallons bisulphite of soda.

The above printing colour gives a very dark shade of olive green ; the lighter shades are made by reducing the colour with more thickening. When the colour is to be reduced it is better to first mix the strong colour with a little more bisulphite than that given, and to add a small additional quantity of acetate of chrome to the reduction.

Coerulein yields rather dull shades, but the colours are extremely fast to both soaping and light.

Sterosine Grey (R. H. & S.) gives a useful shade with a chrome mordant, and the shade can be modified by the addition of any of the other chrome-mordanted colours. The colour is fairly fast to light and washing. It has the property of dyeing unmordanted cotton a fine shade of grey.

The printing colour is prepared according to the recipe given below :—

Sterosine Grey.

2½ gallons sterosine grey paste,
15 gallons thickening,
1¼ gallons acetate of chrome.

This colour is shown in pattern No. 2.

The steam colours requiring mordants are, as stated in the earlier part of this section, usually printed upon cloth which has previously been prepared with oleine. They can all be printed upon cloth not so prepared, if this should be necessary, but the shades so obtained are, generally speaking, not so full, bright, or as fast as when the cloth has been previously prepared.

The actual printing of the colours does not need any more particular attention than usual, but there are some colours, notably pale pink shades, which are rather sensitive to the action of dry heat, such as the goods are subjected to as they pass over the drying chests of the printing machine; care, therefore, should be taken that such pieces are not allowed to remain stationary on the chests, otherwise parts will become overheated; these parts, as also the divisions between the drying chests, will be distinctly shown on the finished prints.

After the goods leave the printer's hands they are occasionally hung in the ageing room for a few hours, but generally, if there are no colours on the piece which specially require ageing, they are sent direct to the steamer.

Some of the colours, for example alizarine blue S and others of a similar nature, are liable to show markings if the thickening material should become broken before entering the steamer, and special care is required to guard against this occurring.

Alizarine colours, and colours which have a tendering action upon the cloth during the time they are in the steaming chamber, are frequently passed through the vapour of ammonia previous to their entering the steamer.

These colours require steaming for about 1½ hours at low pressure in the cottage steamer, but if the continuous steamer is used the operation should be continued for the same length of time, sending the pieces through the machine twice.

After the goods have been steamed they are then ready for soaping. This operation is usually done by passing the goods through the open soaper, which removes the thickening and the soluble salts contained on the goods, while the top colour is detached by the action of the soap combined with the force applied to the piece by the spirt pipes and beaters.

As the pieces are received off the drying tins of the soaping machine they are sent for chemicking, bluing, or finishing, according to the special requirements of the colouring.

SECTION IV.

THE STEAM STYLE: THE BASIC OR TANNIC COLOURS.

THE class of colouring-matters known as the "basic colours" are largely used by the calico printer and comprise some very important colours. These colouring-matters are frequently termed "tannic colours," especially in the print works, because they are fixed on the cloth by the use of tannin or tannic acid.

The basic colours have practically no affinity for the cotton fibre, but they have the property of forming an insoluble colour lake when they are mixed with a solution of tannic acid and steamed, after printing upon the cloth; the colour lake so formed is rendered much faster to soaping by passing the pieces afterwards through certain metallic salt solutions, by which a compound lake of the colour base, tannic acid, and the metal is formed. The salts of antimony and tin are principally used for this purpose, especially the former.

In practice these colours are applied as described below.

The cloth, previous to printing, is prepared with oleine, exactly as described on p. 103. The preparation of the cloth with oleine materially increases the brilliancy of the shades obtained, and renders them faster to the action of boiling soap solutions. When the use of oleine-prepared cloth is inadmissible, the colours may be printed upon unprepared cloth, but with less satisfactory results.

The printing colours generally consist of the colouring-matters (thickened with a suitable thickening for the kind of pattern in hand), tannic acid, acetic acid, and usually a small quantity of a non-volatile organic acid. We will notice each of these ingredients separately, and describe the influence or use of each.

The kind of tannin, or form of tannin material, used varies with the nature of the colour employed, with reference to the brilliancy of the shade required. For the majority of the printing colours, ordinary commercial tannic acid, sometimes known as "common tannic acid," is employed, but as this always imparts a more or less yellowish-brown tinge to the colours, the amount depending upon the purity of the tannin used; the purest form of tannic acid commercially obtainable is occasionally employed for pale shades, which are required specially pure in tone, notwithstanding its high price. For dull shades, like greys, &c., and on the score of economy where the shades are only wanted of a rather dull hue, sumach extract is used in place of the more expensive tannic acid. There are on the market several purified sumach extracts from which most of the injurious colouring-matter has been removed, in some cases so completely as to enable them to be employed for the fixation of even bright colours; they are proportionally cheaper than tannic acid.

In all recipes for printing colours containing basic dyestuffs, acetic acid will be found. The acetic acid is added to retain the whole of the ingredients of the colour in solution and is always necessary. Printers' colours are generally thickened with either starch or British gum, the latter containing starch. Tannic acid, which is always present in the colours now under consideration, forms with starch a precipitate when the solutions are not acid, and the acetic acid is added to the colour to prevent this precipitation. The solubility of some of the colours of this class in water is not enough to allow of strong or deep shades being obtained, but as they are generally much more soluble in acetic acid, the latter is usually employed for their solution. Acetine (glyceryl acetate) is also used for the solution of some colours which are not sufficiently soluble in acetic acid or water. The acetic acid prevents the immediate combination of the colouring-matter with the tannic acid, holding them in solution until the colour has been printed and forced into the texture or fibres of the cloth, and only allowing them to combine and form insoluble colour lakes when the acetic acid is removed during the drying of the pieces as they pass over the drying chests of the printing machine and when they are afterwards steamed. The amount or concentration of the acetic acid in the printing colour necessary to prevent the combination of the colour base with the tannic acid depends upon the particular colouring-matter used, some colours having a much greater affinity for the tannic acid than others. When a colouring-matter requires an abnormally large amount of acetic acid to prevent the formation of an immediate precipitate when mixed with the tannic acid, and especially when it is of a bright shade, it requires special attention both in the colour shop and printing room. Colour tubs and boxes are required for this colour alone, as the presence of a large quantity of acetic acid would dissolve colour from the tub or box, however carefully they may have been washed, and cause it to be soiled, unless the colour last used in the box was of the same shade.

The addition of a small quantity of a non-volatile organic acid, usually tartaric acid, to the printing colour preserves the acidity of the colour on the cloth (after the acetic acid has been removed) during the processes of drying and steaming, and during the latter process enables the dyestuff to readily enter into the fibres of the cloth. The small quantity of tartaric acid usually employed does not prevent the final complete combination of the colour base with the dyestuff. The tartaric acid has also an influence in preventing the formation of the tannin starch compound mentioned above to some extent, and the pieces are, after fixing and washing, somewhat softer to the touch than they would be without this addition. This is particularly noticeable with colours thickened with starch, and is due to the starchy matter being more completely removed, owing to the more soluble condition in which they exist on the cloth.

The colours used for obtaining the various shades will be noticed later.

When the printing colour has been printed upon the cloth, part of it is forced by the pressure of the printing roller against the blanket and cloth into the fibres of the latter, a considerable portion of the colour still lying upon the face of the cloth. The piece then passes over the drying chests of the printing machine, where the piece is dried, and practically the whole of the acetic acid contained in the printing colour is evaporated away. When the goods enter the steamer the remaining small quantity of acetic acid is quickly expelled from the dried colour, but as the thickening material is softened by the moisture in the steam, the tartaric acid, under the influence of the heat and moisture, renders the tannic colour lake more or less soluble, or in such a condition that it will penetrate into the fibres of the cloth, instead of lying principally on the surface, as it does before it enters the steamer.

After steaming, the colours are ready to be passed through the fixing solution, and to have the thickening materials removed either by washing or soaping. Both these operations are usually done at the same time in the machine known as the open soaper (see p. 50), the fixing liquor being placed in the first tank. The liquor is kept at the boiling temperature by means of an open steam pipe, and the compartment in which the liquor is placed is usually capable of containing about 500 gallons of fixing solution. The machine is generally run at such a speed that the pieces take about seven seconds to pass through the boiling fixing liquor. The fixing solution almost universally used is composed of a solution of tartar emetic containing chalk in suspension, the following being about the usual strength and proportions of the ingredients :—

Tartar Emetic Fixing Liquor.

¼ oz. tartar emetic,
¼ oz. chalk,
1 gallon water.

The tartar emetic fixing liquor is prepared in large iron tanks situated above the level of the tank of the soaper, and connected with the latter by means of pipes, taps being provided to allow the liquor to flow into the soaper as required.

The chalk is used in the fixing liquor in order to keep the solution neutral. Practically the whole of the tartaric acid contained in the thickening on the piece leaves the cloth and passes into the fixing liquor; hence, unless chalk or some other substance capable of neutralising it was present, the solution would very quickly become acid, and the acidity would, to some extent, prevent the combination of the antimony contained in the emetic from combining so completely and quickly with the tannin colour lake on the cloth. Again, as the antimony is abstracted from the tartar emetic, the acid with which it was combined is set free, and the chalk also serves to neutralise acidity due to this chemical change.

Tartar emetic is still the salt most generally employed for the fixing of tannic colours on cotton prints, but many substitutes have been, and are now, offered to the printer. The oxalate of antimony, a double oxalate of antimony and potassium, and the double fluoride of antimony and potassium, are two of the substitutes which are used to a somewhat limited extent. Both these substances are sold at prices which are cheaper in proportion to the quantity of oxide of antimony they contain than tartar emetic, but, from our own trials, we could never find any advantage arising from their use, and we have usually found them much inferior in their fixing power to tartar emetic, even when a larger proportion of antimony in the form of these substitutes is used in the fixing liquor containing chalk, as described above. Probably one of the reasons why many of these antimony preparations are inferior in their fixing power to tartar emetic is that much of the antimony they contain is precipitated when they are boiled with the chalk, the resulting precipitated antimony oxide being then in a more or less useless condition for combining with the tannic colour lake.

Many of the basic aniline colours, when printed in dark shades, have a peculiar bronzy appearance, due to the concentration of the printing colour, and the fact that there is a large quantity of colour lying loosely on the surface of the cloth. Colours of this nature are always soaped after fixing, but for a very large number of colours washing is all that is necessary, and is cheaper. The soap solution, containing about ¼ ounce of good quality soap per gallon, is placed in the other compartments of the open soaper, and kept boiling by means of steam pipes; the soap solution is replaced by water when washing only is required.

The soap solution should be continually renewed while the pieces are being passed through the soaper, regulating the flow of the soap solution in accordance with the quantity of colour leaving the printed pieces, the man in charge of the machine regulating the supply of the soap liquor from the appearance of the various tanks.

When dark blotches are soaped the liquor in the tanks very quickly becomes soiled, and if the liquor becomes very dirty the white parts of the prints will be tinted and their brilliancy impaired. When pieces so printed are soaped they require a very large quantity of soap solution to be passed through the soaping tanks in order to prevent the over-colouring of the soap liquor; this has led several chemists to experiment with the object of rendering the detached colouring-matter harmless to the whites of the pieces. One of the best methods which have, up to the present time, been published is to add some tannate of antimony to the soap solution. The tannate of antimony is suspended in a fine state of division in the soap solution, and, on account of the affinity it possesses for the colouring-matter, combines with it and forms an insoluble lake, which does not soil the white parts of the piece, because it is insoluble and is detached from the pieces by the action of the beaters in the tanks further up the machine, and by the water spirt pipes as it leaves the soaping tanks.

The goods, after passing through the open soaper, pass over the drying cylinders of the drying machine, which always work in connection with the soapers, and are then sent forward for finishing.

It would be quite impossible in a work of this kind to notice and give recipes for all the colours of this class, owing to the extremely large number of shades and colours that are now available. There is hardly a week that passes but some new colour or new shade of a previously introduced colour is brought out; for an account of the properties of most of these colours we advise the reader to consult some of the larger manuals on dyeing,* or the dictionaries or tables of the coal-tar colours which have been recently published.† The most recently introduced colours will be found described in the technical press immediately after they are introduced. It is, however, well to bear in mind that the fastness of the various colours should not be judged entirely from the statements made in the journals. The printer should have trials made with each new colour as it is brought out, if it is thought of sufficient interest for his particular kind of work, and form his own opinions of the fastness of the new colours.

The following is a description of those colours which are in general use in the print works, showing their application and pointing out their particular properties :—

BLUE COLOURS.

Methylene Blue.—Methylene blue is one of the colours of this class which is used by all calico printers, probably without exception. The shade obtained is a pretty greenish-blue, and it is fast to light and soap, even in fairly pale shades. Methylene blue resists the action of chemic, the shade being only slightly turned greener, so that if the whites are soiled with this dyestuff they cannot be cleared by the usual chemicking process; for this reason methylene blue cannot be used for dyeing upon tannined mordants.

The colour occurs in commerce in the form of a powder of, generally, a greenish-grey colour, soluble in water and acetic acid, and requiring about four times its weight of commercial tannic acid for its fixation when printed in a dark shade. For the production of a gum colour

* See *A Manual of Dyeing*, by Knecht, Rawson, and Loewenthal.
† See *A Dictionary of the Coal-Tar Colours*, by George H. Hurst.

it is preferable to use dextrine for the thickening material instead of British gum, and, where the shade is required specially bright, to use a mixture of white and ordinary dextrine. The recipe given below is an example of a gum colour prepared on the lines indicated:—

Methylene Blue Gum Colour.

½ gallon water,
4 lbs. dextrine,
3 ozs. methylene blue.
Boil thoroughly; and add
12 ozs. tannic acid,
1¼ pints acetic acid, 8° Tw.,
¾ oz. tartaric acid,
previously dissolved.

After the tannin solution is added, the colour is made up to the proper bulk and cooled.

The starch colour is prepared in exactly the same way as the gum colour, using starch instead of dextrine for thickening.

When pale shades are required, they are prepared by diluting the strong colours with thickening. It is found that the shades are faster, if the thickening used for reducing colours of the tannic class contains some tannic acid; as, when the colour is largely diluted, there is not enough tannic acid contained in the original colour to thoroughly fix the dyestuff. The proper quantity of tannin to be used in the reduction is about 4 ounces per gallon, with sufficient acetic acid to keep the whole mixture in solution when starchy materials are present, as shown below.

Reduction for Tannic Colours.

100 gallons thickening,
22 lbs. tannic acid,
8 gallons acetic acid, 12° Tw.

When very bright pale shades are required the purest kind of tannic acid is used, but for general use the ordinary tannic acid is employed. The reduction is made with dextrine for the gum colours, and with a mixture of starch and gum dragon for the starch colours; in the latter case it is advisable to add to the above quantity of reduction 3½ lbs. of tartaric acid. Gum Senegal is also used as a thickening and reduction for this colour, and should be used in the same way as dextrine.

New Methylene Blues.—Under the name of new methylene blue there are several shades made, varying from a blue slightly redder in tone than ordinary methylene blue to almost a violet shade.

These colours are printed in exactly the same manner as methylene blue, and the shades are of the same solid character, resisting the action of soap solutions and light in a very satisfactory manner. By the kindness of Messrs. Cassella & Co., the makers of these colours, we are able to show two examples of this series. Pattern No. 5 is printed with new methylene blue G B, and No. 6 with the 3 R shade.

Methylene Indigo.—The two marks of methylene indigo blue P and S S are much used by the calico printer on account of their fastness to light and soaping. The shades are much greyer and duller, and not so green in tone as methylene blue. These colours are rarely printed alone, but generally mixed with more or less methylene blue, which increases the brightness and makes the shade bluer. The same recipes for the printing colour can be used as are employed for methylene blue.

Naphthalene blue is another fast blue largely used, especially along with some methylene blue, for the production of a duller and redder shade of blue than can be obtained from methylene blue alone.

Indamine Blues.—Under this name a series of colouring-matters is sold, yielding shades from a greyish-blue, through a pure blue and to quite a reddish-violet shade. The bluer shades are certainly entitled to be called fast colours, and although the red shades are not fast, they are much faster than the corresponding shades obtained from the methyl violets; they are used on this account. Their application, being the same as for the other tannic colours, calls for no special notice.

Capri Blue.—Capri blue is made in several shades, and yields upon cotton an extremely bright shade of blue, shown in pattern No. 7, which is also fast to both light and soaping. It is much used on account of the extreme purity and brilliancy of the colour, and is applied like methylene blue.

Turquoise blue (F. B. & Co.) is shown in pattern No. 8; it will be noticed that the shade is a bright greenish-blue.

Like all the other colours of this class, the best results are obtained upon oleine-prepared cloth, steaming for an hour, and fixing and soaping as usual. The pattern has been printed with a colour prepared as below:—

Turquoise Blue.

2 lbs. turquoise blue,
2 gallons water.
  Dissolve; and add
2 lbs. acetic acid, 9° Tw.,
6 gallons British gum thickening.
  Mix; and add
5 lbs. tannic acid,
  previously dissolved in
5½ lbs. acetic acid, 9° Tw.

The British gum thickening used in this recipe should be prepared by dissolving 10 lbs. of British gum in each gallon of water.

Neutral Blue.—Neutral blue is printed in a colour containing tannic acid, along with acetic and tartaric acids. It gives a reddish shade of blue, approaching violet in tone, and is useful to the printer for the preparation of shades by modifying it with other dyestuffs. This colouring-matter is shown printed upon oleine-prepared cloth in pattern No. 9.

Very dark indigo shades of blue are frequently obtained by mixing together brilliant green and one of the shades of methyl violet, a variety of shades being obviously obtained by varying the proportions of these two colouring-matters, the printing colour so obtained is very cheap. A dark blue obtained in this manner is, however, very fugitive to the action of light, and where a blue of superior fastness is desired it is advisable to employ one of the many dark blue colouring-matters that are now available for this purpose. The latter colours are, however, far more expensive, and are not used so much as they should be, on account of the fact that it is necessary to run the works at a profit to the printer, and buyers do not seem prepared to pay for this increased cost of production for the sake of obtaining the faster shade in dark blotches. For small patterns the cost of the printing colour is not so large a percentage on the value of the resulting print, and in the better class print works it is usual to produce the dark blues from the faster colours in these cases. A recipe showing the production of a dark indigo shade of blue from a mixture of green and violet will be found amongst the "Practical Recipes."

The following colours are some of those which are used to prepare the fast dark indigo shades using this class of colouring-matters :—

Indazine (Cassella).—Indazine is shown in pattern No. 10 and gives a dark blue, having a violet shade. When a bluer shade is desired, the shade can be modified by the addition of methylene blue, and the resulting shades are such that they can be considered fast. The pattern is printed with the colour given below and treated as usual.

Indazine.

5 lbs. indazine,
2 gallons water,
1 gallon acetic acid, 9° Tw.,
1 lb. glycerine.
Dissolve at the boil ; and add
2½ gallons thickening.
Boil ; cool ; and add
15 lbs. tannic acid dissolved in
1½ gallons acetic acid, 9° Tw.

Acetine Blues (B. A. S. F.).—The acetine blues made by this firm are prepared in two shades, marked B and R, and are sent out in the liquid form containing the colouring-matter dissolved in acetine, which is an acetate of glyceryl prepared by boiling glycerine with glacial acetic acid. They yield good useful and fast shades, and require about 8 lbs. of tannic acid per gallon for their complete fixation. The following recipe is an example showing how they can be printed :—

Acetine Blue.

6 gallons British gum thickening,
6 lbs. tannic acid,
1 gallon acetic acid, 12° Tw.,
1 gallon acetine blue R or B.

The tannic acid should be dissolved in the acetic acid and mixed with the British gum thickening. The colour paste, or thick solution, should then be measured into a colour tub and the tannic thickening gradually mixed with it, stirring the whole of the time.

Similar colours are on the market sold under the name of solvent blue, &c., and are used in the same manner.

The printing indulines of Meister, Lucius, and Bruning are colours of a similar nature to the above colours, but they are sent out in the dry powder form, and are dissolved in acetine before they are made up into a printing colour by mixing with the tannic acid thickening.

Solid Blue (Cassella).—These colours can be obtained in shades varying from a full blue to a reddish shade, as shown in patterns Nos. 11 and 12, which have been produced with the colour given below upon oleine-prepared cloth.

Solid Blue.

1 lb. solid blue,
1½ gallons water,
1 gallon acetic acid, 9° Tw.,
2 lbs. glycerine.
Dissolve ; and add
5 gallons thickening.
Boil ; cool ; and add
4 lbs. tannic acid,
4 lbs. acetic acid.

The shades obtained from these colours can be made much faster than the shade obtained with the above colour, if a larger quantity of tannic acid is used ; but are then not so bright.

GREEN SHADES.

The green colouring-matter most largely used is brilliant green, which occurs in commerce in the form of crystals. It is practically the only bright green colouring-matter available for the purpose of obtaining the particular shade given by it. Unfortunately it is very loose to the action of light, but as there is no other colour which will give the same shade, the printer is compelled to use it. For shades of a less brilliant hue a faster colour can be made by the use of either auramine or thioflavine T mixed with one of the bright greenish shades of blue ; a large number of green shades are obtained in this way. Brilliant green is shown in pattern No. 13. It can be printed in a manner exactly similar to that described for methylene blue.

Solid Green (Cassella) yields a shade differing slightly from brilliant green, is printed in a similar manner, and is shown in pattern No. 14.

Methylene Green G G (M., L. and B.), applied in the usual manner, yields a fine shade of green, which is by no means as bright as that given by the other green colours, but far surpasses them in its fastness to both light and soaping. It is particularly useful for the preparation of green shades by mixing with auramine and the other bright yellow colours.

YELLOW SHADES.

Two colours yielding bright yellow shades are largely used for producing bright yellow and mixed shades. These colours are known as auramine and thioflavine T. Both these colours require a very large quantity of acetic acid in the printing colour in order to prevent the immediate formation of a tannic lake, the latter colour being the most liable to precipitate, and, consequently, requiring the largest proportion of acetic acid. The necessary presence of a large proportion of acetic acid in the printing colour has practical disadvantages, which sometimes cause considerable annoyance to both printers and colour mixers, owing to the fact that it is necessary to use tubs and colour boxes for these colours only, as it is impossible to so completely clean them (after being used for other colours) as to prevent the soiling of the yellow by the solution of some of the colour contained in the pores of the wood, or the corners, &c., of copper boxes, by acetic acid of such a strength. A bright primrose-yellow colour fast to light and soaping, and unaltered in tone when chemicked, is much to be desired for use with this class of colouring-matters. Owing to the fact that these yellow colours soil so readily, the bright primrose-yellow colour required for the small portions of patterns done in the steam style is often done with a lake formed from auramine and fixed with albumen, as described on p. 99; or with the extremely fugitive colour produced with Persian berries, alum, and tin.

Auramine O (Leonhardt).—Auramine on cotton is shown in pattern No. 15. As stated above, the colour obtained is practically fast to both light and soaping. The printing colour is prepared with a larger proportion of acetic and tartaric acid than is usual for this class of colours. When the lighter shades are prepared by reducing the dark or standard colour it is necessary to use a reducing paste containing not only some tannic acid, but also a large quantity of both acetic acid and tartaric acid.

The following colour shows the constitution of a fairly strong shade printing colour from which the paler shades are made, as described :—

Auramine.

4 gallons acetic acid, 8° Tw.,
1 lb. tartaric acid,
4 lbs. tannic acid,
4 lbs. starch,
1 lb. tapioca flour.
Boil well; cool to 160° F.; and add
3 lbs. auramine.

It is not advisable to boil the auramine with the thickening and acid, as it is to some extent decomposed if heated, under these conditions, above the temperature recommended.

Auramine is extensively used in the preparation of bright olive and yellowish-green shades as well as a self colour; when used along with methylene green G G it yields extremely bright and fast greens and olives well suited to the export trade, but far too bright for the home markets.

Thioflavine T (Cassella).—Thioflavine T is rather more greenish in colour than auramine, and although it is quite fast enough to be classed as a fast colour, it is, in our opinion, not quite so fast as auramine. Thioflavine is, however, of a more primrose shade than auramine, which makes it a particularly useful colour to the calico printer, enabling much purer shades to be obtained when mixed with other colours than was possible before its introduction. The method of applying thioflavine is similar to that used for auramine, using a rather larger proportion of tartaric acid in the colour. When it is desired to obtain the maximum brilliancy and purity of shade the purest tannic acid should be used in the standard colour and also in the reduction. For the latter purpose it is advisable to use a mixture of white and brown dextrine for thickening the colour (see pattern No. 16).

RED AND PINK SHADES.

These colours are rarely used alone, as they are either not fast enough to light, or too expensive compared with alizarine red and pink; but they find their chief application in toning or shading other colours fixed in a similar manner, the resulting shade being equal to the standard of fastness or looseness which is in practice considered fast or passably fast enough.

Magenta.—Magenta and several members of the rosaniline group of dyes are used by printers chiefly for shading, and also for the purpose of sightening, or rendering visible to the machine printer, the colours used in the "madder style," which would, without this addition, be practically invisible to the printer, and, consequently, he would be unable to attend to the fitting of the pattern, and to know whether the colour was printing properly.

Magenta is usually employed for shading purposes in the form of a solution in acetic acid at 8° Tw., the necessary quantity being added to the colour to be altered in tone. As the quantity of magenta used is generally small, on account of its loose nature, there is no practical necessity to add more tannic acid to the colour, as the tannin already present will be sufficient to fix it. In the colour shop this method of working is very useful, as the same solution of magenta will serve to alter the shade of tannic or steam colours and for sightening dyed reds and pinks. Although it does seem rather irrational to use a basic colour along with colours fixed with metallic mordants, like alizarine, and without the addition of tannic acid, still this method is largely used in practice, the basic colour becoming more or less fixed upon the metallic colour lake formed during steaming. Pieces printed with colours so constituted are treated exactly like the ordinary mordant colours and do not require fixing with tartar emetic.

Pattern No. 17 shows the shade obtained with magenta when printed with tannic acid and fixed with tartar emetic.

Neutral Red Extra (Cassella).—This colour, shown in pattern No. 18, is used in calico-printing in somewhat the same manner, and for the same purposes, that magenta is used. It is, however, rather faster to light than magenta, and is preferable on this account. The pattern has been printed with the following printing colour, steamed, fixed, and soaped as usual :—

Neutral Red Extra.

4 lbs. neutral red extra,
1½ gallons water,
½ gallon acetic acid, 9° Tw.
Dissolve at 175° F.; and add
7 gallons thickening.
Cool; and add
7½ lbs. tannic acid,
⅝ gallon acetic acid, 9° Tw.,
1½ lbs. tartaric acid.

Rhodamine.—Rhodamine is, perhaps, the fastest rose-red colouring-matter of this class, being remarkably fast to light and very good to soaping. It does not appear to us that it is used to so large an extent as its properties deserve, as a variety of fast shades can be obtained by mixing it with other colours fixed with tannic acid. When printed with tannic acid on oleine-prepared cloth and fixed with tartar emetic, the colour does not appear to lose in depth on exposure to light, but the shade becomes rather redder and brighter. Rhodamine is made in two marks, marked B and S, the former being employed for cotton printing. The following recipe is suitable for printing this colouring-matter :—

Rhodamine.

4 ozs. rhodamine B,
¼ gallon acetic acid, 12° Tw.
Dissolve; and add
¾ gallon water,
1½ lbs. starch.
Boil; then add
1 lb. tannic acid previously dissolved in
¼ gallon acetic acid, 12° Tw.

Indamine 6 R (Noetzel).—Indamine 6 R is another practically fast reddish tannic or basic colouring-matter, rather duller in shade than rhodamine, but very useful to the printers' colourist.

The colour for printing can be prepared according to the recipe appended:—

Indamine 6 R.

2¼ gallons water,
¼ gallon acetic acid, 12° Tw.,
½ lb. indamine 6 R,
12 lbs. British gum.
Boil; and add
¼ gallon acetic acid, 12° Tw.,
2½ lbs. tannic acid.

Pyronine G (Leonhardt).—This colour is shown in pattern No. 19 and is printed in the ordinary manner for basic dyes. The shade, as will be seen from the pattern, is bright, and the colour is fairly fast to light and soaping.

Acridine Scarlet 3 R (Leonhardt) is shown printed on oleine-prepared cloth, steamed, fixed, and soaped in pattern No. 20. It is fairly fast to light, and is useful when a bright shade is required, especially for mixing with other colours for compound shades.

Safranine.*—Safranine is employed to a very limited extent in printing, occasionally being used to increase the brilliancy of other red colouring-matters and in the production of prints where fastness of shade is not essential. It is produced in several shades, two of which we show in patterns Nos. 21 and 22. Safranine is very fugitive to the action of light, and, on this account, it is used to a less extent than was the case before the introduction of the newer and faster red colours fixed in the same way. For the purpose of printing it upon the cotton fibre, the latter should first be prepared with oleine and printed with a colour containing safranine, tannic acid, thickening, and acetic acid. After printing, steam and fix in the usual way.

VIOLET SHADES.

The violet colouring-matters belonging to the colours fixed with tannic acid are numerous in shade, but they all have the common fault of being very fugitive to light. On account of their inability to

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stand exposure to light, they are used only where very bright shades of violet are required that cannot be obtained with faster colours of the same brilliancy of colour and in mixtures for making compound shades. A really fast violet colouring-matter, bright in shade and fixed with tannic acid, would be extremely useful to the textile colourist, but has not, so far, to our knowledge, been produced.

Methyl Violets.—The methyl violets are made in shades ranging from quite bluish shades of violet to shades bordering on magenta, as shown in patterns Nos. 23 and 24. They are used to produce mauve and violet shades, but, as stated above, do not yield shades fast to light. The following printing colour can be used for printing any of the shades:—

Methyl Violet.

1 lb. methyl violet,*
1 gallon acetic acid, 8° Tw.
Dissolve; and add
3 gallons water,
3 gallons acetic acid, 12° Tw.,
7½ lbs. starch,
6 lbs. tannic acid.

The presence of oleine on the cloth previous to printing has a considerable effect in increasing the brilliancy of the shade obtained, and where the full brightness is required should never be omitted.

A solution of methyl violet is generally kept in the colour shop, made up without the addition of tannic acid, and is very useful when it is desired to use a small quantity of this colour for modifying the shade of other tannic colours. The same solution can be used for sightening the printing colours used for purples in the dyed styles, and modifying the shade of steam colours fixed either with alumina or acetate of chrome, the methyl violet being fixed upon the colour lake formed between the metallic mordant and the mordant colouring-matter. The following solutions are convenient strengths of two of the principal shades of methyl violet:—

Methyl Violet B S.

1 lb. methyl violet B S,*
1 gallon acetic acid, 8° Tw.

Methyl Violet R S.

¼ lb. methyl violet R S,*
1 gallon acetic acid, 8° Tw.

In the above recipes the marks affixed to the methyl violet indicate the blue shade and red shade respectively.

ORANGE, MAIZE, AND BROWN SHADES.

The orange, brown, and maize shades obtainable from colouring-matters belonging to the class now under consideration are not used to a very large extent as self colours, although they are often useful for mixed shades. Speaking generally, they do not compare either in

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fastness or price with similar shades obtained from alizarine and several of the natural dyestuffs.

The following colours are some of those frequently used by the calico printer:—

Aniline Yellow (Cassella) is shown in pattern No. 25. The colour is often very useful for preparing compound shades. The shade obtained is a dark yellow, inclining to brown. The colour is printed from a printing colour prepared in the usual manner and treated in the ordinary way after printing.

Phosphine 11A (Cassella) is considerably brighter and yellower in shade than aniline yellow, as shown by pattern No. 26. It is employed for printing light brown shades in combination with other colouring-matters, and the shades produced are very bright.

Bismarck Brown, also known as vesuvine, Manchester brown, &c., is now very little used in calico printing, although largely employed in the printing of delaines. It can be applied in a similar manner to the other colours of the basic type, and will mix perfectly with most of the other basic dyes when required.

Acridine Orange N O (Leonhardt).—Acridine orange is shown in pattern No. 27, and is printed as usual for basic colours. In making the printing colour it is advisable to employ a mixture of acetic acid, starch paste, and gum Senegal for thickening. The colour should be dissolved in acetic acid and added to the thickening, and the whole well mixed together. About four times the weight of tannic acid is required to fix the colour, which should first be dissolved in acetic acid, and then be very gradually added to the thickened solution of the colouring-matter. Unless the tannic acid solution is added cautiously the colouring-matter will be precipitated, and the resulting prints will be dull and flat in shade. The colour obtained is fast to soaping, but only fairly fast to light.

New Fast Grey (F. Bayer & Co.).—This colour is shown in pattern No. 28, which has been printed with the following printing colour:—

New Fast Grey.

1 lb. new fast grey,
2 gallons water,
7 lbs. acetic acid, 9° Tw.,
½ lb. glycerine, 40° Tw.
Dissolve; and add
6 gallons British gum thickening.
Then add
3 lbs. tannic acid previously dissolved in
3 lbs. acetic acid, 9° Tw.

The British gum thickening should be made by boiling 10 lbs. of gum with 1 gallon of water.

After printing the colour on oleine-prepared cloth, the latter should be steamed for an hour without pressure, such as obtains in the continuous steamer, fixed with tartar emetic and soaped. The pattern has been soaped at 89° F.

For fuller information relative to the above colouring-matters, and many that have not been noticed at all, but which are to some extent used in printing, the reader is advised to consult one of the many dictionaries of coal-tar colours now published.

In these dictionaries the method of application of each particular colouring-matter is briefly indicated, which, with the information given above, should enable the reader to prepare printing colours from those that are applied in a similar manner, at any rate after a few preliminary trials to obtain suitable proportions of the various ingredients have been made.

SECTION V.

THE STEAM STYLE: THE SUBSTANTIVE COLOURS.

The class of dyestuffs known as the substantive colours, and occasionally as the benzidene colours, have recently been largely employed in calico printing, particularly since the range of shades obtainable from this class of dyes has been so largely extended.

The substantive colours, as the name of the group of dyes denotes, dye cotton directly, especially in the presence of certain neutral or slightly alkaline salts which assist the combination of the dyestuff with the cotton fibre; consequently, the solutions of the colouring-matters are generally merely thickened, and one of the salts mentioned added to the printing colour.

The salts used as assistants in the printing colours are phosphate and sulphate of soda, with occasionally the addition of a little soluble oil.

When the shades are required medium to dark in depth, a small proportion of a solution of albumen thickening is added, which assists in the fixation of the colour upon the piece.

The cloth may be prepared with oleine should there be other colours in the pattern that require oil for their proper development, but a prepare is not actually necessary.

We will now give a few recipes for printing these colours upon cotton, illustrated with patterns, and we would direct attention to the various patterns showing the combination of several colours in a multiple colour pattern at the end of the book, where many examples of the use of these comparatively new printing colours will be found.

For dark colours a thickening containing albumen should be used, prepared as below :—

Thickening for Dark Shades.

4 gallons thick gum tragacanth thickening,
½ gallon blood albumen thickening.

The blood albumen thickening should be made with 3 lbs. blood albumen per gallon of water. The two thickenings must be quite cold before mixing.

Thickening for Pale Shades.

9 ozs. gum tragacanth,
1 gallon water.

Soak the gum in the water over night, boil well, and cool.

The following are examples of printing colours made with phosphate and sulphate of soda as assistants respectively :—

Diamine Violet N.

½ lb. diamine violet N (Cassella),
½ lb. phosphate of soda,
8½ gallons water.
Dissolve at the boil; cool; and add
6½ gallons thickening for dark shades.

This colour is shown in pattern No. 29.

Light Blue.

½ lb. diamine sky blue,*
2½ ozs. diamine green B,*
½ lb. sulphate of soda (Glauber salts),
6 gallons water.
Boil well; cool; and add
10 gallons thickening (as above).

It has been recommended to use acetate of chrome in the printing colour for the substantive dyes, but, although it yields satisfactory results with a few of the members of this group, it is not to be generally recommended.

Any of the substantive dyes may be printed by one or the other of the above recipes, so that it is not necessary to multiply the number of recipes on this account.

After printing, the pieces are steamed for an hour without pressure, and washed by a passage through the open soaper, charged with water only. Occasionally the pieces are lightly soaped before finishing.

Speaking generally, the shades given by most of the substantive colours when printed upon cotton are fast, or moderately fast, to light, but the vast majority can only be said to stand soaping fairly well. There are some of the members of this group of dyes which are not fast either to light or soaping, and it is advisable for the printer to select from the large number of colours now on the market those which, from his own trials, are satisfactory to him in fastness. The printing colours are usually very cheap, and lend themselves to the production of low-priced goods.

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SECTION VI.

THE FLUORESCEIN AND ACID COLOURS.

THE fluorescein colours (under which title we refer to colours like eosines, erythrosine, dianthin B, rose Bengale, phloxine, &c.) are not used to a very large extent in calico printing, because they cannot be properly fixed upon the cotton fibre to withstand washing, and many of them are very fugitive to light. The use of the acid colours is restricted from the same causes, although many of the latter class are fast enough to light.

The fluorescein colours have practically no affinity themselves for the cotton fibre, but they form coloured precipitates with solutions of many metallic salts, and they are printed upon the cloth from a colour containing a metallic salt in solution, which enables the shade produced to be fast enough to washing to enable the thickening to be removed. The colours should only be used when it is not necessary for the prints to stand washing and soaping. For the mordant, the acetate of alumina or chrome are generally used, the former yielding colour made from erythrosine B, using acetate of alumina as the fixing for the brighter shades. The following recipe is an example of a printing agent. The shade produced is shown in pattern No. 30 :—

Bright Pink.

1¾ lbs. erythrosine B (Cassella),
5 gallons water.
Dissolve ; and add
17¼ gallons British gum thickening.
Heat to 122° F.; cool ; and add
1 noggin acetate of alumina, 10° Tw.

The cloth should be prepared with oleine previous to printing, as the fatty matter on the cloth renders the colour faster to washing. After printing and drying, the pieces should be steamed for about one and a-half hours in the continuous steamer, or in the cottage steamer for two periods of three-quarters of an hour each, under slight pressure, after which they should be washed by passing them through hot water contained in the open soapers. Sometimes goods printed with these colours are finished immediately after steaming, without any washing, but in that case the colours should be thickened with a mixture of gum tragacanth and starch paste, instead of British gum, as the latter renders the cloth too hard and brittle when allowed to remain in the finished pieces.

These colours may also be fixed upon the cloth by using albumen as the thickening material, and the shades so produced are then faster to washing because the colouring-matters possess an affinity for the coagulated albumen, which is itself firmly bound to the cloth. The dyestuffs are dissolved in water, and then added to the albumen thickening, or, better, as rendering the cloth softer to the touch when finished, a mixture of albumen and gum tragacanth thickening, as shown below :—

Pink Erythrosine B.

1½ ozs. erythrosine B,
1 quart water.
Dissolve ; cool ; and add
½ gallon bleached blood albumen thickening,
½ gallon gum tragacanth thickening.

Acetate of chrome is used in a similar manner to the alumina salt ; but, as stated before, yields slightly duller shades which, in some cases, are a little faster to washing. The addition of oleine or soluble oil to the printing colour makes the shades faster to soaping on account of the affinity which the colouring-matters possess for the chrome or alumina soaps formed during steaming.

The acid colours are printed upon cotton in a similar way to the eosines, but are only occasionally employed for prints that are not required to be washed. One of this class of colours is shown in pattern No. 31, and this has been printed with the following printing colour :—

Brilliant Croceine.

1½ lbs. brilliant croceine M O O (Cassella),
1 gallon water.
Dissolve ; and add
3½ gallons thickening.
Boil ; and add, when cold,
½ gallon acetate of alumina, 10° Tw.

The acid colours are best printed upon oleine-prepared cloth, steamed, and then finished without washing.

SECTION VII.

STEAM STYLES : DIRECT INDIGO PRINTING—SCHLIEPER AND BAUM'S PROCESS.

SCHLIEPER and Baum's process for the direct printing of indigo upon cotton piece goods has now completely displaced all other methods formerly used for this purpose, at any rate in those works where the process has been thoroughly tried and studied, for it is a process requiring the most minute attention to details, if the results are to be satisfactory and uniform.

The process is based upon the fact that if indigo in a fine state of division is heated with glucose in the presence of caustic soda, the indigo is reduced from the condition of indigotine to indigo white. Indigo white, unlike indigotine, is soluble, and will penetrate into the fibres of the cloth; it has the property, on exposure to the air, of absorbing oxygen and reforming indigotine, reproducing the original colour of the indigo and becoming insoluble in water and soap solutions; consequently, it is rendered fast to the action of washing, because the insoluble particles are contained within the fibres of the cloth.

Although there are several ways in which the indigo can be applied in carrying out these principles, the usual method is to prepare the cloth with a solution of glucose, and to print upon it a colour made from a thickened mixture of finely ground indigo paste and caustic soda lye. The colour having been printed upon the cloth, the latter is passed through the steaming chamber, where the indigo is reduced to the state of indigo-white and at the same time penetrates into the cloth. The indigo now being reduced upon the cloth, the latter is hung in a damp chamber exposed to the action of the atmosphere and the moisture contained in it, which enables the indigo to more thoroughly enter the cloth, and, finally, causes the complete oxidation of the indigo-white to indigotine. The indigo is now completely fixed upon the fibre, and all that remains to be done is to remove the thickening and other matters (except the indigotine) from the cloth, which is accomplished by thoroughly washing it, and finally submitting the cloth to the action of hot soap solutions.

The above is an outline of the principles involved in this process. We will now turn our attention to its application in practice, merely emphasising what we have already stated, that for successful practical results it is necessary that the process should be carefully and thoughtfully studied under the special conditions under which it is carried out in each works, modifying the process in accordance with the special or peculiar conditions under which it is necessary to work.

The Indigo.—The indigo used for printing is of much higher quality than that used for dyeing, and it is essential that it should be in the finest possible state of division.

For printing ordinary dark and medium shades of blue, the better qualities of indigo, known as "kurpah," or a mixture of "kurpah," and the still better quality of indigo known in the trade as "Bengal" is generally used. Very pale and bright shades are printed from colours prepared with either the finest qualities of "Bengal" or, better still, with "Java indigo," as although, theoretically, indigotine alone should be fixed on the cloth in this process, practically the natural impurities present in varying amounts in the several kinds of indigo have considerable influence upon the resulting shades prepared from the colours, owing to the fact that some of the organic impurities are fixed upon the cloth in such a manner as to be immovable in the processes of washing and soaping to which the goods are afterwards treated; hence different qualities of indigo yield different shades of blue, irrespective of the intensity of the shade, which depends upon the proportion of real indigotine contained in the printing colour. Putting the matter in perhaps a clearer way, it may be said that the use of twice the quantity of an indigo containing 25 per cent. of indigotine in the printing colour will not give the same shade as an indigo which contains 50 per cent. of indigotine; the low quality of

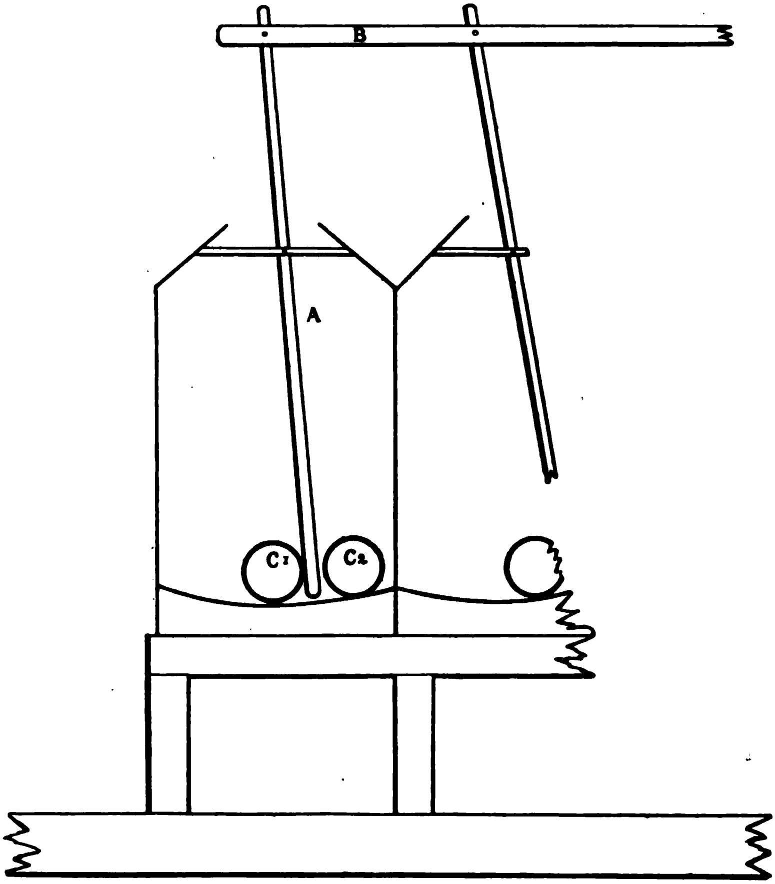

Fig. 48.—Roller indigo grinding machine.

indigo always yielding the duller or blacker shade. In practice, the various qualities of indigo are blended together so as to form mixtures of certain standard compositions with regard to the proportion or percentage of actual colouring-matter contained in it, mixtures of various qualities being used to produce the various shades in the most economical manner, as the high qualities of indigo are dearer in proportion to the colouring-matter they contain than those of lower quality.

The process of grinding the indigo into a fine state of division in the form of a paste is performed in the roller grinding machine, as shown in Fig. 48. The operation is an extremely slow one in practice, often taking as long as three weeks before the indigo is ready for printing. The quicker-acting ball indigo grinding machine, so largely used for this purpose when the indigo is required for dyeing, cannot well be used here, as the rapid movement of the balls in the machine is liable to detach small particles of metal from the interior of the machine, and as they often pass through the material used for straining the colours in the straining machine, they are liable to seriously damage the engraved copper rollers used during the printing of the cloth.

The roller indigo grinding machine consists of an iron tank having a semi-circular bottom, and having at one side a tap of large bore for the purpose of drawing off the indigo paste when the operation of grinding is completed. Inside the tank there are two, or in some cases three, heavy iron rollers lying loosely on the bottom of the tank, and of a length nearly equal to the width of the tank. These rollers, C_1 and C_2, are rolled backwards and forwards, or to and fro, by the action of the arm A, which is worked from the shaft B, the latter moving from an eccentric placed at the end of the series of tanks. The number of these tanks should be arranged to ensure the delivery of sufficient indigo paste for the amount of work usually done in this style, erring on the side of over-production rather than otherwise, as the process cannot be hurried. The indigo to be ground is first placed in the tank, and then the required quantity of water added, after which the machine is started, and allowed to work day and night until the whole is worked up into a uniform smooth paste, in which the indigo exists in a sufficiently fine state of division to be reduced during the steaming of the goods, as well as to produce even or level shades if used for pale colours, a point which can only be found by experience. When this stage is reached the paste is made up to the usual bulk with water, and the strength tested by drying a small portion of it in a water oven, and noting the percentage of solid matter which the paste contains. If it is stronger than usual, more water is added until it is exactly of the standard strength. Little points like these may appear as mere trivial details, but they are really of great importance. In this condition the indigo is stored for use in the colour shop.

Thickening Materials.—Gum Senegal, light British gum, or a mixture of light British gum and starch, are the substances chiefly used for thickening the printing colours. The nature of the thickening has considerable influence upon the quality and depth of the shades produced. The kind of British gum used for these colours is that known in the trade as "light British gum;" it contains a large quantity of unconverted starch, or starch which is only slightly altered by heat. The usual practice is to use for the dark shades a mixture of about two parts of light British gum and one part of Indian corn starch for thickening. Gum Senegal is used to a lesser extent and chiefly for light shades, which are somewhat clearer when thickened with Senegal.

Preparing the Printing Colour.—As an example of a dark shade printing colour, from which the paler shades can be prepared by reducing with the reduction for these colours named on p. 145, the following is given:—

Dark Blue Indigo Colour.

12 lbs. light British gum,
or
3 lbs. Indian corn starch,
6 lbs. light British gum,
1 gallon water.
Boil; and add
6 gallons caustic soda lye, 80° Tw.
Heat slowly to 145° F.; and add
4½ gallons indigo paste containing 30 per cent. indigo,
1 gallon water.

The caustic soda lye must be added very slowly to the dissolved thickening, the whole being well stirred between each addition, otherwise the colour will become rough, lumpy, or uneven in viscosity. This effect is due to the action of the caustic soda upon the starchy matters contained in the thickening materials which are converted by the soda into a peculiar glutinous substance having great thickening properties. This action of the soda upon the starchy matters does not take place until the mixture becomes of a certain strength in soda; if the soda solution is gradually added to the printing colour, and each portion well mixed before a fresh addition is made, the action will occur evenly and regularly throughout the whole colour at the same time, and the result will be that the colour is of even thickness. When, however, the caustic soda is added too quickly, this action takes place locally, owing to the slowness with which the soda mixes with the rest of the colour, and the result is shown in the production of lumps or very thick portions of thickening mixed with the thinner portion of the mixture.

Owing to the action of the concentrated solutions of caustic soda contained in these colours, it is impossible to strain the colours by hand in the usual way, consequently, they are strained in the straining machine noticed on p. 24. Should pale shades be required, prepared by reducing the strong colour given above with thickening, it is well to strain the strong colour and reduction before mixing, and, when they have been thoroughly mixed together, to again pass them through the straining machine. This will ensure the colour being well strained and mixed; and is necessary, because these straining machines never strain the colours so well as can be done, when such a course is possible, by hand.

The thickening used for reducing the colours must be prepared so that it contains a large quantity of caustic soda, the following being a recipe where British gum is used as the thickening material:—

Reduction for Indigo Blues.

1 gallon British gum thickening.
1 gallon caustic soda lye, 80° Tw.

The British gum thickening should first be made, and must be prepared very thick, the caustic soda afterwards being added in small quantities at a time.

Preparing the Cloth for Printing.—This process is performed in exactly the same way as described for the oleine prepare (p. 103), using, however, a hot solution of glucose, standing at 12° Tw. when cold. There are two varieties of glucose in commerce, one being in the solid state and the other occurring as a thick syrupy liquid. Although we believe the latter is the kind principally used, no material difference in the results will be found from the use of either, if the prepare when made ready for use stands at the same height on the Twaddle hydrometer scale.

Glucose is a highly hygroscopic substance, rapidly absorbing moisture from the atmosphere, and as it is absolutely necessary for the production of perfect results that the cloth should be quite dry during the operation of printing, the tissue should be prepared on the same day upon which it is to be printed, and should be carefully wrapped up in cloth until actually required by the machine printer.

Printing the Patterns.—The actual printing of the colours differs but slightly, and only in details, from the usual practice adopted with other colours. The following points should, however be noticed.

In order to ensure the cloth being perfectly dry, it should be passed around a drying drum immediately before it passes to the bowl of the printing machine. By this means the last traces of moisture are expelled from the cloth, and it is warmed or heated above the temperature of the surrounding air. The lapping on the bowl and the blankets should be of leatherine, or of some material upon which caustic soda has no action. The cloth used for the back-grey should be that which will afterwards be used for printing a pattern in the steam style in colours which will not show any unevenness upon cloth so used after bleaching. Many colours would give uneven results upon cloth which had been used as a back-grey in this process, or upon discharged cloth that had previously been printed in this class of printing colour, owing to the "mercerising" action of the strong caustic soda contained in these colours. Care should be taken that the pieces are not over-heated or over-dried after printing, or the shades will be thin and flat.

Steaming the Pieces.—After printing and drying, the pieces should be steamed as soon as possible, and it should be made a rule that all the printed pieces must be steamed and hung before the works are closed.

The printed indigo colours require a short steaming in steam under practically no pressure. This condition obtains in the steam ager described on p. 44, which is largely used for this purpose, the pieces being in the steam for about two to three minutes. It is better to pass a fent through the steamer and notice the effect before passing the goods through, to see that the engine is running at the proper speed to allow the goods to remain for a sufficient length of time in the steaming chamber. As the pieces leave the steamer they have a peculiar olive yellow-brown colour, and if the trial fent is of this peculiar shade it will be quite safe to enter the goods. The pieces before entering the steamer should be quite cool or the reduction of the indigo will be incomplete.

As the pieces pass out of the steamer they should be cooled as quickly as possible; they are then ready for the hanging room.

Oxidising the Reduced Indigo.—The pieces are now conveyed to the hanging room, where the indigo is allowed to absorb oxygen from the atmosphere and regain its original blue colour. The hanging room for these pieces should be an apartment which can be kept as cool as possible, freely ventilated, and the air moistened as much as possible by causing the air that enters the room to pass over water. Owing to the necessity for keeping the room as cool as possible, the use of steam jets for damping the air are not admissible. In this apartment the goods should be hung up in loose folds until the indigo is completely oxidised to the blue condition, the time required to accomplish this depending upon the atmospheric conditions of the apartment.

Washing and Soaping.—All that now remains to be done is to remove the thickening, excess of caustic soda and sodium carbonate which has been formed by the absorption of carbon dioxide gas from the air, and produced by the decomposition of the organic matter, and the other substances which were originally contained as impurities in the indigo.

The washing should first be commenced by passing the pieces in the open width through a dolly filled with water to remove the greater part of the soluble salts. The goods can then be further washed in the rope form in the ordinary dye-house washing machine, using first of all cold water, and afterwards, if necessary, water at 160° F. After a thorough washing the goods can be soaped at about 167° F. until all the removable colouring-matter is taken away, or until the shades are sufficiently pure. The pieces are then hydro-extracted and dried, when they are ready for the finisher.

SECTION VIII.

STEAM STYLE: COMPOUND COLOURS.

In speaking of the application of various classes of colouring-matters to the cotton fibre by printing, it is usual to classify them into divisions corresponding to their properties which fix the best methods for their use. Owing, however, to the fact that nearly every such group of colouring-matters is wanting in one or more colours yielding desired shades, it is frequently necessary for the printers' colourist to make printing colours containing members from two, and sometimes more, groups, in order to produce special shades. For example, a shade obtained from a printing colour composed of mordant (or extract) colouring-matters is frequently modified by the admixture of some of the basic colouring-matters. Again, dark indigo-blue shades are sometimes obtained in an economical manner by the addition of the basic colours, methyl violet and brilliant green, to the colour produced from logwood and chrome. The number of such cases could be multiplied, but this is hardly necessary to illustrate our meaning.

The unscientific method of producing shades, although necessary in practice, should only be resorted to when it is impossible to obtain the same shade by the combination of colouring-matters that require exactly the same mordants and methods for their application, because the shades produced by such mixtures are generally not so fast as could be desired, owing to the more or less imperfect fixation of one of the groups of dyes. The question of cost of production, and whether the buyer demands that the prints should reach a certain standard with regard to the fastness of the colours, has a good deal to do with the use of colours made in this way.

Compound colours are also produced by the use of several mordants along with a colouring-matter, which produces different shades with the several mordants, and in these cases the shade produced will depend, not only upon the particular colouring-matter employed, but also upon the relation of the various mordants to each other contained in the printing colours. An example of this method for producing shades is seen in the case of the claret shades obtained from alizarine printed with a mixture of alumina and chrome as the mordants, the shade depending upon the ratio between these two metallic salts, as well as upon the shade of the alizarine used. No exception can be taken to this system, because the same method of application would be used were the two mordants printed along with the alizarine separately, and these shades are satisfactory with regard to their fastness.

There are many colours (used in most print works constituted upon systems, or rather want of systems, which, although largely used, could not be explained in any reasonable or scientific way) composed of colours requiring several different methods for the proper fixation of each of the different colouring-matters contained in them, many of the printing colours having been handed down from the days when it was usual to mix together various colours, without much regard for how they should be fixed, print them upon the cloth, treat the printed cloth according to one particular method, and if the resulting colour was of the shade desired and fulfilled certain requirements, often not very exacting, with reference to the fastness of the shade, the recipe so obtained was adopted into the practice of the works, and has there remained. Such colours are at the present time rarely "designed," now that the management of print works has passed into the hands of men having some scientific training.

Several examples of compound colours will be found in the section devoted to "Practical Recipes for Printing."

CHAPTER III.—SECTION I.

INDIGO PRODUCED DIRECTLY ON THE FIBRE.

OF all the methods by which indigo is produced synthetically upon the fibre, the process involving the use of indigo salt T, made by Kalle & Co., of Biebrich-on-Rhine, is of the greatest practical importance. By the courtesy of the firm named we are enabled to show a pattern printed with this salt, in pattern No. 32, the print having been produced in the works of Messrs. Kœchlin Freres, of Mulhouse.

Indigo salt T is a combination of orthonitrophenyllactoketone with bisulphite of soda, and is sent out in the form of a paste or in the solid condition.

To obtain a solution, the paste is mixed with luke-warm water. For producing highly concentrated solutions for dark shades, the paste is best liquefied by heating to a temperature of about 35° to 45° C., afterwards cooling the liquor down to less than 30° C., and diluting the liquid with the required quantity of water. When the temperature is raised higher than 50° C., the ketone separates out as an oil, which dissolves again completely on cooling.

Aqueous solutions of the indigo salt which are considerably diluted must not be heated above 40° C., or the ketone will not be dissolved if it is precipitated, unless bisulphite of soda is added. The bisulphite of soda used for this purpose must be without free sulphurous acid.

The paste should be kept in a dark and cool place.

The solid form of the indigo salt has the advantage that it will keep for an indefinite length of time, and thus is more useful than the paste when it is only occasionally required to use it. When required for use it should be dissolved in the following way:—mix 10 kilos. of the indigo salt with 20 kilos. of bisulphite of soda containing 35 to 40 per cent. of real bisulphite of soda, and add to it ½ kilo. of calcined soda dissolved in 4 to 5 kilos. of hot water. Then heat quickly to 40°–45° C., and maintain this temperature for some minutes until the indigo salt is completely dissolved. The solution must now be quickly cooled, when it will form a yellowish crystalline paste; or it may be immediately mixed with the necessary quantity of cold water for use. The solid form of indigo salt T is about 3½ times stronger than the paste.

The solution of indigo salt can be supplied in printing in two ways:—(1) the cloth can be padded with an aqueous solution of the indigo salt and dried. After drying, the pieces can be printed with a thickened solution of caustic soda, using British gum as the thickening material and making up the colour so that it contains about 6 per cent. of caustic soda. After printing, the cloth is hung up (to expose it to the air), washed, acidulated, washed again, and dried. (2) The cloth is printed with a solution of the indigo salt suitably thickened with a neutral thickening. After drying, the pieces are passed through a solution of caustic soda lye standing at from 20° to 23° Bé. at the ordinary temperature. The pieces are now thoroughly washed and dried.

We are indebted to Messrs Kalle & Co. for the information given above as well as for the pattern.

SECTION II.

THE NAPHTHOL COLOURS.

WITHIN the last few years the application of the insoluble oxyazo-dyes to cotton, either by printing or dyeing, has greatly developed, forming a practically new style in calico printing, to which the name ot "Naphthol Colours" or "Style" is applied on account of the use of this substance in the process. Occasionally the style is spoken of as the "Vacanceine Style," so named by Messrs. Read Holliday & Sons, who were, perhaps, the first inventors of this method of application.

The principle of this process is that if a solution of a diazotised amine is added to a solution of alpha- or beta-naphthol an insoluble colour is precipitated. By using various combinations of these classes of bodies a very large number of shades can be produced. In this process, as applied to calico printing, the formation of the insoluble colour takes place within the fibres of the fabric, and the particles are thus fixed upon the tissue. The formation of the colour on the cloth can be effected by two methods—viz., the cloth can be prepared before printing with the solution of the naphthol, dried and then printed with a thickened solution of the diazotised amine, the colour being formed on those parts only where the colour is printed; or the cloth can be printed with a thickened solution of the naphthol, and then the pieces passed slowly through the solution of the diazotised amine. The first process is that which is principally used in printing.

The chemical changes which occur can be represented by the following chemical equations, representing one of the simplest combinations of this kind.

When the alpha- or beta-naphthol is dissolved in caustic soda for the prepare for the cloth, the following reaction occurs:—

$C_{10}H_7OH$	+	$NaOH$	=	$C_{10}H_7ONa$	+	H_2O
Naphthol.		Caustic soda.		Sodium naphtholate.		Water.

The solution of diazotised amine is prepared by dissolving the amine in hydrochloric acid, when it forms the hydrochloride of the base used. This solution is then cooled with ice, and a solution of nitrite of soda poured into it. Some of the hydrochloric acid acts upon the nitrite of soda and nitrous acid is liberated, and this, reacting upon the amine salt, diazotises it, as shown by the following equation :—

$C_6H_5NH_2HCl$	+	HCl	+	$NaNO_2$	=	$2H_2O$	+	$NaCl$	+	$C_6H_5N:NCl$
Aniline hydrochloride.		Hydrochloric acid.		Sodium nitrite.		Water.		Sodium chloride.		Diazobenzene chloride.

The solution obtained as the result of the chemical reactions between these bodies, suitably thickened, usually forms the printing colour.

When a printing colour of this nature is printed upon cloth, prepared as described, the diazo-compound acts upon the naphthol contained in the fibres of the cloth, and the colour is formed within the fibre where, and only where, the two substances are brought together. The following equation represents the changes occurring :—

$C_{10}H_7ONa$	+	$C_6H_5N:NCl$	=	$NaCl$	+	$C_6H_5N:NC_{10}H_6OH$
Sodium naphtholate.		Diazobenzene chloride.		Sodium chloride.		Insoluble colouring-matter.

The pieces are then washed to remove the bye-products and the thickening, after which the pieces are soaped.

A large number of substances that can be diazotised, and which, when combined with naphthol, produce useful shades, are offered to printers, some of them being definite chemical compounds and others mixtures containing several such compounds mixed in proportions to yield special shades.

In order to give a general idea of the shades obtained by using the diazotised solutions of various commercially prepared amines or bases, the following list is given, showing the shade produced when printed upon cloth prepared with both alpha- and beta-naphthol :—

Base gives with	*α-Naphthol*	*β-Naphthol*
Aniline	Brown	Bright orange
Toluidine	Brown	Brown
Paratoluidine	Brown	Very bright orange
Metanitraniline	Brown	Bright red
Paranitraniline	Yellow brown	Red
Nitroparatoluidine	Yellow brown	Orange
α-Naphthylamine	Puce	Claret
β-Naphthylamine	(Nearly) black	Bluish red
Amidoazobenzol	Yellow brown	Dull red
Orthoamidoazotoluol	Red brown	Yellow

The most important colours obtainable by this process are the various shades of red and maroon. The red from paranitraniline and beta-naphthol resembles the shade of Turkey red, and is much cheaper to produce; it is not, however, quite so fast as Turkey red, but cannot be said to be a loose colour.

Having now described the principles of the process, we will proceed to the practical working of the process and illustrate this by patterns.

Preparing the Cloth.—The prepare is made by dissolving, usually, beta-naphthol in a solution of caustic soda by the aid of heat and diluting the solution to the required strength. Many printers use a solution so prepared, but it will be found an advantage to add some oleine or soluble oil (castor oil soap) and glucose. The following recipe was used in printing patterns Nos. 33, 34, and 35:—

Naphthol Prepare.

3 lbs. beta-naphthol,
½ gallon caustic soda lye, 34° Tw.
Dissolve in hot water; and, when dissolved, add
12 lbs. oleine,
5 lbs. glucose,
dissolved in
20 gallons water.
Then make up to 100 gallons with cold water.

The solutions of naphthol and glucose should be quite cold before mixing them together.

The cloth is impregnated with this prepare on the slop-padding machine and carefully dried. The cloth, after leaving the rollers of the slop-padding box, must be passed over the drying chests at such a speed that, when it is delivered at the other end, it is completely dry, but not overheated. The steam passing into the drying chests must be regulated to ensure the cloth being properly dried at the speed at which the cloth is travelling, and this at as low a temperature as possible. If it is not to be printed immediately, it should be well wrapped up in cloth to prevent, as much as possible, the air from acting upon it, and it is better to prepare only so much cloth as will be required for printing at once. Cloth prepared with naphthol should always be printed as soon after preparation as possible, as it is liable to turn brownish in tone when kept, and thus the purity of the "whites" in the finished print will be affected; the colours will also be liable to develop unevenly. Drs. Lauber and Caberti have lately found that the addition of an alkaline solution of glycerine antimon-oxide to the naphthol prepare will prevent the cloth from becoming brown; it can then be allowed to lie, if required, for a few days before printing.

Alpha-naphthol is not often made use of, but, when required, it can be used in exactly the same way as described for the beta-naphthol.

Unless otherwise stated, all the remarks which follow apply to the beta-naphthol-prepared cloth in describing the colours obtained.

Preparing the Printing Colours.—The general method adopted for preparing the printing colour is the following, which was the method used for producing pattern No. 33, called vacanceine maroon:—

Vacanceine Maroon, Standard Solution A.

1 lb. 7 ozs. α-naphthylamine (Read Holliday & Sons),
2 gallons water.

Melt the naphthylamine in the two gallons of boiling water, and, whilst stirring all the time, add

1 lb. 1½ ozs. hydrochloric acid, 30 per cent.

When the whole has been converted into a paste, add

2 lbs. 3 ozs. hydrochloric acid, 30 per cent.
Cool thoroughly, and add
10 lbs. ice.

Stir well, and when the whole has been thoroughly well mixed, so as to reduce the temperature to near the freezing point, pour into the paste, underneath the surface, stirring the whole of the time, a cold solution containing

12¼ ozs. nitrite of soda
dissolved in
¼ gallon water.

In order to allow the action to complete itself, the mixture should now be stirred for about ten minutes, and then the bulk of the liquid made up to 5 gallons by the addition of water. This forms the solution from which the printing colour is made; only as much as will be required immediately should be prepared, as it does not keep long.

The printing colour is made from the above solution by mixing it with thickening, and, just before printing, adding the acetate of soda as below:—

Printing Colour.

1 gallon standard solution A,
1 gallon thickening,
1¼ lbs. acetate of soda.

The thickening used for preparing the colour with which the pattern was printed was a thick solution of gum tragacanth, but a thick solution of British gum may be used.

There is a method sometimes used for preparing these colours without the use of ice, which consists in thickening the solution of the amine when dissolved, and also the nitrite solution; the two thickened solutions are then mixed, stirred for some time, and, just before they are used, the acetate of soda is added. We do not recommend this method, as, in practice, it will be found unreliable and uncertain in its results, the shades varying considerably in intensity at various times.

The colours begin to decompose very rapidly, especially when at the elevated temperature of the machine room, and the gases evolved during decomposition cause the colour to froth considerably in the box of the machine. This frothing, however, unless very excessive, does not cause the shades to become uneven or to lack solidity as might be expected.

After the pieces have been printed and dried, they are washed well, and then soaped until they are sufficiently bright in shade, half-an-hour's soaping at 160° F. usually being sufficient. After well washing, they are then hydro-extracted and dried on the tins.

The scarlet red shades are obtained by using paranitraniline, which gives a bright scarlet-red shade, while beta-naphthylamine gives a bluer shade of red.

Pattern No. 34 was printed from a colour made exactly as described for the maroon shade, but β-naphthylamine was used instead of the α-naphthylamine.

Pattern No. 35 has been printed with the following colour:—

Paranitraniline Red.

Solution A.

9 lbs. paranitraniline (R. H. & Sons),
4½ lbs. nitrite of soda,
2½ gallons water (cold).

Solution B.

25 lbs. 13 ozs. hydrochloric acid, 30 per cent.,
25 lbs. 13 ozs. ice.

The latter does not form a solution but a liquid, in which the ice is floating. After the two mixtures have been made, and each well mixed together, solution A is slowly poured into solution B, stirring the whole of the time; after stirring ten minutes, the liquor is ready to be made into a printing colour, using the proportions given below:—

Red Printing Colour.

3 gallons thickening,
1½ gallons above solution,
4 lbs. acetate of soda.

The washing, soaping, &c., of the pieces after printing is exactly the same as for the maroon shade.

The acetate of soda, when added to the printing colour, has the effect of rendering the shades brighter, but, at the same time, the colours do not keep so well after the addition. This is the reason why it is always added just before use.

Pattern No. 36 shows a black, printed upon cloth dyed with paranitraniline red, and as the printer will often be required to dye pieces for subsequent printing, we will, although slightly outside our province, give the details with regard to the method of dyeing, as the process is not described in most of the text-books on dyeing. The cloth is first padded in a naphthol solution, prepared in this particular case as follows:—

Naphthol Prepare.

145 grammes beta-naphthol are dissolved at the boil in
10 litres water, to which
140 grammes soda lye of 75° Tw. had been added, and then
500 grammes Turkey red oil are added.

After drying the pieces, they are passed slowly, and in the open width, through the following developing or raising bath to develop the colour, after which the pieces are well washed, soaped, washed and dried, when they are ready for printing:—

Developing Bath.

300 c.cm. luke-warm water are poured on
60 grammes paranitraniline C and
150 c.cm. sulphuric acid, 170° Tw., are slowly added.
When completely dissolved, add, while continually stirring,
1 litre cold water, and when the solution is cold,
500 grammes ice are added, and then, while continually and slowly stirring,
35 grammes nitrite of soda, dissolved in 250 cubic centimetres water, are allowed to run in.

The mixture is left standing for 15 to 20 minutes under occasional stirring, then by adding cold water, brought to 10 litres, and before using it, a cold solution of 300 grs. acetate of sodium, dissolved in one litre water, is added.

By the addition of alkaline solutions of copper to the naphthol preparing solution, copper lakes are formed, which are not only different in shade to the colours obtained upon the plain naphthol prepare, but are also faster to light.

Messrs. Meister, Lucius, and Bruning have devoted considerable attention to the effect of copper salts upon this class of colours, and have published the following process for obtaining fast brown shades from para- and meta-nitraniline and beta-naphthylamine.* The formula for the prepare is :—

Copper Naphthol Prepare.

300 grammes beta-naphthol,
540 grammes soda lye, 36° Tw.,
500 c.cm. oil A,
1,000 c.cm. alkaline copper solution.

Alkaline Copper Solution.

1,000 c.cm. chloride of copper, 76·6° Tw.,
500 grammes tartaric acid,
1,200 c.cm. soda lye, 76·6° Tw.,
400 grammes glycerine.

Oil A.

1,000 c.cm. oxyoleic acid (Dr. Schmitz and Toenges ; Dusseldorf),
600 c.cm. warm water,
100 c.cm. soda lye, 76·6° Tw.,

The cloth, after being prépared with the above copper naphthol prepare in the usual manner, is printed with the following colours, yielding light and dark brown shades respectively :—

Light Brown Printing Colour.

200 c.cm. diazo solution from :—
28 grammes meta-nitraniline,
500 grammes thickening,
290 c.cm. water,
10 c.cm. hydrochloric acid, 36·8° Tw.

Dark Brown Printing Colour.

500 c.cm. diazo solution from :—
28 grammes paranitraniline in 500 c.cm.,
470 c.cm. thickening,
30 grammes acetate of soda crystals.

* *The Dyer and Calico Printer*, June 20, 1895.

With the meta-nitraniline it is necessary to add some hydrochloric acid to the printing colour in order to obtain even shades.

After printing, the goods are washed, soaped at 60° C. for twenty minutes, and afterwards steamed for a short time, which further develops the colour.

Dianisidine blue is now very largely produced directly on the fibre, both in printing and dyeing, and may be worked along with any of the other naphthol colours in multiple colour patterns. Either dianisidine base or the salt may be used, the latter being the most pleasant to work with, as it does not affect the mucous membrane. The following recipes are given by Messrs. F. Bayer & Co. for its production :—

Beta-Naphthol Prepare.

26·5 grammes β-naphthol are dissolved in
27 c.cm. soda lye, 36° Tw., and
200 c.cm. water ; then add
50 grammes Turkey red oil ; stir the whole in
50 grammes tragacanth thickening (6½ lbs. per gallon), and add
20 grammes acetate of soda ; then add water up to
1 litre.

The cloth is slop-padded with the prepare, dried, and then printed with either of the printing colours given below, after which it should be soaped for twenty minutes at 140° F. The printing colours and prepare given are for medium shades of blue ; they can be made stronger for darker shades.

Dianisidine Printing Colour No. 1.

A. 6·4 grammes dianisidine base are dissolved in
210 c.cm. water, and
10 c.cm. hydrochloric acid, 36° Tw.

B. 25 c.cm. sodium nitrite solution, 14¼ per cent.

C. 18 grammes copper chloride solution, 77° Tw.,
287 grammes tragacanth thickening (6¼ lbs. per gallon),
287 grammes British gum thickening (7½ lbs. per gallon).

Add *B* slowly, and with constant stirring to *A*, then gradually mix with C. After straining, the colour is ready for printing.

Dianisidine Printing Colour No. 2.

8·32 grammes dianisidine salt are dissolved in
5 c.cm. hydrochloric acid, 36° Tw., and
97 c.cm. hot water ; then add
116 grammes ice, to which add
25 c.cm. nitrite solution, 14¼ per cent.,
18 grammes copper chloride, 77° Tw.,
287 grammes tragacanth thickening,
287 grammes British gum thickening.

This colour is made up in the same way as described for No. 1.

In the case of both these printing colours they should, when ready for printing, contain an excess of nitrite, so as to be sure that the dianisidine is completely diazotised. To test if this is the case, a piece of iodide of starch test paper must be dipped into the colour, which should be turned blue; if the paper turns yellow, there is not enough nitrite present, and the blue, when printed, will be too red in shade.

Joseph Arnold has patented * the addition of alumina salts to colours to be printed on cloth prepared with beta-naphthol, so as to obtain purer colours when developed, and particularly the production of patterns in insoluble dianisidine blue from the di- or tetra-azo derivatives of amido and diamido products. The most important application of this method is in the production of red patterns upon a blue ground. The addition of cupric chloride to the printing colours is apparently desirable in some cases. The following proportions are given for printing red upon dianisidine blue :—

Naphthol Prepare.

20 grammes beta-naphthol,
22½ grammes soda lye, 20° B.,
75 grammes soluble oil,
65 grammes acetate of soda solution, 40 per cent.
Make up with water to 1,000 c.cm.

The prepared fabric is printed with a colour made from :—

Red Printing Colour.

12 grammes paranitraniline,
10 grammes water,
6½ grammes nitrite of soda,
50 grammes water,
100 grammes ice,
18 c.cm. hydrochloric acid, 21° B.,
20 c.cm. ice-cold water,
270 grammes tragacanth starch thickening,
60 grammes finely-powdered sulphate of alumina.

The addition of cupric chloride to this printing colour generally has the effect of making the shades purer and faster to light.

The goods having been printed with the colour, they are dried and then passed through the blue developing bath, prepared as below, after which they are washed in running water, soaped, and dried.

Dianisidine Blue Developing Bath.

20 grammes dianisidine,
31 c.cm. hydrochloric acid,
320 c.cm. water,
600 grammes ice,
12·7 grammes nitrite of soda,
88 c.cm. water,
55 c.cm. cupric chloride, 40° B.,
200 c.cm. ice-cold water.
Then add water until the solution measures 1,000 c.cm.

* *The Dyer and Calico Printer*, Nov. 20, 1895.

Other shades can be produced by using different substances for the printing colour, the general claim being that any dye which contains no alumina becomes very dull in shade when passed through the dianisidine solution, and that, if the colour does contain alumina, the latter preserves the brightness of the resulting shade.

The puce colour obtained by the combination of diazotised benzidine with β-naphthol is now much used in calico printing, and it is printed with a colour made, as below, upon cloth prepared with β-naphthol:—

Benzidine Puce.

55 lbs. tragacanth thickening (1 lb. per gallon),
8 lbs. acetate of soda.
Dissolve; and add
37 lbs. puce solution.

Puce Solution.

74 lbs. benzidine sulphate, 36 per cent.,
31 lbs. ice,
9 lbs. cold water,
13 lbs. hydrochloric acid, 34° Tw.
Mix together; and add, slowly,
33 lbs. nitrite of soda solution, 14½ per cent.

After printing, the pieces are washed and soaped as usual.

Diazo Fast Black.—Under the name of diazo fast black, Messrs. Meister, Lucius, & Bruning sell a colour which is very useful for printing, along with other colours, upon a naphthol-prepared cloth in multiple colour patterns; it has the advantage over logwood and aniline black in yielding a better white when printed over an acetate of tin resist. The printing colour is prepared as follows:—

Solution A.

6¾ ozs. diazo black salt are finely ground with
4¾ ozs. hydrochloric acid, 36° Tw., and
1 quart cold water; then add
1¼ lbs. ice,
2¼ noggins nitrite of soda solution, 29 per cent.
Stir well for some time, and then make up to
½ gallon with cold water.

Black Printing Colour.

½ gallon solution A,
3 lbs. 12⅘ ozs. flour thickening,
2¼ noggins chloride of copper, 76·6 Tw.,
8 ozs. acetate of soda.

Flour Thickening.

2 lbs. 6 ozs. wheat flour,
2 lbs. 8 ozs. water,
2 lbs. 2⅜ ozs. acetic acid, 9° Tw.,
3 lbs. tragacanth thickening (9½ ozs. per gallon).

This black is printed and treated exactly like the other naphthol colours.

Messrs. Rivett & Scott have recently described* a method of producing colourings containing black, blue, green, or yellow shades, along with any of the naphthol colours, produced by printing upon cloth prepared with beta-naphthol, the process having apparently been patented in this country. The method consists in printing any of the naphthol colours along with printing colours of such a nature that they are fixed merely by printing, hanging or raising, such as the colours made from Prussian blue and the raised lead yellows. Acids are added to the colours to act upon the prepare as may be required. The black printing colour is made from a mixture of logwood and gall liquor, red prussiate of potash, and nitrate of iron. Blues are obtained by using Prussian blue paste with oxalic and tartaric acid in the colour. Yellow, from nitrate of lead under the addition of citric and tartaric acids. Green, by mixing suitable proportions of the blue and yellow printing colours. After printing the above colours in a multiple colour pattern with one or more of the naphthol colours in the same combination, the pieces can be passed through a solution of bichromate of soda or potash, which will raise the yellow and green colours, after which they are washed as usual. The process is simple, and the prints obtained by this method are cheap.

Graessler has published a recipe for printing "naphthol red" in the form of a steam colour containing xylidine and beta-naphthol in the printing colour; it requires no preparation of the cloth before printing, but we do not think the method is used in practice.

SECTION III.

ANILINE BLACK—COLOURS FORMED AND FIXED BY OXIDATION.

Aniline black is an insoluble substance produced by the partial oxidation of aniline salts by means of various salts of copper and vanadium in the presence of air and chlorates of the alkali metals. It can also be produced, under the influence of heat, from a mixture of aniline salts, chlorate of soda or potash, and potassium ferrocyanide. The first methods mentioned are used for making printing colours for ageing, while the latter method is used for steam aniline blacks.

Aniline black has completely replaced the blacks formerly used in the "madder style," and in this application it finds one of its principal uses to the printer. It is also much used for printing blacks upon pieces which have previously been dyed with Turkey red or indigo blue, as it will work along with the other discharge colours printed

* *The Dyer and Calico Printer*, Feb. 20, 1896.

upon the same piece. For the latter purpose, the vanadium aniline black is preferred, owing to the short time required to age it in order to fully develop the colour.

Although it is possible to print the insoluble aniline black upon calico in a similar manner to that used for printing the insoluble pigment colours, this method is very rarely carried out in practice, as far better results are obtained by developing or forming the aniline black on and within the fibre.

The printing colours contain a salt of aniline, an oxidising agent or substance rich in oxygen, and, usually, a metallic salt—*e.g.*, copper or vanadium—which will act as a carrier for oxygen from the substance containing it to the aniline salt.

Aged aniline blacks may be divided into three kinds—viz., copper sulphide blacks, white paste blacks, and vanadium blacks, according to the particular carrier of oxygen used in the colour.

For these printing colours the following special drugs are required:—

Aniline Salts.—Aniline salts as purchased are known as "ordinary" aniline salts and "basic" aniline salts, the latter being made by grinding the former up in a mill with a small quantity of aniline oil, for the purpose of neutralising the small quantity of free acid usually present in the ordinary salt. The basic salt is used chiefly for steam aniline blacks, and the other kind for aged blacks. The shade of black obtainable from any sample of aniline salt depends upon the purity of the aniline oil from which it was prepared with regard to the presence and proportion of para- and ortho-toluidine; pure aniline yielding a pure black; ortho-toluidine, a bluish-black; and para-toluidine, a black with a brownish tone. As the relation of these three bases is generally quite beyond the control of the printer, a sample should be selected which is satisfactory in this respect.

Copper Sulphide.—The copper sulphide used for aniline blacks must be in the form of a paste, in which the particles of copper sulphide are in as fine a state of division as possible. It occurs in commerce in the form of a paste containing about 25 per cent. of solid matter, and should be quite free from, or contain merely traces of, soluble salts or free sulphur. It may be made in the works by precipitating a solution of sulphate of copper with a solution of sulphide of soda—made from caustic soda lye and sulphur—filtering, washing the precipitate, and then allowing it to drain until it contains 25 per cent. of solid matter; but, as it costs as much, or even more, to make it than to buy it ready made, this is rarely done by the printer.

White Paste.—White paste should be sulphocyanide of copper, but the commercial article is a mixture of sulphocyanide of copper and sulphate of barium. White paste varies considerably in composition, as will be seen from the results given below, showing the proportions of water, sulphocyanide of copper, and sulphate of barium in three samples offered to printers:—

ANALYSIS OF WHITE PASTE.

	No. 1.	No. 2.	No. 3.
Water and soluble salts, . .	43	59	31
Cuprous sulphocyanide, . .	27	21	42
Barium sulphate, . . .	30	20	27
	100	100	100

Vanadium Solution.—Vanadate of ammonia is the salt purchased for use in producing aniline blacks, but, before it can be used, it is necessary to prepare an acid solution of it, and to reduce it with glycerine. The following is a convenient method of preparing this solution ready for use when required :—

Vanadium Solution for Aniline Blacks.

½ oz. vanadate of ammonia.
Dissolve in
4 ozs. water.
Then add
3 ozs. hydrochloric acid, 30° Tw.
When dissolved, mix with
11 c.cm. glycerine,
2 ozs. water.

Place the mixture in a white porcelain evaporating basin; heat until the colour changes to blue, then make up to
½ gallon with water.

This solution contains vanadium equal to nearly 2¾ grains of vanadate of ammonia per fluid ounce.

The Printing Colours.—The stock colours made in the colour shop are usually prepared without one of the necessary ingredients, in order that they may be kept for some time after preparation ; the colours, as required, are finished by the addition of the omitted chemical. It will be obvious that only so much complete colour should be made up as will be required for immediate use. We will now give recipes for each kind of aniline black, merely pointing out that it is sometimes useful to employ both sulphide of copper and white paste in the same printing colour :—

Aniline Black (with Copper Sulphide).
Stock Colour.

1 pint cotton-seed oil,
4½ gallons water,
5 lbs. starch,
5 lbs. chlorate of soda,
½ lb. salammoniac.
Boil ; and add
12 lbs. British gum.
Boil; then cool, and add
10½ lbs. aniline salts.

The presence of British gum has the effect of preserving the cloth from tendering, owing, probably, to the presence of reducing substances. The above standard is stored and, when required, a printing colour is made as below.

Printing Colour—Aniline Black.

12 gallons of above standard colour,
1 gallon copper sulphide paste.

The next recipe is for a black (with white paste), the aniline salts being left out of the stock colour and added just before printing.

Aniline Black (with white paste).

Standard or Stock Colour.

5 lbs. starch,
4 gallons water,
3 lbs. chlorate of soda.
Boil; cool; and add
1 lb. white paste.

Printing Colour.

4½ gallons stock or standard colour,
½ gallon water,
5½ lbs. aniline salts.

The aniline salts should be dissolved in the water before adding them to the standard colour.

The above printing colours will work along with the colours for the dyed style, the cloth being either prepared with chlorate of potash or merely bleached. After printing and passing through the ageing machine in the usual manner, the pieces must be hung in the ageing room (see *Madder style*) until the aniline black is fully developed, an operation requiring from 36 to 60 hours. When the black is being used in combination with printed mordants the goods are, after the black has been sufficiently aged, dunged, washed, and dyed as usual for mordant colours; but when aniline black only is on the pieces they are frequently passed through a solution of bichromate of potash and soaped, which renders the colour slightly less liable to turn green on exposure to the air.

The length of time required to age the black printed from the recipes just given, quite unfits them for use along with colours which must be finished immediately or very soon after printing; as, for example, when a black is required along with discharge colours upon indigo-dyed cloth, &c. By the use of the vanadium solution, described above, a colour can be made which will fully age or develop in a few hours, and a colour so prepared is used in all cases requiring quick ageing.

The vanadium solution will, if required, act as the carrier of oxygen from the chlorate to the aniline salt without the use of any other carrier. The following recipe is taken from Sansone's book on *Printing of Cotton Fabrics* :—

Aniline Black (with vanadium alone).

1 gallon water,
1½ lbs. starch,
¾ lb. dextrine.
Boil; cool to 120° F.; and add
1¼ lbs. aniline oil,
1¼ lbs. hydrochloric acid, 32° Tw.
Cool; and add
¾ lb. chlorate of soda,
1 lb. water; then add
½ lb. vanadium solution.

A more practical, because cheaper and quite as effective, quickly-ageing black may be prepared by using both sulphocyanide of copper and vanadium in the same printing colour, which then requires a much less quantity of the expensive vanadium salt. The following recipe will be found to work well, and is the colour referred to as vanadium aniline black in various sections of this book :—

Vanadium Aniline Black.
(With Sulphocyanide of Copper).

Stock Colour.

4 gallons water,
5 lbs. starch,
3 lbs. chlorate of soda.
Boil; cool; and add
1 lb. white paste.

Printing Colour.

4½ gallons stock colour,
½ gallon water,
6½ lbs. aniline salts,
8 fluid ozs. vanadium solution.

The four recipes just given show the various methods of obtaining aniline black by the ageing method. These printing colours cannot be steamed, because they would injure the cotton fibre at a high temperature.

When a steam aniline black is required the copper salts are not used, but the aniline salt is oxidised by the use of a mixture of chlorate and ferrocyanide of potash. In order to further guard against any tendering action which may occur during steaming, it is advisable to employ basic aniline salts for this colour, as it will then contain no free acid.

Steam Aniline Black.

4 gallons water,
5 lbs. starch,
2¼ lbs. chlorate of potash.
Boil well; and add
3 lbs. ferrocyanide potash (yellow prussiate).
Cool, and add
5¼ lbs. aniline salts.

This printing colour should be printed upon unprepared, but well bleached, cloth, and the goods must be passed through Mather & Platt's steam aniline ager immediately afterwards. It will be found advisable to pass the goods twice through the aniline ager, each passage taking about two minutes, rather than to run the machine slower. After ageing, as described, the black will be to a great extent developed, and for some styles it is necessary to finish off here; but, where it can be done, better results will be produced if the pieces are steamed for a longer period. As, however, there is a tendency to reduce the strength of the fibre by the liberation of acid fumes during steaming, means must be taken to guard against this. The usual method adopted is to pass the pieces through a small machine constructed on lines similar to the ageing machine, in the bottom of which iron trays, containing liquor ammonia, are placed; the air inside the chamber is thus impregnated with the vapour of ammonia, which, as the pieces are passing through the chamber, neutralises any free acid that may have been liberated by the short steaming in the steam ager. The goods are then steamed for about forty-five minutes (without pressure) in the cottage or, better still, the continuous steamer. When the pieces have been steamed, they are further oxidised or "raised" by quickly passing them in the open width through the following raising solution:—

Raising Liquor for Blacks.

16 gallons water,
40 lbs. sulphate of soda (Glauber salts),
3 lbs. bichromate of potash.

The liquor should be kept slowly boiling, and the pieces passed through at such a speed that they remain for 30 to 60 seconds in the solutions. The pieces are then well washed, soaped for 30 to 45 minutes at the boiling point, washed well, and dried; they are then ready for finishing.

Pieces printed with steam aniline black are very liable to turn greenish in shade when stored in the warehouse, due to the reducing action of the sulphurous acid contained in the atmosphere of all large towns; this defect shows itself principally at the edges and in the exposed folds of the goods. In order to prevent this as much as possible, it is advisable to add some borax to the finishing size, which will absorb and render harmless any sulphur dioxide that may be present in the air. This greening action is noticeable chiefly in fine cover patterns.

Naphthylamine Puce.—Very fast puce shades can be obtained by the use of nitrate of naphthylamine instead of aniline salts; when reduced, fine fast grey shades are obtained. These colours are, however, very little used in practical work. The following recipe for such a colour is given by Sansone :—

Naphthylamine Puce.

1 gallon starch paste,
3 lbs. nitrate of naphthylamine,
2½ lbs. acetic acid,
½ lb. chlorate of soda,
2 lbs. water,
½ lb. vanadium solution.

Dissolve the naphthylamine in the acetic acid and mix with the starch paste. The chlorate of soda is then dissolved in the water and slowly added, stirring all the time. Just before printing, add the solution of vanadium.

The cloth, after printing, is treated exactly like cloth printed with vanadium aniline black, and this colour may be used along with the latter or in similar styles.

Cutch Browns.—Although the colours obtained from catechu are produced by oxidation, the processes of application differ from those used for aniline black. Notwithstanding this, we have considered it advisable to include it in this portion of our work.

Catechu is used in printing for the production of brown shades, but it is much less used now than was formerly the case. Catechu, or cutch, occurs in commerce in the form of large dark brown cubes, which are with difficulty soluble in boiling water, a large portion separating out on cooling, producing a turbid liquid. The presence of a small quantity of acetic acid, caustic, or carbonated alkali greatly increases the solubility in the liquid, and a stock solution of catechu, prepared with one of these additions, is stored for preparing the printing colours. Generally two stock liquors are kept—one prepared with acetic acid and water, and the other containing an alkali, each being used for colours treated in different ways after printing. As ammonium chloride (sal ammoniac) is generally used in the colours made with the acetic acid solution, this chemical is often added to the stock solution of catechu, but it may be added to the printing colour if desired. The following solutions are examples, showing the two methods for preparing these stock liquors :—

Catechu Stock Solution No. 1.

9 lbs. catechu,
1 gallon water,
2 lbs. ammonium chloride,
½ gallon acetic acid, 12° Tw.

The catechu should be boiled with the water until quite dissolved, an operation taking from ten to twelve hours. During the boiling the bulk of the liquid must be kept up by occasionally adding water, and, when solution is complete, the pan should be filled up to the usual bulk with water to replace that which has evaporated. When the liquor has boiled and been made up to bulk, the ammonium chloride and acetic acid should be added, and the liquor cooled, when it is ready for use.

The other stock solution is prepared in a similar manner, using the following proportions :—

Catechu Stock Solution No. 2.

3 lbs. catechu,
1 gallon water,
7 ozs. purified soda ash.

Instead of soda ash, caustic soda may be used, as given below :—

Catechu Stock Solution No. 3.

3 lbs. catechu,
1 gallon water,
½ noggin caustic soda lye, 50° Tw.

The production of the colours from catechu in printing depends upon the oxidation of the catechuin contained in the catechu ; this oxidation may be accomplished by adding oxidising agents to the printing colour, or by passing the whole of the cloth through a solution, which will have an oxidising action upon the colour printed upon the piece. The latter method can only be used when a one-colour pattern is printed, or when all the colours printed upon the piece are made from cutch, or in those cases where the other colours are not affected by their passage through the oxidising bath.

The first class of printing colours are prepared from an acetic acid solution of catechu, which requires the addition of thickening and a suitable oxidising agent. British gum and gum Arabic or Senegal, the latter gums by preference, are the most suitable thickening materials to use. The oxidising agents generally employed are the salts of copper, the nitrate and acetate being generally preferred. Acatate of lime is frequently added to the colour in addition to the various substances named.

The following colours show the application of these two copper salts :—

Catechu Brown No. 1.

3 gallons catechu stock solution No. 1,
½ gallon nitrate of copper solution, 50° Tw.,
8 gallons Senegal thickening.

Catechu Brown No. 2.

3 gallons catechu stock solution No. 1.,
1 gallon acetate of copper, 20° Tw.,
8 gallons gum Arabic thickening.

Both these colours should be printed on cloth prepared with a solution of chlorate of soda or potassium to assist the oxidation of the cutch, and thus shorten the time required for ageing. After ageing, the cloth can be passed through a solution of potassium bichromate, or may be simply dunged, if there are other colours printed upon it that require dyeing.

The alkaline solution of catechu is used for those styles where the goods are passed, after printing and ageing, through a solution of bichromate of potash, and it is merely reduced with thickening to give the required shade, adding a little more alkali when greatly reduced.

An iron mordant can be used with catechu, as in the following recipe. It yields darker shades:—

Dark Cutch Brown.

3 gallons catechu stock solution No 1,
8 gallons thickening,
1 gallon iron liquor.

The pieces, after printing, are aged overnight, and then passed through a solution of bichromate of soda or potash to oxidise or raise the colour.

SECTION IV.

RAISED COLOURS.

In this class the shade is produced upon the cloth by printing a colour which requires, for the development of the shade, to be passed through a liquor, which may have for its object the precipitation or fixation of the insoluble colouring-matter, or rather pigment, upon the cloth. In this way several shades of yellow, orange, and buff prints are prepared.

Iron Buff.—This buff is due to the colour of iron oxide (ferric oxide, iron mould), and is produced by printing a colour containing ferrous acetate, steaming the pieces and then fixing, or completing the process of fixation, by passing the pieces through a solution of soda ash, which precipitates the whole of the iron upon the cloth. Any iron which may still be present in the ferrous condition is converted into the ferric state during the process of washing which follows, the oxygen being derived from the air and from that contained in the washing water.

The ferrous acetate used for this purpose is best prepared from a mixture of acetate of soda and copperas, the solution obtained, of course, containing sulphate of soda as well as ferrous acetate; as the iron liquor, so largely used as a mordant in the madder style, is not suitable for this purpose, because of the large amount of organic matter always present, which is, in the dyed style, an advantage.

The commercial salts, acetate of soda and copperas, should be mixed for this process in about the proportions of one part of acetate of soda to six or seven parts of copperas, and dissolved in water until the solution stands at 40° Tw. This solution then forms the stock liquor, from which any of the shades of iron buff can be prepared by the addition of more or less thickening.

Instead of acetate of soda, the lead salt is frequently used for preparing ferrous acetate; but there is no practical advantage arising from its use; it is more expensive, and the mixture must be allowed to settle and the clear liquor decanted for use.

The thickening material chiefly used is British gum, the following recipe being such as to yield a medium shade of buff:—

Iron Buff Printing Colour.

1 gallon ferrous acetate liquor, 40° Tw.,
3 gallons British gum thickening.

After printing the colour so prepared upon unprepared cloth, the latter can be slightly steamed, or not, as thought desirable, the practice varying in the various print works. After printing and drying or steaming, the pieces are passed full width through a solution of soda ash, from 8° to 10° Tw. in strength contained in a dolly, the solution being cold and the pieces passing through the liquor at the rate sufficient to allow them to remain in the solution for about two minutes. From the dolly the goods pass to the washing machine, where the soda is washed away and the process of oxidation is practically completed; but some printers pass the pieces through, or enter the pieces in, a weak solution of bleaching liquor at 1° Tw. to ensure the complete oxidation of the iron.

Iron buff is fast to the action of light, soap, and chemic, but is extremely sensitive to the action of acids.

Chrome Yellow.—Chrome yellow can be printed, or formed, upon the tissue by first printing a thickened solution of acetate of lead, and then passing the pieces through a boiling solution of bichromate of potash or soda containing either salt or, better, sulphate of soda, when the acetate of lead is converted into the yellow insoluble chromate of lead.

For printing these yellow shades it is advisable to prepare the cloth with a solution of sulphate of soda, 3 to 4 ozs. per gallon, before printing, as the colour has then less tendency to spread and is better fixed to the cloth.

The printing colours are usually thickened with British gum, the depth of shade depending upon the quantity of acetate of lead contained in the colour per gallon. The following proportions will yield a shade of medium depth:—

Raised Yellow Printing Colour.

3 lbs. white lead acetate,
1 gallon water.
Dissolve; and add
1 gallon thick British gum thickening.

After the goods have been printed they should be hung in a cool room for a few hours and then sent forward for raising.

The raising of the colour is performed in the dolly described on p. 57, several of them being worked together. The first dolly contains the raising liquor, kept nearly boiling by means of an open steam pipe passing into the liquor; the second and third dollies contain water to wash out the raising liquor from the goods; after which they are usually passed between spirt pipes; and then further washed in the dye-house washing machine. The liquor used for raising generally contains about four ounces of bichromate of potash per gallon with about twelve times its weight of salt or sulphate of soda. Both the following solutions are used on the large scale :—

Raising Liquors for Chrome Orange.

No. 1.

4 ozs. bichromate of potash,
2½ lbs. common salt,
1 gallon water.

No. 2.

4 ozs. bichromate of potash,
3 lbs. sulphate of soda,
1 gallon water.

Bichromate of soda can be used instead of the potassium salt, if required, using proportionate quantities in accordance with the percentage of chromic acid contained in each.

Chrome Orange.—Raised chrome orange is always produced by passing the goods, already raised to a yellow shade, through an alkaline solution containing neutral chromate of potash, the alkalinity being due to the addition of lime. The following recipe yields good results :—

Chrome Orange Raising Liquor.

2 ozs. lime,
2 ozs. neutral chromate of potash,
20 gallons water.

The orange tone is produced in about half a minute and the goods are then washed and dried.

The orange tone is due to the formation of a basic chromate of lead by the action of the lime on the yellow normal chromate of lead.

CHAPTER IV.—SECTION I.

DYED STYLES: THE MADDER STYLE.

The dyed styles differ from the processes previously described in that the colouring-matter does not form a part of the printing mixture, but is subsequently applied to the cloth in the dye-beck. The printing colour consists of the various mordants, thickened with a suitable thickening paste. These colours are printed upon either prepared or unprepared cloth, according to the nature of the mordant contained in the printing colour, after which the goods are passed through the processes known as ageing and dunging, whereby the mordant is fixed on the cloth in a suitable condition to combine with the colouring-matters to be afterwards applied, the thickening material being removed at the same time.

The salts of iron, alumina, and tin, are those most frequently used as mordants in this style, alone and in combination with one another, while, by the use of the various colouring-matters that are capable of being applied by dyeing on these mordants, a very large number of useful and fast shades can be obtained.

The iron mordant is chiefly employed in the form of "iron liquor," also known as "pyrolignite of iron" and "black liquor," containing the iron salt in the condition chiefly of ferrous acetate, but containing much tarry matter. It is found in practice that this solution is preferable to a purer solution of ferrous acetate, which could easily be prepared, on account of the shades being richer and fuller, a result which is probably due to the fact that the tarry matters contained in this iron liquor prevent the too quick oxidation of the iron into the ferric condition; this allows time for the solution to more thoroughly penetrate into the fibres of the cloth before this oxidation takes place, a change which is accompanied with the formation of an insoluble salt of iron which, if formed on the surface, is then unable to enter into the cloth and is probably washed away during the process of dunging.

Iron liquor is generally sold as a liquid standing at 24° Tw., dark in colour, and having an odour somewhat resembling burnt wood. All the recipes for colours given below are for iron liquor of this strength.

When the printing colour is intended for a black obtained by dyeing with logwood along with certain proportions of other dyestuffs, the iron is either used alone—that is, without the addition of any other mordant, or mixed with some acetate of alumina. Iron alone rarely yields a satisfactory shade of black; therefore the alumina salt is employed in conjunction with it to modify the shade and render it more pleasing in tone. For purple shades, produced with alizarine as the dye, it is usual to add to the printing colour a solution of arsenite of soda (which is generally called "purple fixing liquor" in the colour shop), especially when pale shades are being produced. The arsenite of soda, being a reducing agent, probably prevents the too rapid oxidation of the iron mordant, allows it to more thoroughly penetrate into the fibres of the cloth, and thus produces faster and brighter shades. Another probable factor in this increased fastness of shade is that the arsenic enters into combination with the mordants and finally forms part of the resulting colour lake, complex combinations of this nature frequently giving rise to shades of superior fastness compared with those of simpler constitution.

The following is a list of the shades given with the dyestuffs named upon an iron mordant applied in the dye-beck, it comprises the colouring-matters chiefly employed in the works in connection with the "madder style":—

Dyestuffs.	*Shade Produced.*
Alizarine (blue shade),	Purple.
Di-nitrosoresorcine,	Green.
Sumach,	Brownish-black.
Persian berries,	Yellowish-brown.
Myrabolams,	Brownish-black.
Logwood,	Black.
Quercitron bark,	Yellowish-brown.

The colouring-matters just named are the principal ones used for dyeing the pieces in this style, but there are a few other dyestuffs that are occasionally used.

No preparation of the cloth previous to printing is absolutely necessary for the complete fixation of the iron mordants, but the ageing process is very much decreased in length if the cloth receives a preparation with chlorate of soda or potash, preferably the latter. The prepare should contain from 2 to 4 ounces of chlorate of potash per gallon of water; it is applied in the same way as described for oleine prepare, p. 103.

Alumina used as a mordant in this style is employed chiefly in the form of acetate, or sulphate-acetate, of alumina, sold under the name of "red liquor." These alumina mordants should be perfectly free from any trace of iron, as the latter will have a tendency to destroy the brilliancy of the shades unless means are taken to render its presence harmless. It is, however, easy to obtain red liquors free from iron; these are often sold under the name of "tin-red liquor."

Alumina is largely used for the production of reds and pinks by subsequently dyeing the printed pieces with the several shades of ordinary alizarine, with a large number of other dyestuffs, both natural and artificial, it yields a very large number of shades. It is also largely employed (along with varying proportions of iron liquor) as the mordant for the production of chocolate, black, and other shades, corresponding to the dyestuffs used in the after process of dyeing.

In the preparation of printing colours for reds, pinks, and colours where the slightest trace of iron would impair the brightness of the resulting shade, a small quantity of a tin salt, in the stannous condition, is added; this prevents the iron from soiling the shade. The tin salt is generally introduced in the form of tin crystals (stannous chloride), either alone or mixed with certain proportions of acetate of soda, forming a kind of acetate of tin. The presence of the tin salt has the effect of keeping any iron that may be in the colour in the ferrous state, or, if originally existing in the form of a ferric salt, of reducing it to the ferrous condition, in which form it will not be fixed on the cloth, and will therefore leave it when the cloth is dunged. The tin acts in the same manner with any iron existing as impurities in the thickening or other ingredients of the printing colour, or introduced accidentally during the printing or other processes through which the pieces pass before dunging. Where the alumina mordant is to be mixed with iron for chocolates, &c., the tin salt is of course omitted.

The following list shows the shades obtained by dyeing upon alumina mordant with each of the dyestuffs named :—

Dyestuff.	*Shade Produced.*
Alizarine (blue shade),	Bluish-red.
Alizarine (yellow shade),	Yellowish-red.
Alizarine orange,	Reddish-orange.
Sumach,	Pale buff.
Myrabolams,	Dull yellow.
Persian berries,	Yellow.
Quercitron bark,	Yellow.
Logwood,	Violet-grey.

The cloth does not require any preparation when an alumina mordant colour is to be printed upon it. The presence of an alkaline chlorate on the cloth does not affect the fixation of the alumina, so that prepared cloth may be used when an iron mordant is to be printed upon the same piece as the alumina mordant.

By means of colours prepared from iron or red liquor, or mixtures of the two mordants, a large range of shades are obtained by afterwards dyeing with the various dyestuffs mentioned below.

We will now describe how printing colours are prepared from the mordants named, and the manner in which the metallic mordant is fixed on the cloth in a suitable condition to combine with the dyestuffs afterwards to be applied.

The thickening material generally used for the printing colours in the dyed style is flour, usually alone, but sometimes mixed with certain proportions of British gum. About 2 lbs. of flour per gallon are required to suitably thicken the mordants, the quantity varying to some extent with the quality of the flour and the nature of the ingredients of the printing colour.

Printing Colours Prepared from Iron Mordants.—Blacks.— The name given to a printing colour prepared with a mordant which requires dyeing before any shade or colour is produced at all is that of the shade it is chiefly employed in producing, although, of course, the same colour will give different shades if dyed with other dyestuffs. For example, a strong iron mordant printing colour is usually termed "black," because it is chiefly used to produce black shades by dyeing with logwood, but the same printing colour will yield a dark myrtle-green shade if, instead of logwood, dinitrosoresorcine is used for dyeing. A weaker iron printing colour is usually termed "purple," because used for obtaining purple shades by subsequent dyeing with alizarine, although, in this case, arsenic is generally introduced into the colour as well as iron.

As an example of a strong iron mordant suitable for the production of blacks from logwood and for other purposes, the following recipe is given :—

Black No. 1.

3 gallons iron liquor, 24° Tw.,
3 gallons water,
¾ gallon acetic acid, 8° Tw.,
1 pint cotton-seed oil,
13 lbs. flour.
Boil well; cool; and strain.

This colour is useful for all cases where a strong iron mordant is required, and where the presence of alumina is either useless or undesirable, as, for example, when the pieces are to be dyed with the so-called "solid green."

For the production of blacks from logwood it is preferable to use a colour containing alumina as well as iron, as the blacks obtained from a colour so prepared are of a less rusty or bronzy tone. For this purpose the recipe given below will be found more suitable than the one mentioned above :—

Black No. 2.

2 gallons iron liquor, 24° Tw.,
1 gallon red liquor, 14° Tw.,
¾ gallon acetic acid, 8° Tw.,
1 pint cotton-seed oil,
13 lbs. flour.

For paler shades, either of the above colours may be reduced with flour paste to any required degree.

For the purpose of obtaining purple shades by dyeing with alizarine, the iron liquor is associated with a solution of arsenite of soda, containing an excess of pyroligneous or wood acid, usually prepared in the colour shop, and known as "purple fixing liquor." There are many recipes for making purple fixing liquor, but the following is an old and well tested formula :—

Purple Fixing Liquor.

5½ lbs. arsenious acid (white arsenic),
6 lbs. soda crystals,
½ gallon water.

Mix the white arsenic and the water in a colour pan, turn on the steam and gradually add the soda crystals, bringing the liquor to the boiling point. When all the soda crystals have been added, continue boiling until the arsenic has dissolved ; then add

12 gallons wood acid.

Stir well, place in a wooden cask, allow to stand some hours, and add

3 gills hydrochloric acid, 32° Tw.

It is advisable to allow the liquor to stand a few days before using it, as it seems to improve in quality by keeping.

The various strengths of purple mordants are prepared by using equal parts of iron liquor and purple fixing liquor, adding more or less thickening according to the intensity of the shade required, the thickening usually consisting of flour paste.

The strongest shade of purple is generally prepared from proportions of the various ingredients somewhat resembling those given below, which will serve as a type of this class of printing colour :—

Purple.

1 gallon iron liquor, 24° Tw.,
1 gallon purple fixing liquor,
4 gallons flour paste.

Add a small quantity of an acetic acid solution of methyl violet to render the colour visible on the piece during printing. This is called "sightening" a colour.

The production of printing colours for obtaining chocolate shades which contain both iron and alumina will be treated later.

Printing Colours prepared from Red Liquor.—Reds.—From acetate of alumina, or "red liquor," printing colours, used chiefly for obtaining reds and pinks, are obtained by dyeing with alizarine; hence such colours or thickened mordants are termed reds and pinks according to their strength. In order to prevent the accidental presence of iron salts from influencing the shades, a small quantity of tin crystals or stannous chloride is added to the colour; this prevents the iron from fixing itself on the fibre. As in the case of the iron mordant colours, the thickening material usually employed is flour paste, tin crystals being added to the extent of ¼ to ¾ oz. per gallon of colour, the larger proportion being used in the case of dark red shades.

Red.

1 gallon tin red liquor, 14° Tw.,
2 gallons water,
6 lbs. flour.
Boil well; cool; and add
¾ oz. tin crystals.
Sighten with magenta solution.

Pink shades are prepared in the same way but a larger proportion of thickening is used.

Chocolate Shades.—An extremely large variety of shades are produced by the employment of printing colours containing various proportions of iron and red liquor in the same colour, even when the same dyestuff is used for dyeing; the range is still further extended when various colouring-matters are employed in the dye-beck. In the colour shop, colours so made are usually called "chocolates," because they yield various shades approaching to chocolate when dyed with alizarine.

These colours are generally prepared from "iron liquor" at 24° Tw. and ordinary "red liquor," standing at 18° Tw., the proportion of one to the other varying, usually, from 1 of iron liquor to 4 of red liquor, to as much as 1 of iron liquor to 200 of red liquor. The following printing colour is an example of a colour prepared on this principle, where the proportion is 1 to 12:—

Chocolate.

1 gallon iron liquor, 24° Tw.,
12 gallons red liquor, 18° Tw.,
13 gallons water,
1 gallon acetic acid, 12° Tw.,
1 quart cotton-seed oil,
45 lbs. flour.
Boil well; and cool.

Paler shades are obtained by reducing the strength by the addition of more flour paste.

It would be useless to multiply the number of recipes for this kind of colour, as the principle will be readily understood from what has just been stated; the greater the proportion of iron liquor the darker and blacker the shade becomes, while the larger the quantity of red liquor contained in the colour, the redder and brighter are the shades obtained.

When a colour containing only alumina is to be printed, and where no colour containing iron liquor is to be printed, on the same piece, the cloth is not in any way prepared previous to printing; but for colours which are prepared from iron liquor (whether alone or mixed with alumina) the cloth should first be prepared with chlorate of potash or soda, as described on p. 171.

As the pieces pass over the drying chests of the printing machine a large proportion of the acetic acid contained in the printing colour in combination with the mordants is expelled, thereby rendering the salts more basic in character, by reducing the proportion of acid with which they are combined, the metallic mordant at the same time entering into combination with the fibre to a small extent.

The pieces are then passed through the ageing machine (see p. 43), where they are subjected to the action of warm and moist air. During their passage through this machine the thickening material on the cloth is softened; the cloth can then fully exert its attractive influence upon the mordant, under which influence, combined with the action of the oxygen of the air and the elevated temperature of the apartment, the mordant is either completely fixed, or is rendered in such a condition as to be completely fixed when hung for some time longer and then passed through the dunging machine. In the case of colours containing iron mordants the iron becomes oxidised during this process into the ferric state, and the iron exists on the aged piece, either as hydroxide, or as an insoluble basic ferric acetate, or as a mixture of these two bodies. The chlorate in the prepare facilitates this oxidation.

After passing through the ageing machine the goods are either hung in the ageing room or allowed to remain (made up into bundles) in the ageing room for about two days, when they are ready for the dunging operation. The object of keeping the goods for the time stated in the ageing room is to allow time for the ageing process to complete itself, the principal part of the process taking place in the ageing machine.

The next process through which the goods pass is that known as dunging, so called because formerly cow dung was the principal agent used in the process. Dunging removes the thickening material from the cloth, detaches the loosely adhering mordant from the piece, and completes the fixation of the mordant on the cloth, rendering it in a more suitable condition to combine with the dyestuffs presented to it in the dye-beck.

The dunging of the pieces is done in a continuous manner in the machine described on p. 56, the pieces passing alternately through the first, second, and third dunging liquors, and, finally, through boiling water, to remove all the substances used in the printing process from the cloth. The first and largest tank, or dolly, is filled with liquor, usually prepared from a mixture of arseniate or binarseniate of soda, chalk, and cow dung with, occasionally, the addition of silicate of soda and nitrogenous substances like glue size. As an example of a first dunging liquor the following is given:—

First Dunging Liquor.

100 gallons water,
1½ gallons binarseniate of soda solution, 18° Tw.,
½ gallon cow dung,
6½ ozs. chalk,
½ gallon glue size.

The goods pass slowly through this solution, which should be kept slowly boiling, taking care that the goods pass through the liquor in the open or full width.

The dunging liquor should be so constituted that, while it will allow the mordant to be properly fixed on the cloth, it will deprive any mordant which is detached from the piece and finds its way into the liquor of all its affinity for the fibre; otherwise, the mordant will be taken up by the cloth evenly over the whole surface and the unprinted parts of the cloth (which should remain white during the dyeing process) will be soiled. This condition is secured in the above liquor, in which the glue size and cow dung materially assist in preserving the purity of the white parts of the print.

The second dunging cistern generally contains merely a weak solution of binarseniate of soda, the goods passing, full width, through the solution, which is usually kept at about 160° to 180° F. The second dunging tank is generally of about 1000 gallons capacity, or about half the size of the first tank, the pieces requiring about twenty minutes to pass over the whole of the rollers. The second dunging liquor should be of about the following strength:—

Second Dunging Liquor.

1 gallon binarseniate of soda solution, 18° Tw.,
100 gallons water.

From the second dunging liquor the cloth is usually drawn through pot-eyes, which cause it to assume the rope form, into a washing machine charged with boiling water containing a little cow dung; after which, it passes through another similar machine containing pure water only. As it leaves the last machine the cloth is plaited down on to waggons, and as these are filled it is conveyed into the dye-house for dyeing.

Silicate of soda is not used to a large extent in this country for dunging. Some printers use a small quantity along with the arseniate or binarseniate of soda and the other ingredients named above; but it usually bears a comparatively small proportion to the other substances used. On the Continent, however, we believe that it is used very largely, and that its use has greatly extended during the last few years, owing to the manufacture of silicate of soda in the liquid form practically free from an excess of alkali.

If arseniate of soda is employed instead of the binarseniate recommended above, care should be taken that it does not contain a large quantity of free alkali, which would tend to strip the mordant off reds and pinks by dissolving the alumina.

The pieces are now ready for dyeing with the particular dyestuffs required to produce the given shade, particulars of which will be given under the heading of the several dyestuffs noticed later in this section.

Chromium Mordants or Colours.—Although acetate of chrome is largely used as the mordant in steam colours, it cannot be employed in the same way as the acetates of iron or alumina in the dyed style, because the chrome is not sufficiently well or completely fixed by the processes of ageing and dunging. This is the reason why the use of chrome-mordanted cloth in the dyed style has until recently been so limited.

Within the last few years, however, considerable attention has been given to the fixation of oxide of chrome on the cotton fibre by printing; and several mordants have been found, and various methods devised, for fixing them upon the cloth after printing. The two compounds chiefly employed for this purpose, at the present time, are, probably, the bisulphite and chromate of chromium.

Bisulphite of chrome is usually purchased by the printer as a liquid, which merely requires thickening with starch or flour paste to prepare it for printing, the quantity or proportion of thickening being regulated in accordance with the shade desired.

After printing and drying, the fixation of the mordant can be effected in two ways, both of which are used according to the nature of the pattern printed.

In those cases where chrome mordants of various strengths only are printed on the cloth the pieces are, after printing and drying, passed through Mather & Platt's steam ageing machine, where a large proportion of the chrome mordant is fixed on the cloth, the fixation being completed by passing the goods in the open width through a solution of soda crystals, 2 to 4 ounces per gallon (according to the strength of the colours on the piece), kept at about 200° F. in a dolly. The mordant is completely fixed in this solution; after a thorough washing, the goods are then ready for dyeing.

Where an acid resist has been printed on the cloth the pieces are, after printing and drying, passed twice through the steam ager, hung for a few hours, and washed; or they may be dunged in the manner usual with reds and purples.

Chromate of chromium has been patented by Gallois as a mordant, and the patent is worked by Messrs. Meister, Lucius & Bruning, who supply the chrome mordants ready for use. They are applied in the same way as the bisulphite of chrome, and the fixing on the cloth is effected merely by passage through the steam ager or by steaming without pressure. It will be found an advantage to use a little glycerine in the printing colour, which will reduce the salt during steaming and fix it more completely on the cloth.

Chromic acid, which is now sold at a very low rate, serves for the preparation of a chrome mordant similar in its properties to the chromate of chromium just noticed, chromate of chromium being formed (at any rate as an intermediate product) in the process of its fixation on the cloth. The best method of making this mordant is the following:—

Chrome Mordant.

Dissolve 8 ozs. chromic acid in
½ gallon water.
Cool; and add
8 ozs. glycerine,
½ gallon water.

The solution should be kept cool, and if this is done it will keep in good condition for a considerable time, although it will turn darker in colour.

The mordant can be thickened with thick starch paste, mixed cold, using proportions according to the shade desired. Where a stronger colour is required than can be made from the liquor given above, the requisite quantity of chromic acid should be first dissolved in water, and gradually added to the thickening previously mixed with the same weight of glycerine, taking care that the temperature of the mixture is kept low, otherwise the colour will decompose and form a stiff paste. The strong colour will not keep.

The pieces, after printing and drying, are passed through the steam ager and washed, when they are ready for dyeing; or, before dyeing, they may be dunged, as described for alumina mordants. When treated in this way, the pieces are, before dyeing, of a pale fawn colour in the parts printed. The mordant on the piece probably consists of a basic chromate of chromium mixed with the hydroxide or oxide of chrome, but the pieces readily take up the dyestuffs from the dye-beck and yield full shades. The reduction of the chrome compounds may be carried further, if more glycerine is added to the printing colour; but there is then a tendency for the colour to run during steaming. By passing the pieces through the continuous steamer, the chromium mordant is reduced to the green stage; when it is not required to resist the mordant, this may be done.

The chrome mordant described above can be reserved with citric acid or bisulphate of soda, thickened and mixed with china clay.

The pieces now mordanted with iron, chrome, alumina, or mixtures of these mordants are now ready for dyeing, yielding various shades according to the nature of the dyestuff or dyestuffs employed.

We will now notice some of the principal dyestuffs used in the dyeing of pieces in this style, particularly with regard to their application for this special purpose, noticing the shade produced with each mordant; the student should then be able to form a general idea of the shade produced by combining one or more of the dyestuffs together or the effect produced by them on compound mordants. Before doing this, however, we will describe the general method of charging the dye-becks with the pieces and the usual system followed in practically conducting the operation of dyeing.

The form of dye-beck most commonly used is shown in Fig. 36 (p. 59). After putting in the requisite quantity of water, one end of the piece is thrown over the wince and tied to the listing, which has been previously threaded through the beck. The wince is then thrown into gear by means of the clutch and the cloth is slowly drawn into the beck, the man in charge of the machine arranging the pieces in the beck in the proper quantities between each peg rail and behind the mid feather. When sufficient cloth has entered the beck, the machine is thrown out of gear and the two ends of the cloth united, either by tieing them together with small knots or by roughly stitching the pieces together by hand or with the "Donkey" sewing machine. The cloth is now finally arranged in the beck and the wince again put into gear.

In order to preserve the purity of the white or unprinted parts of the cloth as far as possible, glue size (or a similar substance) is usually employed in the dye-beck, and is generally introduced at this stage, the size being first diluted with water and poured as evenly as possible into all parts of the liquor in the beck, and the goods kept in motion the whole of the time. While the pieces are being worked in the glue size the dyestuffs are weighed out, mixed with water, and then added slowly to the contents of the beck.

The actual dyeing now commences, the steam is turned on, and the temperature is slowly brought to the point required (according to the nature of the dyestuffs employed), and continued as long as may be necessary.

Speaking generally, the temperature employed in dyeing printed pieces is lower than would be used were the goods merely of a plain shade, and in many cases the dye liquor is, consequently, not so completely exhausted. This decrease in temperature is necessary in many cases, owing to the fact that the white parts of the print would at the higher temperature be soiled to such an extent as to render the clearing either impossible or extremely difficult to accomplish. As an average of the temperatures usually employed in dyeing it may be stated that the goods are dyed by gradually bringing the temperature up to 160°–180° F. during forty-five minutes, proportioning out the time evenly and checking with a thermometer every ten minutes or so, and then continuing the dyeing at this temperature for another fifteen minutes. Occasionally the dyeing is finished at a temperature of 200° F.

After the dyeing process has been completed, the pieces are drawn out of the becks and washed in an ordinary washing machine, to remove the spent dye liquor, then piled up wet on a waggon ready for the next operation. Sometimes the dye liquor is run off and the goods partly washed in the beck before they are washed in the machine.

The general treatment of the pieces after dyeing is as follows:— The pieces are first well washed in hot or cold water, squeezed, soaped in the becks until the loose colouring-matter is detached or the brightness of the colour is satisfactory, and dried. The pieces are next chemicked to clear the "whites" and then finished. In many cases it is necessary to use a large quantity of blue pigment in the finishing size to mask the soiled nature of the white parts of these prints, especially in the case of dark chocolate shades, as they cannot be completely cleared.

When the pattern is printed with alumina mordant only and dyed with alizarine, or when the only other colour on the piece is aniline black, the pieces are treated with oleine, &c., as described on p. 182.

Colouring-Matters used for Dyeing in the Madder Style.— **Alizarine.**—Alizarine has now completely displaced madder in the dye-house for all purposes for which the latter was formerly used.

Commercial alizarine is made in several shades, varying to a considerable extent according to the particular make and brand. The bluer shades are usually marked B or V, and the yellow shades Y or G, in addition to which there are intermediate shades marked with special letters, according to the manufacturer.

The alizarine is always sent out in the form of a paste, containing 20 per cent. of solid matter, and all the remarks which follow refer to a paste of this strength.

Alizarine Red and Pink.—Where it is necessary to dye pieces having unprinted or white parts in the pattern, a different method is required in dyeing to that used in dyeing plain Turkey red shades.

The quantity of alizarine required to dye the pieces cannot be definitely stated, as it varies with each pattern, depending upon the area of cloth covered with mordant, the depth of the shade, and, to a large extent, upon the weight of the cloth; because upon the latter depends the amount of colour or mordant contained in the body of the piece, thin cloth allowing some of the colour to pass through it on to the back grey, while with a very thick cloth the whole of the colour may be absorbed by it; hence the latter will require more dyestuff to yield the same shade than a thinner piece. The amount of dyestuff employed is usually left to the foreman of the dye-house, the manager of the works or colourist merely fixing the proportions of the various materials constituting the dye.

An excess of dyestuff usually has the effect of soiling the white or unprinted parts of the cloth to such a degree that they are only with difficulty cleared in the subsequent processes, while too small a proportion of colouring-matter generally produces flat or bare shades. Experience only can guide in this matter, supplemented by practical trials on a moderate scale.

When the pieces have a pattern only in alizarine red, the dye liquor usually contains only alizarine, the brand used varying, according to the shade of red desired; glue size, and, occasionally, a little blood albumen solution to preserve the white from being unduly soiled; acetate of lime, particularly if the water in the works is soft, to assist the operation of dyeing, the lime entering also into the composition of the colour lake; and oleine, with occasionally a little acetate of tin to brighten the shade. As an example of such a dye the following is given, the quantities stated being required to dye twenty pieces, each of 25 yards medium quality cloth, when printed in deep red with an average roller:—

Dye for Alizarine Red.

10 lbs. alizarine,
2 gallons glue size,
½ gallon oleine,
¼ quart blood albumen solution,
1½ quarts acetate of lime, 6° Tw.

The shades can be rendered slightly brighter by the addition of a small quantity of acetate of tin to the dye liquor. The acetate of tin used for this purpose is made by mixing together solutions of acetate of soda and tin crystals.

The dyeing is usually commenced in the cold, the temperature then being gradually increased during 30 minutes to 160° F., and continued for 15 minutes at this temperature; then the heat is allowed to rise often to 200° F., at which the dyeing is continued for 15 minutes longer. This may be taken as the average method and heat of dyeing printed reds, but it is varied in practice, according to the result desired.

The pieces, after dyeing, are then thoroughly washed in the ordinary dye-house washing machine.

At this stage the pieces have a sombre red colour, and the white or unprinted parts of the cloth are badly stained with the dyestuff used. Both these conditions are, however, altered in the subsequent processes of steaming and soaping.

Before steaming, the goods are impregnated by slop-padding with a solution of oleine containing either phosphate of soda or oxalate of ammonia. The best results are obtained, as regards brightness, from an oleine prepared from olive oil rather than from castor oil, although the latter is chiefly used. The phosphate of soda or oxalate of ammonia is used to clear the whites, or rather to render the colouring-matter adhering to the parts which should be pure white in such a condition that it is easily removed in the operation of soaping.

The following proportions of the several ingredients will be found to be suitable for fairly deep shades of red:—

Finishing Oleine for Reds.

No. 1.	*No. 2.*
100 gallons water,	100 gallons water,
14 gallons oleine,	14 gallons oleine,
14 lbs. phosphate of soda.	3½ lbs. oxalate of ammonia.

The goods having been slop-padded and dried are sent to the high pressure steamers and steamed for about an hour at from 15 to 20 lbs. pressure.

At this stage the red will be found to have attained a much brighter hue, and the white parts of the piece will be turned brighter in shade and yellower in tone.

The goods, after steaming, are then soaped at the boil by passing them through the range of soaping becks described on p. 54, the beck being charged with soap solution containing about $\frac{1}{4}$ oz. of good quality soap per gallon, and the pieces being soaped for from three-quarters of an hour to an hour, according to the appearance of the pieces.

After soaping, they are washed, squeezed or hydro-extracted, and dried, when they are ready for the finisher.

Alizarine on Mixed Iron and Alumina Mordants.—Alizarine is seldom used alone for the dyeing of chocolate shades upon mixtures of iron and alumina mordants, but is usually associated with some of the natural dyestuffs to modify the shade.

The pieces are, however, dyed in the same manner as described for the production of red shades, with the exception that the temperature is rarely allowed to rise above 160° F., and that the treatment with oleine and steaming is omitted. The lower temperature is necessary, owing to the necessity of preventing, as far as possible, the soiling of the unprinted parts of the cloth, which cannot be removed so completely as in the case of dyed reds by treatment with oleine and steaming; for the same reason it is essential that an excess of colouring-matter should not be used in the dye-beck. With all these precautions, in addition to the clearing which the pieces get as they pass through the chemicking machine, the whites obtained are never pure; consequently, it is usual to employ a large quantity of blue in the mixture used for finishing the goods in order to cover up the soiled cloth.

Recipes for dyeing chocolate shades from mixtures of alizarine and natural dyestuffs will be found amongst the "Practical Recipes,"

For chocolate shades, the blue shade alizarines are generally employed.

Alizarine on Chrome Mordants.—The shade given by alizarine upon a chrome mordant is a dull claret, which, in practice, is usually toned by the addition of other dyestuffs to the dye-beck. Pieces mordanted with chrome have by no means the same affinity for colouring-matters as is possessed by either iron or alumina-mordanted cloths; hence the dyeing is conducted at a comparatively high temperature, as high, in fact, as can be used without soiling the cloth to such an extent that the unprinted parts will resist clearing. The dye-beck is, also, never so completely exhausted as in the case of alumina mordants; this makes it necessary to employ a large quantity of colouring-matter per piece to obtain a comparatively pale shade; for this reason chrome mordants are rarely used for anything but medium and pale shades in dyeing. The concentration of the dye liquor has also considerable influence upon the depth of shade produced; hence the dyeing should be conducted in cased pans to prevent the dilution of the liquor by condensed steam.

The dyeing is generally commenced cold, the temperature raised during half an hour to 200° F., and the dyeing continued at this temperature for fifteen to thirty minutes. After dyeing, the pieces should be washed through hot water to remove the excess of dyestuffs as completely as possible, and then soaped as usual. The dyeing of the various batches should be conducted as nearly as possible under the same conditions with regard to the amount of water in the beck, and to the temperature, otherwise there will be considerable difficulty in obtaining regular shades.

Orange Alizarine.—Orange alizarine, or alizarine orange, sometimes called nitro-alizarine, is sold in the form of a thin paste, containing 15 per cent. of colouring-matter, and is largely used for dyeing reddish-orange shades when used alone upon alumina mordants, the shade often being modified by the use of ordinary alizarine along with it in the beck.

Chocolate mordants (iron and alumina) yield yellow-brown shades with alizarine orange only, modifications of the shade being produced by using either Persian berries or ordinary alizarine (blue shade) along with it.

Dyeing is usually done at 160° F., the pieces afterwards being well soaped and washed.

Dyed on a chrome mordant, orange alizarine yields a yellowish-brown shade, the colour apparently having a greater affinity for the mordant than ordinary alizarine, and there is less tendency for the whites to be soiled.

In addition to alizarine orange and the usual proportion of glue size, the dye liquor generally contains a small quantity of chalk, held in suspension, to keep the liquor from becoming acid.

Logwood.—In dyeing, logwood is principally used in the form of chips or raspings resembling coarse sawdust. The extracts and liquors are rarely used for dyeing, as the shade obtained from the chips is purer in tone than is obtained from the extracts, owing to the more or less oxidised condition in which the colouring-matter exists in the latter. The rasped wood is also cheaper than either the liquors or extracts, and yields perfectly even shades.

The dye-beck should contain, besides logwood, a small quantity of chalk to ensure the neutrality of the dye liquor, the addition of chalk being usual with all the natural dyestuffs when employed in dyeing.

The extensive use of aniline black has of recent years greatly reduced the use of logwood for the production of printed blacks, owing to the superior fastness of the former, steam aniline black now being very often employed for those styles which were formerly printed with an iron mordant and dyed with logwood. Notwithstanding this, there are still large quantities of goods done in the old way, and, for certain special patterns and styles, the process is used even in works where the aniline process has superseded logwood in many of its applications.

Logwood blacks are dyed upon a mordant consisting of iron alone, or a mixture of iron with a smaller proportion of alumina, the alumina modifying the shade and preventing the colour from exhibiting the peculiar rusty tone which a pure iron mordant usually gives. For dyeing, logwood is rarely used alone, as it seldom gives the desired shades by itself; for this reason, sumach or quercitron bark, or both, are used along with it in quantities merely sufficient to change the shades of black to the required tone. As an example of a mixture employed for dyeing a black the following is given :—

Dye for Blacks.

100 lbs. logwood,
8 lbs. sumach,
4 lbs. quercitron bark.

The dyeing is usually done at a temperature of 160° F., gradually raising the heat from the ordinary temperature to 160° during three-quarters of an hour, and then continuing the dyeing at this temperature for a quarter of an hour; or in some cases the temperature is allowed to rise to 200°, and the dyeing finished at the boil.

Logwood is also largely used as one of the ingredients of mixtures used for dyeing dark chocolates, the logwood, in fact, acting as the darkening agent.

After dyeing, the goods are washed and soaped as described for alizarine dyed colours, the whites being subsequently cleared by passing the cloth through chemic liquor on the chemicking machine.

Dyed on a chrome mordant the resulting shade is a black or grey, depending upon the strength of the mordant. Chrome-dyed blacks have, however, a tendency to turn greenish in shade on exposure to the atmosphere, and are rarely dyed upon cotton piece goods. Some fine shades of grey can be obtained upon chrome mordants by the use of logwood in combination with other dyestuffs in sufficient quantity to turn the shades to the tone desired; but, owing to the greening of the chrome logwood lake, they can only be considered as fairly fast.

Dinitrosoresorcin, also known as resorcine green, fast myrtle, solid green, &c., is supplied to printers in the form of a dirty greenish paste, only slightly soluble in cold water, dissolving more readily when hot.

It is very largely employed in calico printing for dyeing fast myrtle shades upon printed iron mordants, yielding various shades according to the strength of the mordant. For modifying the shade, astringents are often employed along with the solid green, sumach or quercitron bark being those chiefly employed.

The shades produced with solid green are very fast to light and soaping. By steaming the pieces under pressure the shade is changed to a tobacco brown.

Quercitron Bark.—Quercitron bark is sold in two qualities, ordinary or common bark, and prepared bark; the latter yields brighter shades than the former, but is more expensive.

Quercitron bark yields greenish-yellow shades with an alumina mordant, the prepared bark differing from the ordinary bark in yielding a considerably brighter shade. With iron mordants olive-black, olive-grey, and pale grey shades are produced, according to the strength of the mordant printed on the cloth. Chocolate mordants produce shades corresponding to the effect produced by combining the above-named shades in proportions equal to the ratio of the mordants. Chrome-mordanted cloth is dyed an olive-yellow shade.

Bark is very largely employed for dyeing printed goods, but principally along with other dyestuffs applied either in the dye-beck, or afterwards, as described under *Tannic colours used in the madder style*.

Persian Berries.—Persian berries are employed in dyeing in the form of the crushed berry, the extract being very little used for this purpose. The shades obtained with the various mordants are very similar to those obtained by the use of quercitron bark, but are stronger or more intense and cheaper to produce. The colours derived from Persian berries are not quite so fast to light or soap as those obtained from bark. Persian berries are used in the same manner and, practically, for the same purpose as bark.

Sumach and Myrabolams.—These astringent bodies are used, along with logwood and other dyestuffs, for producing mode or dull shades. Both these substances yield peculiar black or grey shades on iron mordanted cloth, the shades depending upon the strength of the mordant; alumina yields olive-yellow shades. The blacks and greys produced by the employment of sumach are far more pleasing in tone than those obtained from myrabolams; consequently sumach is preferred for shading these colours.

These bodies, being tannin-containing substances, give rise to the formation of tannin lakes or compounds on the goods, in the form of aluminium or iron tannates, which have the property of combining with the basic coal-tar colours; hence they are much used for this purpose, the goods being first tannined or treated with the tannin matter and then dyed in a solution of one of the basic coal-tar colours. Myrabolams are chiefly used in this style, the original shades produced on the mordanted cloth before dyeing with the basic colour being more suitable for the production of dark olive and green shades, for which this modification of the process is chiefly used. (See *Basic colours used in the madder style*).

Peachwood—Sapan Wood.—These red woods are used, to some extent, for dyeing chocolate-shades, and especially for brightening deep shades. They give reddish-brown shades on iron mordanted and brownish-red to pink shades on alumina-mordanted cloth, the alumina colours, especially, being extremely loose to the action of boiling soap solutions. Their application is not to be recommended for cotton piece dyeing; they are now chiefly employed because it has not been considered advisable to alter the recipes which were drawn up when these woods were in general use.

Such a large number of shades can be dyed upon chrome mordants by the use of the artificial colouring-matters that it is impossible to notice them here. An idea of the shades obtained in each case can be formed from the description given in reference to the steam colours produced from the same colouring-matters. At the same time many of the dyes are unsuitable for dyeing, as they either yield uneven shades, are too expensive, or do not give regular results; the depth of shade produced at one time not corresponding to that obtained at another time, even when the conditions are kept as regular as possible.

SECTION II.

THE USE OF BASIC DYES IN THE MADDER STYLE.

Some of the basic coal-tar colouring-matters are largely used, especially for the production of dark blue, olive, and bright green shades, in the process now to be described, which has already been briefly noticed.

The goods are first printed with the pattern, or combinations of patterns, in various mordants, according to the shade desired, chocolate or pure alumina mordants being chiefly used. After the pieces have been aged, dunged, and prepared for dyeing, they are dyed with an astringent, such as sumach or myrabolams (either alone or mixed with other dyewoods or adjective colouring-matters), whereby the metallic mordant on the cloth is converted into a compound containing tannic acid and capable of combining with the basic colouring-matter.

The tannin material, and other colouring-matter used along with it, are chosen so as to yield shades of such a character that, when afterwards dyed with the basic colour, the shade desired is produced. The shade is thus influenced by the nature of the mordant on the cloth, the materials used in the first dyeing, and by the colouring-matters applied in the last process of dyeing.

For dark green and olive shades, the goods are printed either in an iron or a chocolate mordant; the larger the proportion of iron the darker or blacker is the shade obtained, alumina tending to render the shade brighter and yellower in tone. Bright green shades are usually dyed upon a pure alumina mordant; dark indigo blues upon chocolate mordants of various strengths.

For the first dyeing, a mixture of sumach and prepared bark is generally employed for the green, olive, and dark olive shades, which produce blackish-olive shades on chocolate mordants, and yellow shades on the alumina-prepared cloth.

For dark indigo blues, the first dyeing is done either with sumach or myrabolams upon chocolate mordants.

After the goods have been dyed in these astringent mixtures, they are washed in hot water and are then ready for the second dyeing. Unfortunately, there are very few of the basic colours that can be used in this process, owing to the fact that most of them stain the unprinted parts of the cloth, so that it is impossible to obtain pure whites in the prints. In fact, it is only what may be considered the more fugitive colours of this class, like brilliant green, methyl violet, and the colours belonging to the rosaniline group of colours, that can be used, most of the fast colours, with perhaps the exception of methylene green GG, being unsuitable for the reason stated. With most of the fast colours it is impossible to clear the whites by chemicking when stained to the degree which always occurs in dyeing with them. On this account, the selection of colouring-matters for the second dyeing operation is very limited, the following colours being those chiefly used, viz.:—Methyl violet, blue and red shade; magenta crystals; brilliant green; and, occasionally, methylene green GG.

The pieces, after dyeing with the artificial coal-tar colours, have the colour lake in the form of a compound, containing iron or alumina with tannic acid and the colour base; this colour base is only fairly fast to washing and the action of light. In order to render the shades faster, the goods are treated with tartar emetic, the latter being added to the dye-beck immediately after the pieces have been treated in the beck for the required time to complete the process of dyeing.

The goods are washed as they are withdrawn from the dyeing liquor, soaped, and then chemicked until the white parts are sufficiently cleared.

The following description of the manner in which the principal shades produced in this way are obtained will serve to further illustrate the application of the processes indicated :—

Green and Myrtle Shades.—The cloth is first printed with either an iron, chocolate, or red mordant, according to the shade desired. Iron gives the darkest or blackest shade, chocolate mordants yield shades depending upon the proportion of iron to alumina in the colour, while red mordants give the brightest shades. After ageing and dunging, the pieces are "tannined" in the first dyeing operation, the particular dyestuffs and tannin matter used likewise depending upon the shade to be subsequently produced.

As the astringent in the first dyeing process sumach is, for these shades, principally used. In addition to sumach, quercitron bark or berries are usually employed in this operation, the proportions of the two ingredients of the dye being varied in accordance with the shade desired. Sumach has the effect of making the shades darker or blacker when the mordant contains iron, and only slightly yellower when alumina is the mordant, or the colour contains a large proportion of alumina. Quercitron bark or Persian berries influence the shades considerably on all the mordants by turning them very much yellower in tone, this effect showing itself most markedly with colours dyed upon alumina mordants, or with colours which contain a large proportion of alumina to iron. The proportions in which these dyestuffs and astringents are used are regulated by the above-mentioned considerations; they vary with every colouring.

For the second dyeing process, brilliant green alone is generally used, except for pale bright green shades that are required to be specially fast, when methylene green GG can be used.

The following particulars, for a dark myrtle and bright green shade respectively, will give a general idea of the proportions of the various materials used :—

Dark Myrtle Shade.—Print on the cloth a fairly strong iron mordant, age, dung, and prepare for dyeing.

Prepare the dye-beck with the usual quantity of water and glue size, enter the pieces and add, for each 25 yards of good quality cloth printed with a blotch pattern, approximately :—

Tannin Bath—First Dyeing.

1 lb. sumach,
1 lb. quercitron bark,
1 oz. chalk.

The dyeing should then be started, and the temperature gradually raised to 160° F. in half an hour, and then kept at this heat for fifteen minutes, after which the pieces should be washed, preferably in hot water.

The second dyeing is conducted in the same way as described for the first one, using, for the same quantity of cloth printed in the same style of pattern, about :—

Second Dyeing.

1 oz. brilliant green crystals.

At the expiration of the time required for dyeing with the brilliant green :—

Fixing.

1 oz. tartar emetic,

previously dissolved in some water, is added to the liquor in the dye-beck, and the heat of the liquor maintained for about fifteen minutes to ensure complete fixation.

When dark myrtle and green shades are in hand, the treatment with tartar emetic is frequently omitted.

From what has been mentioned above, it will be seen that a large variety of shades can be produced by varying the character of the mordant, and the proportion of the astringent.

Bright Green Shades.—These shades are dyed upon either a pure alumina mordant or a chocolate mordant, in which the proportion of iron is small compared to the quantity of alumina present. The first dyeing is done with a mixture of quercitron bark or Persian berries, and sumach, the latter being present in only a small quantity compared to the other ingredient. The other details of the process are exactly the same as for the myrtle shade.

Indigo-Blue Shades.—These shades are always dyed upon chocolate mordants. The first dyeing or tanning is usually done with sumach, myrabolams, or valonia alone. For the second dyeing process, a mixture of brilliant green and the blue shade of methyl violet is used, the proportions of the two colouring-matters being varied to yield the special shade of dark blue desired. When the shades are required darker or blacker than can be obtained with a mixture of the green and violet, a small quantity of magenta is used along with them. In order to obtain these shades as fast as possible, particular attention should be paid to the treatment with tartar emetic.

All the methods of resisting the mordants, printing mordants of various kinds upon the same piece, &c., exactly as used in the madder style proper, can be employed in this modification of it.

CHAPTER V.—PADDING STYLE.

SECTION I.

BUFFING, TINTING, OR PRODUCING PALE PAD SHADES.

THE great development in the production of fast shades in colours belonging to the substantive (or direct cotton dyeing) dyestuffs has led to the extensive use of these colours for obtaining pale and medium pad shades upon cotton prints, and the process is very much cheaper, both in labour and materials, to work than in the older processes, which have been practically displaced for this work.

All the dyes belonging to this class are not equally fast to light or soaping, but from the almost bewildering variety now offered to the dyer, a few can be selected which should fulfil all reasonable requirements with regard to fastness of shade; from these, either alone or by the combination of several of them, almost every desired shade can be produced.

The substantive colours dye cotton directly without any mordant, but various substances are used to assist the operation of dyeing or combination with the cotton fibre. The particular nature of the assistant used varies with the colouring-matter to be applied, and full instructions are generally given by the manufacturers of the dyes. The chemicals most frequently used as assistants are soap, phosphate of soda, common salt, and Glauber's salt.

Three methods are used for applying the colours to the printed pieces—viz., on the mangle, on the slop-padding machine, and by dyeing the goods in the dye-beck.

Application on the Mangle or Buffing Machine.—This method of application is used for pale shades, the pieces being passed through the solution of colouring-matter, with the necessary assistant, in the open width. The liquor in the box is usually kept hot and the pieces after passing through the liquor, have the excess of the latter squeezed out of them by passing them between the squeezing rollers placed over the box, the expelled liquor flowing back again into the liquor tank. As copper or brass has an injurious effect upon the shade of some of these colours—*e.g.*, chrysamine, both the bowls of the squeezing rollers should be of sycamore, and be kept in good condition, because upon the even squeezing out of the superfluous liquor depends, to a considerable extent, the evenness of the resulting shade. In most cases, the bulk of the liquor in the box should be kept up by the occasional addition of liquor of a rather more concentrated nature than is contained in the box, as the pieces usually extract more of the dye from the liquor than corresponds to the quantity or bulk of the liquid which they withdraw from it. The pieces are, immediately after leaving the squeezing rollers, passed over drying tins, and, when dried, are ready for finishing, the small quantity of soap, salts, &c., contained in the goods being far too small to make it worth while washing them.

This padding, or tinting, is always done after the goods have been cleared in the white parts by chemicking, and when soap is used with the dyestuff, the presence of the lime salts contained in the cloth, derived from the chemic liquor, gradually accumulates in the liquor box, forming insoluble lime soaps, which float upon the surface of the liquor, and carry with them a large proportion of the colouring-matter, which, being withdrawn from the liquor, gradually causes the shade to become paler. In practice this may be obviated by the use of hypochlorite of soda for chemicking in place of the lime salt, or by replacing the soap, if possible, with phosphate of soda. If it is absolutely necessary to use soap as the assistant along with the dye, and no departure from the ordinary process of chemicking is permissible, then shorter batches of cloth should be passed through smaller quantities of liquor, and the latter renewed for each batch.

Application on the Slop-Padding Machine.—This method is used for deeper shades than are done on the mangle, because, when the shade is darker, slight inequalities in squeezing out the excess of liquor show much more plainly, and this is more easily guarded against in this machine owing to the fact that metal rollers of smaller diameter are used, and they are more under control on the slop-padding machine than on the mangle. The rollers should be carefully wrapped with fine cloth, and the nip should be as even as possible.

Application by Dyeing.—When the shade required is darker than can be conveniently produced by either of the two methods just described, the pieces are dyed in the dye-beck. As the liquor is never completely exhausted, it is usually kept after use, and strengthened when again required. Dyeing is generally done at the boil, the goods being worked until dyed to shade; the latter point is found by washing a small portion of the cloth taken out of one end of a piece, drying it upon a steam pipe, and comparing it with a standard shade book.

After dyeing, the goods are always washed well before drying, because much stronger liquors are used in dyeing than are ever used when the goods are run on the mangle or slop-padding machine.

The following is a list of some of the substantive colouring-matters applied to cotton prints by the methods just noticed, with the shade produced by each :—

Colouring-Matter.	*Shade.*
Erika G,	Pink.
Titan pink,	Pink.
Direct scarlet,	Pink.
Chrysamine,	Yellow.
Cressotine yellow,	Yellow.
Direct yellow G,	Yellow.
Chloramine yellow,	Yellow.
Brilliant geranine B,	Pink.
Benzo-azurine G,	Blue (greenish).
Benzo-sky-blue,	Blue.
Benzo purpurine 4 B,	Red.
Clayton yellow,	Chrome yellow.
Diamine blue B,	Blue.
Diamine scarlet B,	Scarlet.
Mikado brown G,	Orange-brown.
Mikado orange G,	Orange.
Sterosine grey,	Grey.
Thioflavine S,	Pure chrome yellow.
Titan brown R,	Terra cotta.

Below we give examples, showing the use of some of the assistants mentioned above. As practically all these colours can be used by one, at least, of the methods mentioned, they will serve to give a general idea of the constitution of the liquors used for tinting.

Slop-Pad Chrysamine Yellow.

½ oz. chrysamine,
1¼ oz. soap,
1 gallon water.

First, the soap should be dissolved in some of the water at the boil, then the chrysamine added, stirred until dissolved, and made up to 1 gallon by the addition of the remainder of the water.

The solution should be effected in a wooden cask heated with a steam pipe made of iron and not in a copper vessel, as chrysamine is acted upon by copper.

This solution may be used full strength or diluted with water to give the proper depth of shade. If a stronger solution is required for use with the slop-padding machine or for dyeing less water must be used.

Slop-pad Chloramine Yellow.

This colour is shown in pattern No. 38, which was first printed with aniline black and then padded with the following liquor :—

62½ gallons water,
6 ozs. chloramine yellow (Fr. B. & Co.),
7 ozs. phosphate of soda.

Slop-pad Benzo-Sky-Blue.

100 gallons water,
2 lbs. benzo-sky-blue (Fr. B. & Co.),
5 lbs. phosphate of soda.

Benzo-sky-blue is shown slop-padded over a print printed with naphthol claret in pattern No. 39.

Slop-pad Direct Scarlet B.

12 gallons water,
1 oz. direct scarlet B (Kallé),
1 oz. Glauber's salt (sulphate of soda).

Pattern No. 40 has been printed with artificial indigo obtained from Messrs. Kallé & Co.'s indigo salt T and padded with the above liquor.

Slop-pad Direct Yellow G.

19 gallons water,
1 oz. direct yellow G (Kallé),
1 oz. Glauber's salt.

Direct yellow G is shown in pattern No. 41.

Slop-pad Brilliant Geranine B.

62½ gallons water,
2 ozs. brilliant geranine B (Fr. B. & Co.),
7 ozs. common salt.

Geranine B slop-padded over a pattern printed in aniline black is shown in pattern No. 42.

CHAPTER VI.—RESIST AND DISCHARGE STYLES.

SECTION I.

RESISTS UNDER THE STEAM STYLE (Mordant Colours).

A LARGE number of the shades produced by the use of steam colours can be resisted, and many effects are obtained in this manner.

The particular substances used for resisting the colour printed over the piece depends upon the nature of the mordant and the colouring-matters contained in the printing colour, while there are some colouring-matters which, so far, cannot be satisfactorily reserved. The particular behaviour of the various colouring-matters towards the ordinary resists should be studied, and the most suitable one found for the standard colours—often containing many different colouring-matters in the same printing colour—usually employed in the works. We can, therefore, only notice a few of the most largely used resists for producing reserves under the ordinary well-known colours, and indicate the general application to a particular class, at the same time pointing out the fact that there are many exceptions to the general rules given.

For resisting alizarine pink, printed from a colour containing sulphocyanide of alumina as the mordant, either acid oxalate of potash or the product obtained by the addition of caustic soda to a solution of sulphate of zinc with citric acid is the most largely employed; these substances can also be used for many printing colours of similar constitution. The following recipes illustrate the method of preparing both these reserves:—

Resist under Alizarine Pink.

No. 1.

1 gallon water,
3½ lbs. British gum,
13 ozs. binoxalate of potash.

Boil together the British gum and water, cool to 140° F., and add the binoxalate of potash in fine powder; cool and strain. The colour should be "sightened" by the addition of a little sulphate of indigo or "indigo extract."

Resist under Alizarine Pink.

No. 2.

9½ lbs. citric acid crystals,
1 lb. 2 oz. sulphate of zinc,
1¾ gallons caustic soda lye, 45° Tw.,
21 lbs. china clay,
1½ gallons British gum thickening.

The citric acid and sulphate of zinc should be dissolved in the caustic soda lye. The solution so obtained is then used to work up the china clay into a thin cream, when it is slowly mixed with the British gum thickening. The colour or resist so produced is then coloured or "sightened" to render it visible during printing, with a little indigo carmine, and, after straining, it is ready for use.

Many colours, including a large number of shades, obtained with acetate of chrome, as well as those produced with other mordants, can be reserved by means of a resist containing citric acid, with the mechanical aid of china clay. The recipes appended are of this type:—

Citric Acid Resist.

No. 3.

2 lbs. citric acid crystals,
1¼ quarts water,
5½ lbs. china clay,
1 gallon dextrine thickening.

Rather superior results are obtained with some colours by using either gum Arabic or Senegal, in place of dextrine, for thickening, as shown below:—

Acid Resist.

No. 4.

3 lbs. citric acid,
½ gallon water,
1½ gallons gum Arabic, or Senegal, thickening,
7½ lbs. best white china clay.

When preparing either of these resists the china clay should first be thoroughly mixed with the thickening, and then the citric acid, previously dissolved in the water, slowly added.

Tartrate of chrome forms a good resist for several printing colours of this class. The tartrate of chrome is prepared in the form of a liquid (as described on p. 71), and is mixed with more or less thickening and tartaric acid, as required:—

Tartrate of Chrome Resist.

No. 5.

1 gallon tartrate of chrome liquor,
3 gallons British gum thickening,
1 lb. tartaric acid.

No. 5 resist is used principally under steam alizarine pink shades.

These resists are printed upon either the unprepared or oleine-prepared cloth, and dried. The pieces can then be padded or covered with the printing colour, steamed and soaped as usual.

The parts of the cloth previously printed with the resist will, after soaping, form the "whites" in the finished print.

The following printing colours are used to produce white patterns upon cloth which has been padded with chrome mordant printing colours, but which has only been dried carefully at as low a temperature as possible, the colour lake not being formed at this stage; hence they may be regarded either as resists or discharges, depending upon how we regard their action :—

Chrome Resist.

91 lbs. British gum thickening (6 lbs. per gallon).
7 lbs. bromate of potash.
2 lbs. chlorate of soda.

After padding the cloth with the chrome printing colour and carefully drying it, the resist is printed and the cloth again dried. The pieces are then steamed for an hour under pressure, passed in the open width through a chalk bath, and then soaped.

Another white resist, applied in the same manner as the above, is made from red prussiate and an alkaline chlorate, as given below :—

Chrome Resist.

20 lbs. British gum.
2¼ gallons water.
2 lbs. chlorate of potash.
2 lbs. chlorate of soda.
17 lbs. red prussiate.
35 lbs. carbonate of magnesia in paste.

The alkaline chrome mordant described on p. 70 can be discharged with the following printing colour, so that, upon the pieces being subsequently dyed, a white pattern upon a coloured ground will be obtained.

Alkaline Chrome Mordant Discharge.

27 lbs. dextrine,
4 gallons 2¼ pints water,
18 lbs. citric acid,
12 lbs. tartaric acid.

SECTION II.

RESISTS UNDER BASIC AND TANNIC STEAM COLOURS.

THERE is no really good resist for the basic colours, and, practically, they can only be used satisfactorily for pale shades, applied either by padding or covering.

The resist most in use is tartar emetic, with the addition of china clay. The tartar emetic causes the formation of the insoluble colour lake before the colour reaches the fibre, and the china clay acts as a mechanical resist by preventing the colour touching the cloth. With dark shades the resist is unable to prevent the colour attaching itself to the cloth, and thus the "whites" are poor in these cases. The following recipe may be used for medium and pale pads or covers:—

White Resist under Basic Colours.

1 gallon thick British gum thickening,
3½ lbs. china clay,
½ lb. tartar emetic.

The china clay should be worked into a thin paste with water before adding it to the thickening.

After printing the above resist and covering or padding with the basic printing colour, the pieces should be steamed as usual, fixed, and soaped in the open soaper.

The cloth may be prepared with oleine before use if the colours actually require it, but better "whites" are obtained upon unprepared cloth, and, if possible, such should be used.

Oxide of tin, tannate of antimony, and several other chemicals have, at various times, been suggested as resists for these colours; but in our trials we have found none of them to give so good results as tartar emetic.

When a resist containing china clay is reduced, the reducing thickening (reduction) should contain about the same proportion of china clay per gallon as was contained in the strong resist.

There is another method for producing white designs upon cloth that is to be dyed with basic colouring-matters, consisting of padding the cloth with a solution of tannic acid, drying and winding-on for printing. The pieces are then printed with a strong solution of soda-lye, thickened with light British gum or dextrine (see below). Next, they are steamed by passing them through Mather & Platt's steam aniline ager, running the machine at such a speed that the goods remain inside the steaming chamber for about two minutes. The pieces are now passed through a solution of tartar emetic, when "tannate of antimony" is fixed upon all the cloth, with the exception of those parts that have been printed with the alkaline resist. After a thorough washing, the goods are dyed with any of the basic colouring-matters which will dye the cloth without soiling the resisted white to a greater extent than can be cleared by chemicking.

Tannic Mordant Discharge.

2¼ gallons water,
31 lbs. dextrine,
41 lbs. caustic soda lye, 77° Tw.

Goods that have been dyed on a tannin mordant with the basic dyestuffs in medium shades can be discharged with a chlorate and prussiate discharge (as given below), which is very useful, not only for this purpose, but also for printing discharge covers over job pieces to cover over defects in printing, and render the goods marketable.

Discharge for Dyed or Printed Basic Colours.

7 gallons British gum thickening (10 lbs. per gallon),
19 lbs. china clay,
7 lbs. chlorate of soda,
2 lbs. red prussiate of potash.

The goods, after printing, should be steamed and then soaped.

SECTION III.

RESISTS UNDER INDIGO PRINTED DIRECTLY UPON THE CLOTH.

In order to resist or reserve a white upon cloth which will afterwards be printed with a pattern, or padded with a printing-colour containing indigo, by the Schlieper and Baum process, the cloth should first be printed upon those parts required white in the finished print with precipitated sulphur, which will prevent the colour being fixed upon the parts so printed.

The precipitated sulphur should be as pure as it is possible to obtain it in commerce, in an extremely fine state of division, and when a portion is incinerated it should leave only a mere trace of ash. Many samples of precipitated sulphur contain large quantities of sulphate of lime, others are not sufficiently fine and are quite unsuitable for this purpose.

The reserve colour is made by merely mixing the precipitated sulphur with British gum or dextrine thickening, using from two to four lbs. to the gallon of thickening, according to the depth or strength of the colour that will be printed over it. After printing the previously prepared cloth with the reserve colour, it is padded or covered with the indigo colour, and the pieces steamed and treated as usual.

Coloured reserves are difficult to produce under caustic indigo blues, because precipitated sulphur is, practically, the only reserve at present known for this purpose. The ordinary reserve containing citric acid, &c., does not answer in this case, and red prussiate of potash (although it will oxidise the indigo) does not yield a good white. The chief difficulty is to find a dyestuff which will fix itself upon the cloth in the presence of sulphur, and the caustic contained in the colour afterwards printed over the reserve. Messrs. Bloch and Schwartz found that the following colours gave the best results of those tried when used in this manner; but they state that the shades are not fast, and that the colours are so much attacked by the caustic soda that the shades given are pale. The following formula was used by them for the reserve colour:—

Coloured Reserve for Indigo.

1 lb. dyestuff,
¾ lb. phosphate of soda,
¼ lb. soap,
7 lbs. dextrine,
1 gallon warm water.
Made into a paste with
5 lbs. of precipitated sulphur.

Chrysamine R (Farbenfabriken) gave the best result, and yielded a yellow-orange shade; alkali-yellow G (Dahl), lemon-yellow; Erica G (Actiengesellschaft), rose; and benzo-purpurine B (Farbenfabriken), a strawberry colour.

A yellow resist is often prepared by adding a cadmium salt to the ordinary sulphur white resist. The caustic in the blue printing colour reacts upon the sulphur, forming sulphide and poly-sulphides of soda, and these precipitate the cadmium in the form of the yellow cadmium sulphide. The colour is, however, rather expensive to use:—

Yellow Resist under Indigo.

1 gallon British gum thickening,
2 lbs. precipitated sulphur,
2 lbs. cadmium chloride.
Cadmium nitrate may be used in the place of the chloride, if desired.

In a similar manner a resist red can be produced by mixing with the sulphur resist some red liquor and tin crystals, which, while resisting the indigo, will cause the fixation of a sufficient quantity of alumina to yield a fairly deep shade of red when afterwards dyed with alizarine.

Resist Red under Indigo.

1 gallon British gum thickening (10 lbs. per gallon),
4 lbs. precipitated sulphur,
4 ozs. tin crystals,
1 gallon red liquor.

SECTION IV.

RESISTS OR RESERVES UNDER NAPHTHOL COLOURS.

A WHITE can be reserved upon naphthol-prepared cloth by printing, after preparing, a resist composed of a bisulphite of one of the alkali metals, preferably potash, afterwards covering or padding with the diazotised printing colours.

The best results are obtained by using sulphite of potash as recommended by Messrs. Meister, Lucius & Bruning. The recipe given below answers the purpose perfectly:—

White Resist for Naphthol Colours.

3 gallons water,
25 lbs. British gum.
Dissolve; and add
45 lbs. sulphite of potash, 90° Tw.

The goods, after padding or covering, are treated as usual with regard to washing, &c.

By printing a resist composed of a tin salt, and afterwards covering with paranitraniline red, a yellow and red pattern is produced. For a tin resist, the following recipe may be taken as an example:—

Yellow Resist under Paranitraniline Red.

1 quart water,
4 lbs. china clay.
Mix into a thin paste, free from lumps, and add
3 lbs. tin crystals,
1 gallon British gum thickening,
1½ lbs. acetate of soda.

It is found advisable to avoid the use of oleine in the naphthol prepare, when the pieces are to be printed with a resist to obtain white patterns upon coloured grounds; the results are also better if the preparing solution is slightly thickened with gum tragacanth.

A white resist under these colours can be obtained with tin by using a resisting colour composed of tin crystals and tartaric acid; and, by using certain basic colouring-matters along with acetate of tin, coloured resists are produced. The following recipes show the methods of preparing colours of this type:—

White Resist.

6 lbs. dextrine thickening (10 lbs. per gallon),
10 lbs. tin crystals,
2½ lbs. tartaric acid.

Yellow Resist.

22½ ozs. auramine concentrated (M., L. & B.),
21 lbs. thickening (see below),
½ gallon acetic acid, 6° Tw.,
28 ozs. glycerine,
56 ozs. tartaric acid,
67½ ozs. tannin solution,
15 lbs. white resist.

The tannin solution is prepared by dissolving 10 lbs. of tannic acid in 1 gallon of acetic acid.

Blue Resist.

2½ lbs. marine blue R I,
¾ gallon acetic acid, 6° Tw.,
3½ lbs. tartaric acid,
2½ lbs. glycerine,
30 lbs. thickening,
6½ lbs. tannin solution,
2½ lbs. acetate of tin, 52·6° Tw.

Green Resist.

The green resist is prepared with the same proportions of thickening, &c., as for the blue, but brilliant green crystals are used in place of marine blue in the same proportion.

Thickening.

56 lbs. wheat starch,
16¼ gallons water,
4¾ gallons acetic acid, 12° Tw.
Boil well; and cool.

All these colours should be printed on the prepared cloth, dried as usual, or hung in a warm place over night, and then passed through the solution of the diazotised amine as usual (M., L. & B.). It is not necessary to pass the pieces through the tartar emetic fixing liquor to fix the basic colours when printed as resists in this style.

SECTION V.

RESISTS OR RESERVES UNDER ANILINE BLACK.

Aniline black, when once developed upon the cotton fibre, cannot be discharged by any reagent which could be used in practice without damaging the cotton fibre; hence, the patterns are produced (in the case of covers or pads) by reserves or resists, which prevent the formation of the colour upon the parts printed. In the case of covers the reserve colour is printed upon the cloth previous to printing the aniline black mixture; but pads are usually done with the steam aniline black mixture, in which case the reserve colour is printed upon the cloth, after the latter has been padded (or slop-padded) with the aniline black mixture, and dried at as low a temperature as possible. After steaming, the black will be found to be developed upon all parts of the cloth, except where the resist colour has been printed.

The resisting agents generally employed are the acetate of soda or lime, arseniate or aluminate of soda, neutral oxalate of potash, or a sulphocyanide. When an alizarine red printing colour contains sulphocyanide of alumina it may be used as a red resist, as the aniline black cover will be resisted and will not affect the development of the red lake; and if it should be desired to obtain a red by afterwards dyeing with alizarine, sulphocyanide of alumina may be used for resisting the black, when enough alumina will be fixed upon the fibre to yield a fairly deep shade of red.

The following recipes show the application of each of the above-named substances for this purpose, the colours being intended for use with the various aged aniline blacks mentioned on p. 161.

White Resist under Aniline Black.

No. 1.

1 gallon water,
2 lbs. acetate of soda,
3½ lbs. British gum.
Boil well until dissolved; and cool.

White Resist under Aniline Black.

No. 2.

3 quarts acetate of lime liquor, 28° Tw.,
1 quart water,
3 lbs. British gum.
Boil; and cool.

White Reserve under Aniline Black.

No. 3.

1 gallon arseniate soda solution, 25° Tw.,
3 lbs. British gum.

White Reserve under Aniline Black.

No. 4.

1 gallon aluminate of soda, 30° Tw.,
3 lbs. British gum.

White Reserve under Aniline Black.

No. 5.

9 ozs. potassium sulphocyanide,
1 gallon British gum thickening.

In the case of the steam aniline black, when printed over a reserve in a cover pattern, although any of the above resists may be used, we recommend the following as being far superior, and free from any tendency to run or spread during steaming:—

White Reserve for Steam Aniline Black.

No. 6.

34 ozs. neutral oxalate of potash,
3 lbs. British gum,
1 gallon water.

When reserves are used, the cloth receives exactly the same treatment after printing as usual, so that no special notice is required.

Reserves upon Slop-Padded Blacks—Steam Aniline Blacks.—The black is produced upon the fibre by slop-padding with an aniline black mixture prepared in a similar manner to the steam aniline black recipe given on p. 163, omitting the thickening, although occasionally the liquor is slightly thickened with gum tragacanth, as shown in the recipe below :—

Slop-Pad Steam Aniline Black Liquor.

I. 3¼ lbs. chlorate of soda,
3½ gallons water.

II. 7¼ lbs. aniline salts (basic),
2¼ gallons water,
3 pints gum tragacanth thickening.

III. 5⅝ lbs. yellow prussiate of potash,
3 gallons water.

The three solutions marked I., II., and III. should be made separately, and mixed together just previous to use.

The cloth is passed through the above liquor in the slop-padding machine (see p. 57), and carefully dried over the chests as usual, care being taken not to overheat the goods or allow them to stand over the chests, or the aniline black will be formed and it will then be impossible to produce a good white. When the goods are dry, they should be immediately printed with any of the white reserve colours, steamed as described for the ordinary steam aniline black, chromed and finished in the ordinary way.

Coloured reserves can be obtained by using any of the pigment colours, thickened with albumen, with the addition of acetate of soda to reserve the black, the pigment being fixed when the albumen coagulates during steaming. The following general recipe will serve to show the method of using pigment colours for this style.

Pigment Coloured Reserves under Aniline Black.

1 gallon blood albumen thickening,
1 quart gum tragacanth thickening,
5 to 10 lbs. pigment,
3 lbs. acetate of soda,
1 quart water,
½ gill turpentine,
½ gill glycerine.

Messrs. Grafton and Browning have patented a method for the application of the basic aniline colours to the production of discharges (or, rather, reserves) upon slop-padded aniline black grounds, which consists in, first preparing the cloth with tannate of antimony, by padding in a solution of tannic acid, and passing it through tartar emetic. The cloth so prepared, after being washed and dried, is slop-padded with the usual aniline black mixture, dried, and then printed with a printing colour containing a basic aniline colour and acetate of soda. Upon steaming, the black is raised and the aniline basic colour fixes itself upon the tannate of antimony attached to the cloth, and forms a fast-coloured reserve. The following recipes are taken from *The Dyer and Calico Printer*, Sept. 20, 1893 :—

Grafton and Browning Process.—The goods are first impregnated by slop-padding with a tannin solution, the composition of which may be as follows :—

Padding Liquor.

20 gallons water,
2 lbs. commercial tannic acid,
2 lbs. sulphate soda.

The goods are then dried and run through a milk-warm tartar emetic bath (or any of its numerous substitutes), of the following composition :—

Fixing Liquor.

80 gallons water,
4½ lbs. tartar emetic (34 per cent.),
10 lbs. sal ammoniac.

Then the goods are washed, well dried, and slop-padded in the aniline liquor and semi-dried, and the discharge colours printed on.

The colouring-matters required are a good red, pink, blue, yellow, and green, whence, by mixing these, any compound colour may be produced. As a red colour, ordinary pigment red may be used; for pink, the various brands of rhodamine, pyronine, or geranine, but the first mentioned is the best. Auramine O or thioflavine T may be used as yellows. Ethylene-blue or Cassella's excellent new methylene-blue N may be used for blue. Any of the basic greens may be used, or they may be produced by mixing. For dark blues, use new blue D (Bayer). The following two recipes may serve as examples :—

Basic Discharge Blue.

7 gallons paste,
1 pint glycerine,
½ gallon water,
1 lb. new methylene-blue N,
24 lbs. acetate of soda,
½ gallon acetate of lime,
1 lb. oxalic acid.

Basic Discharge Pink.

4 gallons paste,
1 gill glycerine,
1 quart water,
9 ozs. anisoline,
14 lbs. acetate of soda,
12 ozs. oxalic acid.

It is very important that the fastest basic colouring-matters procurable should be employed, as the practice of combining fugitive colouring-matters, such as many of the basic dyestuffs, with a fast colouring-matter like aniline black is a practice much to be deplored.

W. E. Kay, of the Thornliebank Printing Company, has protected a method of applying basic aniline colours as coloured reserves on aniline black (prussiate) grounds, by using, along with the thickened basic colour, both the acetates of soda and zinc. The cloth, after being padded with the prussiate aniline black mixture, is dried, printed with the colours prepared as described, steamed, and finished as usual. The acetates prevent the development of the black upon the parts printed, and the zinc contained in the colour reacts with the ferrocyanide to form zinc ferrocyanide, which behaves in a similar manner to tartar emetic, and fixes the basic colour on the fibre.

Both the above processes require a licence before they can be worked—in Great Britain, at least.

SECTION VI.

RESISTS UNDER DYED COLOURS.

By printing upon cloth various acid mixtures in any required pattern, and afterwards padding or covering with the thickened mordants or colours used in the madder or dyed styles, the fixation of the mordant upon the parts printed with the acid is prevented, and upon subsequent dyeing, yields a white in the print. In the case of padded or covered purples, the colour used for covering contains both iron and alumina, and use is made of the property possessed by tin crystals in preventing the fixation of iron upon the cloth for obtaining red resists under these purple covers and pads, the tin crystals being used along with acetate of alumina; the iron only is resisted, while the alumina is deposited upon the cloth, and gives the red colour when dyed with alizarine.

The following recipes are for some of the resists used for resisting red, pink, chocolate, or purple mordants :—

White Resist for Dyed Colours.

No. 1.

2 gallons lime juice, 50° Tw.,
1½ gallons caustic soda lye, 70° Tw.,
24 lbs. china clay,
1 quart water,
2 gallons thick Senegal thickening.

Mix the lime juice and caustic soda lye thoroughly, raise to the boil, and add the china clay (previously mixed with the water into a smooth paste); then add the thickening; boil well; and cool.

This resist will work under padded or covered reds, chocolates, or purples :—

White Resist for Dyed Colours.

No. 2.

1 lb. bisulphate of potash,
¼ gallon lime juice, 50° Tw.,
¾ gallon water,
4¼ lbs. British gum,
3 lbs. china clay.

This resist is much more active than No. 1, and will usually require reducing with thickening and china clay unless the padded colours are very dark in shade.

Dark Red Resist for Dyed Purples.

No. 3.

1 gallon red liquor, 18° Tw.,
2 lbs. flour.
Boil; cool to 100° F.; and add
½ lb. tin crystals.

Light Red Resist for Dyed Purples.

No. 4.

1 quart red liquor, 18° Tw.,
3 quarts water,
2 lbs. flour,
3 ozs. tin crystals.

For chrome mordant the No. 2 resist will be found the most effective. When a white is desired upon pieces that have been slop-padded with the mordant, the pieces are usually printed with the No. 2 resist, after carefully drying at as low a temperature as possible.

After the pieces have been printed with the resist, and padded or covered with the printing colour, they are dried, aged, dunged, dyed, &c., as usual.

Although we have spoken of purples, reds, &c., in describing the resists, it must be borne in mind that the printing colours, being really mordants, yield shades varying with the dyestuffs employed in the dye-beck. They are, however, usually known by the shades they produce with alizarine.

George Donald's new process for obtaining coloured discharged effects on mordant dyeing colours requires five operations :—1st. Pad in tannin liquor containing 1½ per cent. of tannic acid and then dry. 2nd. Pass into tartar emetic to form tannate of antimony, and dry. 3rd. Print on or mordant in any convenient way an alumina, iron, or chrome mordant. 4th. Print on a basic aniline colour, some citric acid being added to the printing colour, then steam. The tannate of antimony fixes the aniline colour; citric acid acts as a resist to the alumina, iron, or chrome mordants, which are rendered soluble, and therefore removable by the citric acid. 5th. Dung, then dye with alizarine, or any of the true mordant-dyeing colouring-matters allied to alizarine in its properties. This process is stated to give good results. Brooks, in 1861, used a similar process. The pieces were mordanted with alumina, iron, or chrome, then a basic aniline colour containing tannic, and a fairly large proportion of tartaric or citric acid was then printed on, and the pieces steamed. Then they were passed through a bath of tartar emetic and arseniate of soda, and finally dyed with the required dyestuff.

Through the kindness of Messrs. Read Holliday & Co., of Huddersfield, we are enabled to show a pattern dyed upon a chrome mordant, using gambine R and Y for dyeing, the following being the process used:—

PATTERN No. 37.—The cloth was first padded with a solution of bisulphite of chrome at 8° Tw. The bisulphite of chrome was prepared by mixing concentrated solutions of chrome alum and bisulphite of soda, allowing the sulphate of soda formed by the double decomposition between the two salts to crystallise out and using the clear liquor only. The cloth was then dried and printed with the following printing colour, which prevents the chrome mordants from being fixed upon the parts printed with it:—

Chrome Discharge Colour.

4 lbs. starch,
2½ gallons water.
Boil; and add
6 lbs. citric acid (ground to a fine powder).
Cool; and strain.

After printing with this discharge colour the goods are passed through Mather & Platt's steam ager (see p. 44), and then through a chalk bath, after which they are rinsed and are ready for dyeing.

The dyeing was done with a mixture of the two marks of gambine, using the following proportions on the weight of the cloth:—

Dyeing.

1¼ per cent. gambine R,
1¼ per cent. gambine Y.

Enter the goods into the dye-beck, raise to the boil in half an hour, and keep the liquor boiling for half an hour. After dyeing, rinse and soap as usual. It is advisable to add a small quantity of tannin, chalk, and glue size to the dye-beck, which will produce fuller shades and whites of greater purity.

SECTION VII.

DISCHARGES UPON CLOTH DYED WITH SUBSTANTIVE COLOURS.

SINCE the introduction of the substantive colouring-matters, yielding comparatively fast shades upon cotton goods, large numbers of pieces have been dyed with them, and, recently, many effects have been obtained by discharging the dyed colours with white or coloured discharge printing colours.

The dyeing of the cloth presents no difficulty. Although fuller details will be found in any of the newer books published on dyeing,* we will give a short description of the process used. The dyes fix themselves upon cotton (without the aid of any mordant) from a boiling solution in water; but it is usual (and better) to employ either soap, phosphate of soda, sulphate of soda, or common salt along with the dye in the liquor, to assist the combination of the colouring-matter with the cotton fibre. As the dye liquor is rarely exhausted, and as the same shade generally requires to be often repeated, it will be found advantageous to set apart (if possible) a special dye-beck for the dyeing of each shade, because then the liquor contained in it will merely require strengthening with colouring-matter, &c., before being used again. The dyestuff, together with the assistant selected, should be dissolved in boiling water, and the solution so obtained added (in suitable proportions to give the required intensity of shade) to the liquor in the dye-beck. The goods are now entered and the dyeing commenced; the liquor is rapidly brought up to the boiling point and the dyeing continued until a small trial bit, when washed and dried, has the same shade as the pattern on the order sheet. When the goods have been taken out of the beck and dried, they will be found to be slightly darker than the trial bit, and, consequently, darker than the stock pattern. This is just as they should be, because the shade of the body of the piece will be rendered somewhat lighter during the operations through which it will pass after printing with the discharge colours. After dyeing, the goods are well washed, hydro-extracted, and dried. Should the pieces at this stage be found too dark in shade, they are soaped down to the shade desired.

The quantity of dyestuff used varies with the shade to be produced, the weight of the cloth, and the kind of colour used; but it may be roughly stated that from 1 to 5 per cent. of the weight of the cloth of dyestuff, according to the shade desired, with about 10 to 20 per cent. of any of the salts above-named as assistants, will be required.

* See *A Manual of Dyeing*, by Knecht, Rawson, and Loewenthal.

It must be borne in mind that the volume of the water used in the dye-beck has also considerable influence upon the depth of shade obtained, on account of the liquor not being exhausted; the larger the volume of water used in the beck, the paler will be the resulting shade.

As an example of an actual dyeing, the following proportions of colouring-matter and assistants were used for pattern No. 45, the percentages given being calculated upon the actual weight of the cloth dyed:—

Benzoazurine G.

5 per cent. benzoazurine G,
5 per cent. Glauber's salt (sulphate of soda),
2 per cent. soap.

Discharging upon the Dyed Cloth.—There are two reagents used for effecting the discharge of the colour upon the dyed cloth—viz., tin crystals and a mixture of bisulphite of soda and zinc. The tin salts discharge is chiefly employed for coloured discharges, the various colours being obtained by the addition of colouring-matters to the discharge printing colours, while the zinc discharge is generally used for white discharges.

Zinc-Bisulphite Discharge.—The following recipe yields good white discharges upon cloth dyed with the majority of the substantive colouring-matters:—

Zinc-Bisulphite Discharge Colour.

a. 24 lbs. zinc powder,
30 lbs. British gum thickening,
4 lbs. glycerine.

b. 4½ lbs. ammonia,
9 lbs. bisulphite of soda liquor, 70° Tw.

The zinc powder must be of good quality, and contain from 80 to 90 per cent. of zinc in the form of free metal. The ingredients of the portion of the discharge colour, marked *a* in the above recipe, should be well mixed together by grinding in the indigo mill for from four to five hours; the mixture so obtained may then be stored, and will keep for a considerable time. The British gum thickening should contain 10 lbs. of British gum per gallon. Just before it is intended to use the colour, the ammonia and bisulphite mixture, *b*, should be very slowly added to the mixture marked *a*; after the whole has been well stirred and strained, the colour is ready for use. As the colour will not keep for more than twenty-four hours after the bisulphite solution has been added, only sufficient colour should be made as is actually required for the work in hand.

There is always a tendency for colours containing zinc powder to clog the engraving during printing, but this tendency may be reduced by carefully selecting as fine a sample of zinc powder as can be procured, and paying particular attention to the thorough grinding of the powder in the mill with the glycerine and gum.

Unlike the tin salts discharge, zinc does not tender the cotton fibre, even when the cloth has been dyed to a dark shade, and a strong discharge colour has been used.

The pieces, after printing, should be steamed for a period of forty-five to sixty minutes, either in the continuous steamer, or without pressure in a cottage steamer. After steaming, they are treated with a weak souring liquor (hydrochloric acid), well washed, and dried.

In the case of colours that are sensitive to the action of weak acids, and the shade of which is altered by the acid treatment to which the goods were subjected after steaming, the pieces are, after washing, passed through a weak solution of soda ash, and again washed before they are dried.

Discharging with Tin.—Tin does not yield so pure a discharge as zinc powder, and hence is not often employed to produce "whites." When, however, tin is used as the discharging agent, it is possible to employ colouring-matters that are fixed with tin in the discharge colour, and so obtain coloured discharges. The basic colouring-matters fixed with tannic acid and tartar emetic may also be mixed with the tin discharge colour along with tannic acid; after steaming, a colour so made will effect the discharge of the dyed colour, as well as precipitate the tannic colour lake, the latter being rendered faster by passing the pieces through a solution of tartar emetic. Should it be desired to employ one of the alizarine colours for the purpose of obtaining some particular shade of discharge colour, acetate of tin may be added to the alizarine printing colour to effect the discharge of the shade already on the cloth, without interfering with the fixation of the alizarine lake.

To illustrate the method of using tin for both fixing the colour and producing the discharge the following recipe, used for pattern No. 45, is given, showing the production of a yellow discharge by the use of Persian berry extract:—

Yellow Discharge on Direct Dyeing Colours.

5 lbs. water,
$2\frac{1}{2}$ lbs. wheat starch,
5 lbs. acetate of tin, 32° Tw.,
3 lbs. British gum thickening (10 lbs. per gallon).
Boil; and add
2 lbs. tin crystals.
Then add
$\frac{1}{8}$ lb. citric acid (in fine powder),
$1\frac{5}{8}$ lbs. Persian berry extract, 53° Tw.,
$\frac{3}{8}$ lb. acetic acid, 9° Tw.

The two following tin discharges are used for mixing with any of the prepared printing colours made from basic colours, or those of the alizarine type; or they may be used for producing white discharges in the few cases where zinc powder does not give a satisfactory result:—

Tin Discharges on Direct Dyed Colours.

No. 1.

10 gallons acetate of tin, 28½° Tw.,
25 lbs. wheat starch,
3 gallons acetic acid, 9° Tw.
Boil; and add
14 lbs. acetate of soda (in fine powder).

No. 2.

10 gallons acetate of tin, 28½° Tw.,
25 lbs. wheat starch,
1 gallon acetic acid, 9° Tw.

For producing the coloured discharges, the following proportions of tin discharge and tannic or alizarine printing colour are taken:—

Coloured Discharges on Direct Dyed Colours.

1½ to 2 gallons tin discharge colour,
1 gallon tannic or alizarine printing colour.

When it is necessary to submit the goods for a considerable time to the action of steam—as, for instance, when the zinc powder white discharge has been printed upon the same piece—No. 2 tin discharge should be used; the No. 1 tin discharge being used when a few minutes steaming only is required.

The dyes belonging to the eosine group may be used along with tin for producing coloured discharges, but they do not yield fast shades.

The coloured discharge printing colours prepared with the basic colouring-matters and fixed with tannin do not keep well, the shades obtained gradually becoming paler; hence, it is advisable to prepare only so much colour as will be used during the day.

After the goods have been printed and steamed—the duration of the steaming depending upon the nature of the discharge colour and colour upon the piece, and may be from two to forty-five minutes—they are treated according to whether they have been printed with a basic colour requiring fixation with tartar emetic or not. Should the shades require passing through tartar emetic, the goods are passed through the open soaper, the first tank of which is filled with the solution of tartar emetic and chalk, mentioned on p. 124, while the other tanks usually contain water only, the temperature of which is generally about 160° F.

When the pieces have been printed only with colours made from the alizarine or eosine dyes they should be washed in the open width, by passing them through a dolly filled with water, and then again washed well in the ordinary dye-house washing machine. Colours requiring to be soaped are, after this, treated with soap solution at as low a temperature as possible, to avoid unnecessary stripping of the colour from the pieces.

Patterns Nos. 43 to 50 illustrate the application of these discharge colours.

PATTERN No. 43.

Dyed with	*Printed with*
2 parts diamine blue BX,	*Pale yellow*—Tin salts discharge.
1 part diamine gold,	*Yellow*—Persian berries with tin salts.
½ part diamine black BO.	*Blue*—Alkali blue with tin salts.

PATTERN No. 44.

Dyed with	*Printed with*
1 part diamine blue BX,	*Blue*—Alkali blue with tin salts.
1 part diamine black BO,	*Brown*—Alizarine puce.
1 part diamine gold.	

PATTERN No. 45—See pp. 210 and 211.

PATTERN No. 46.—Dye the cloth to the required shade from a bath containing 3 per cent. titan blue 3R and 20 per cent. common salt, rinse, dry, and print with the zinc dust discharge. Steam for thirty minutes, pass through a weak solution of hydrochloric acid, wash well, and dry.

PATTERN No. 47.—The cloth was first dyed, in the manner common to direct colours, with a mixture of

1 part diamine gold,
2 parts diamine black BO,
1 part diamine fast red F.

The cloth, after dyeing, was printed with steam alizarine puce, steamed, and finished as usual.

PATTERN No. 48.

Dyed with	*Printed with*
1½ parts diamine gold,	*Blue*—Alkali blue with tin salts.
1 part diamine black RO,	*Brown*—Alizarine puce.
½ part diamine red F.	

PATTERN No. 49.

Dyed with	*Printed with*
1 part diamine gold,	*Pale buff*—Tin salts discharge.
1 part diamine black BO,	*Brown*—Alizarine puce.
1 part diamine red F.	

PATTERN No. 50.

Dyed with	*Printed with*
3 parts cotton brown N,	*Pale buff*—Tin salts discharge.
2 parts diamine brown G.	*Dull yellow*—Persian berries with tin salts.

It will be noticed from the patterns shown, and from a consideration of the nature of these discharges, that it is far easier to obtain successful coloured discharges than to obtain "whites." Coloured discharges can frequently be produced in cases where it is quite impossible to produce pure "whites."

SECTION VIII.

DISCHARGE EFFECTS ON INDIGO.

INDIGO PIECE DIPPING AND DISCHARGING.

THE designs in this style are produced by printing (upon cloth previously uniformly dyed with indigo) colours which (upon subsequent treatment) discharge the indigo on the parts printed, leaving a white or coloured design upon the blue ground.

Although we are more particularly concerned with the printing of the pieces, we will now give a short description of the method principally used for dyeing piece goods with indigo, because the machinery employed differs to a slight extent from that used in many works where dyeing only is carried on, and because the goods are usually dyed by the printer himself previous to printing.

The system of dyeing is that which is known as the hydrosulphite method, in which the indigo is reduced to the state of indigo-white by the action of hydrosulphites; the hydrosulphites are formed by the action of powdered metallic zinc upon a solution of bisulphite of soda, the addition of lime being made to render the solution alkaline, in which condition the indigo is the more readily reduced, and the solution of the indigo-white effected. The dyeing liquor thus consists of an alkaline solution of indigo-white.

There are other methods by which indigo can be reduced and rendered soluble and suitable for dyeing. Such of them as are at the present time used by printers for this purpose will be found described in the larger manuals devoted to dyeing.*

The application of the solution of indigo-white in dyeing depends upon the avidity with which the indigo-white absorbs oxygen when exposed to the atmosphere and re-forms indigo-blue insoluble in water. If the cloth, then, is impregnated with the indigo solution, and, afterwards, exposed to the air, the insoluble indigo-blue will be formed on and within the fibre of the cloth, entrapped, as it were, in the substance of the fibre. Such are the principles involved in the process of indigo dyeing. We will now turn our attention to the practical details necessary for carrying out these principles.

The Indigo.—For indigo dipping the very lowest qualities of indigo are generally used, such as contain from 25 to 28 per cent. of indigotine, or a smaller amount of the medium qualities of "kurpahs," in proportion to the quantity of indigotine they contain. The varieties of indigo known in the trade as "figs" and "Madras" are

* See *A Manual of Dyeing*, by Knecht, Rawson, and Loewenthal; or, *Dyeing*, by J. J. Hummel.

principally used, either alone or mixed (when of too low a quality) with more or less of "kurpah" indigo, which contains a higher percentage of indigotine. The indigo, before reducing, must be ground into a fine paste with water; this can be done in the indigo grinding machine described on p. 143, or, what is quicker and effective enough for our purpose, in the cylinder indigo grinding machine. The cylinder grinding machine consists of a steel cylinder mounted so that it can be revolved by power at a high rate of speed, the axis of the cylinder running horizontally. Inside the cylinder there are some heavy steel balls which, when the cylinder revolves, crush the indigo contained in the cylinder, in a similar manner that the rollers do in the roller grinding machine. The indigo and the required quantity of water are placed in the cylinder and the machine started, and the indigo will be ready for use after grinding for a few hours. Usually, however, it will be found better to first grind the indigo for about a day in the roller machine, and to finish the grinding by putting the rather coarse paste so produced in the cylinder machine for two or three hours. The indigo paste is now reduced with water until it is of the usual strength, and is then ready for use.

Reducing the Indigo.—For reducing the indigo, the following quantities of the various substances named should be obtained:—

2 gallons bisulphite of soda, 50° Tw.,
2¼ lbs. zinc powder,
7 lbs. slaked lime in powder.

The bisulphite of soda solution should be measured out and put into a large cask, and the zinc powder slowly, and with constant stirring, dusted into it. When all the zinc has been added to the liquor, the whole should be stirred for at least ten minutes. In the meantime the slaked lime should be placed in a tub, and 6 gallons of water at 130° F. poured upon it, the mixture being stirred until it forms a thin cream, when it should be added slowly to the mixture of bisulphite and zinc powder.

2 gallons of indigo paste, 30 per cent.,

should now be added to the mixture, and the whole well mixed for at least fifteen minutes. After standing for a day or so, the indigo will be completely reduced and ready for use. This mixture forms the strong stock solution of reduced indigo, from which the dipping vats are prepared and strengthened (after use).

The solution of reduced indigo should be of a peculiar brownish-yellow colour; if there is any trace of green, it indicates that the indigo is only partially reduced, and that more of the mixture of bisulphite of soda, zinc, and lime should be added. The reduced indigo solution will keep for a long time if it is kept covered so as to prevent the air coming into contact with the surface of the liquor more than can be avoided. When any of the liquor is required, the whole mixture should be well raked up, to render it uniform in composition, on account of the large quantity of insoluble matter contained in it.

The Indigo Dyeing Vats.—The continuous system of dyeing is probably now used by calico printers in connection with the hydrosulphite vat to the greatest extent. It is, in our opinion, the most suitable for this purpose.

The machines used in the continuous system of indigo dyeing are shown in Figs. 49 and 50.

The machine generally employed for pale shades is shown in Fig. 49. As will be seen, the cloth is laid on the waggon A, from which it passes over the two wooden bars BB, placed above for the purpose of lifting the cloth above the head of the boy who superintends the

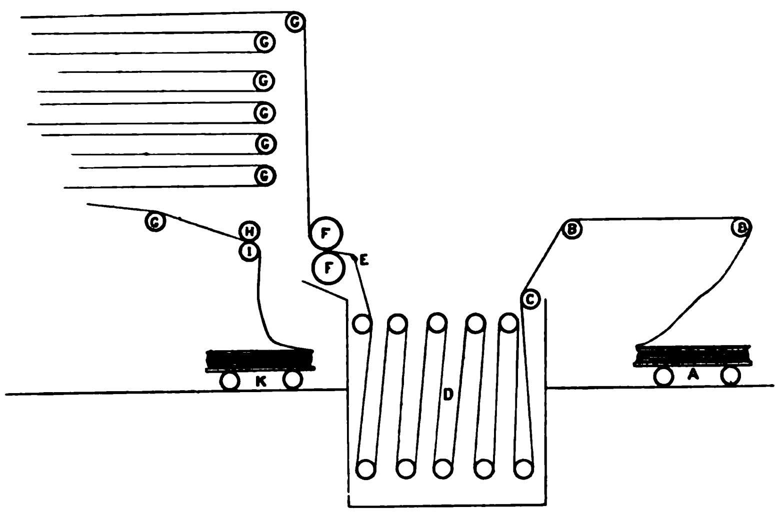

Fig. 49.—Sky-blue indigo dipping machine.

passage of the piece into the vat standing opposite C, and smoothing any creases or folds before they can pass into the vat D. An iron frame provided with guiding rollers, around which the cloth passes while in the dyeing liquor, stands inside the vat arranged so that it can be removed when required, for the purpose of setting the vat, threading up the rollers or cleaning the vat. The roller frame is lifted out of the vat by means of a chain and pulley block (not shown in the sketch). The guiding rollers are usually made of iron and perforated to allow the liquor in which they revolve to pass freely through them, the ends of the rollers also being open for the same purpose. The top row of rollers is, when the frame is immersed in the liquor, just underneath the surface of it, the bottom rollers being situated at such a height in the frame as to raise them from 2 to 3 feet from the bottom of the vat. This space under the lower rollers is intended to receive the insoluble matter suspended in the liquor after setting, which is always allowed to settle before the frame is lowered into the vat. When the deposit has accumulated to such an extent as to nearly touch the bottom rollers, the vat is allowed to settle, the clear liquor taken out, and the deposit removed with a shovel. The bar marked C is for the purpose of facilitating the work of the attendant in taking out the turned edges, &c., in the piece entering the vat. On passing from the liquor, the piece is passed through one of Birch's spiral openers E, and then between the squeezing rollers FF. The squeezing rollers are made of iron, turned quite true. The bottom roller works in fixed gun-metal bearings, and the top roller, which is covered with several layers of blanket first of all, and then faced with fine cotton cloth, is pressed by means of levers at each side provided with sliding weights for regulating the amount of pressure. Special care should be taken in covering the top roller. The joinings in the lapping should be so arranged as to barely show any trace of a join on the piece passing through the rollers, and, as it rapidly wears away on account of the pressure and the destructive nature of the dyeing liquor, care is required to keep the covering properly trimmed whilst working the machine. The cloth having been saturated with the dyeing liquor, and the excess removed, the goods pass over the rollers marked G, and the indigo-white is during the passage through the air oxidised into indigo-blue. The cloth is drawn over the airing rollers by the friction rollers H and I, the bottom one being driven by a strap from a pulley on the end of the bottom squeezing roller F. On coming from the rollers H and I, the piece is plaited down on the waggon K. This machine requires two boys and a man to work it.

It is found by experience that it is best to make the dye liquor of such a strength that the piece is dyed to the right shade (sky-blues only are meant here) by one passage through the vat. There is less liability of bad work being turned out by so doing than when the piece is sent several times through the liquor, as the cloth, even when of a "curly" nature like satteens, will generally pass the rollers quite evenly the first time through, but it is very difficult to prevent the edges curling during subsequent passages, and the least irregularity in the passage shows in sky-blues. As the pieces pass through the liquor, the latter becomes weaker and weaker, and if the engine was run at the same speed throughout, the shade would gradually become paler and paler; but it is quite easy, after a little practice, to so govern the speed as to obtain an even shade throughout the whole batch.

After dyeing, sky-blues are merely washed, dried, and, if wanted for printing, wound on centres ready for the printing machine.

Fig. 50 shows the vats used for dyeing medium, dark, and very dark shades of indigo. It will be noticed that there are two vats, and the piece after passing through one vat is aired and then passed into the second vat, after which it is again aired.

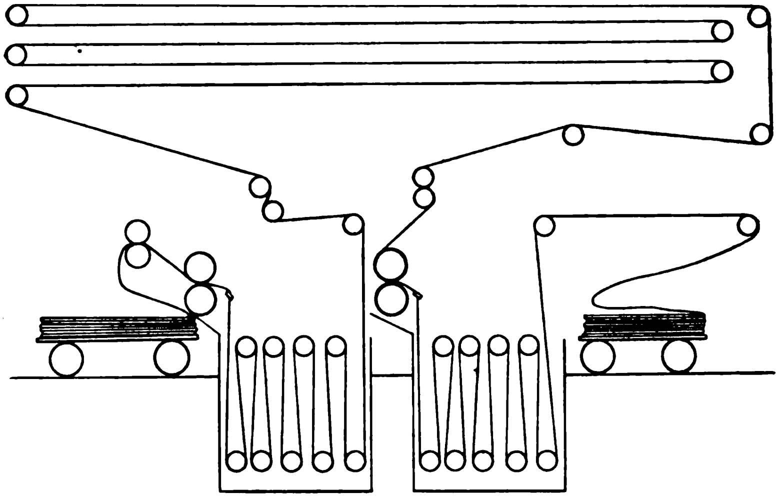

Fig. 50.—Dark blue indigo dipping machine.

Setting the Vats.—The vats are usually made of about 100 to 150 gallons capacity each, and are filled to about 18 inches from the top edge. For a vat holding about 130 gallons, the following quantities of materials should be used, being supplied in the way described. The vat is first filled to the proper height with water from a tap placed at the side. Into a tub measure 3½ gallons of bisulphite of soda (50° Tw.), and gradually add to it (with constant stirring) 4 lbs. of zinc powder. When this has been stirred for about ten minutes it is added to the water in the vat and the whole well mixed together by means of the rake. The object of this addition of hydrosulphite to the vat is, partly, to remove the oxygen that the water contains dissolved in it; and, partly, to retain the indigo in the reduced condition when diluted, or to reduce any indigo that may have been oxidised after dyeing the last batch of cloth.

Sixteen gallons of the reduced indigo are now added and well mixed with the liquor in the vat. At this stage the vat has generally a greenish colour, and is more or less "dead,"—that is, the bronzy blue scum or "flurry," usually to be seen on the surface of the vat, is absent, and when the rake is lifted from the liquor the indigo is slow in absorbing oxygen from the air to convert it into the blue condition. These indications denote that the liquor is not sufficiently alkaline, providing the proper quantity of hydrosulphite and indigo have been used; powdered slaked lime should now be gradually added until the vat appears to be in a normal condition, a point which can only be found by experience. After each addition of lime, the vat should be raked up for some minutes in order to allow time for the solution and action to be completed. For the quantities given above, 6 to 7 lbs. of freshly slaked lime will usually be required.

The quantities given above are suitable for setting each of the two vats for the dark blue dipping machine; or for resetting the same, after they have been exhausted by use. For the sky-blue machine only half the quantities named will be sufficient.

A mixture of indophenol with indigo has been advocated for preparing the dipping vat, indophenol being reduced and behaving somewhat like indigo in the vat, but, after trial on the large scale, we have found no advantage arising from its use, while the pale shades are much redder in shade than those obtained from indigo alone and are not so fast, either to light or soaping. The mixture is, however, used by some dyers and printers; so, probably, their experience may be different from ours.

Before the frames carrying the guide rollers are lowered into the liquor, the latter should be allowed to stand for some hours to enable the insoluble matter held in suspension in the liquor to settle to the bottom of the vat underneath the feet upon which the frame rests. It will be found best to set the vats in the evening and, after well raking the whole of the liquor, to allow it to stand overnight, when they will, in this case, be ready for use in the morning.

Stamping the Pieces.—The ordinary ink, or colour, used for stamping the order number, &c., upon the ends of the various pieces of cloth is useless for goods intended for dark indigo-blues, because it becomes practically invisible after dipping. For this reason, the pieces are stamped with a white indigo reserve colour which resists, or partially resists, the blue. The following is a good recipe for a stamping colour for the blues, the recipe being formerly used as a reserve under indigo, and will be found in Crooke's *Handbook of Dyeing and Calico Printing*:—

Stamping Colour for Indigo Dyed Pieces.

2½ lbs. sulphate of copper,
1 gallon water,
2 lbs. white acetate of lead.
Dissolve; draw off the clear liquor; and thicken with
1½ lbs. flour,
1 lb. British gum.
Cool; and add
1 noggin nitrate of copper, 80° Tw.

The pieces, after stamping, are sewn together, wound on to a centre, and are then ready for dipping.

Dipping Sky or Pale Blues.—Pale blues are best dyed by passing them into the single tank machine, through liquor made of such a strength that the proper depth of shade is obtained by a single passage when the machine is delivering at a sufficient rate of speed. As stated above, the shade can, after a little practice, easily be obtained regular throughout the whole batch of cloth by gradually reducing the speed of the engine working the machine as the vat becomes gradually weaker in strength.

Trials upon fents sewn between greys should first be made to find the exact speed at which to run the engine for the shade required. The fent, after airing, should be washed well, and dried, and should be slightly darker than the pieces required. When passed through the machine at the same speed as the fent the pieces will be very slightly paler.

Care should be taken that the goods enter the machine free from creases or turned edges, and that they pass evenly between the squeezing roller or "nip," or light stains will be formed, owing to the liquor being more thoroughly expelled in these places. For the same reason, particular attention should be paid to the condition of the lapping on the squeezing rollers.

The cloth for sky-blues should be well bleached and quite free from any greasy matter, which is often present, owing to the use of unsuitable fatty matters in the composition used for sizing the warps. As some of these fatty matters are of such a nature as to be immovable, even by the most thorough bleaching process, such cloth cannot be used for this purpose. Frequently the dyed pieces will be found to be covered with small white specks, which are generally due to the presence of what is known as "dead" cotton fibres in the cloth; this defect cannot be remedied by the dyer.

After dipping and thoroughly airing (to oxidise the indigo), the pieces should, as soon as possible, be well washed and dried. If it is necessary to leave the goods for any length of time after dipping and before washing and drying, they should be stored in a cool, damp place, and kept well covered with damp cloths. If the pieces are allowed to dry at the edges, yellow stains will probably be found in the finished pieces.

Dipping Dark and Medium Blues.—Dark shades of blue are dipped through the twin tank or vat machine, and are passed through several times, until the shade required is obtained; this point is found by cutting a small piece out of one end of one of the pieces, souring, washing, drying, and comparing it for depth of shade with the pattern on the order sheet. If the pieces are for printing, the pieces should be dipped until the face of the cloth is very slightly darker than the pattern, because the face of the cloth loses some of its depth of shade all over the surface from the colour applied on the printing machine and the passage through the cutting liquor. The back of the cloth, the side not singed or sheared, always appears darker than the face;

care should, therefore, be taken to compare the pattern with the proper side of the cloth. When the goods have been dipped to a shade so nearly approaching the pattern, that it is likely the goods would be too dark if passed again at the same speed through the liquors, a small piece of the cloth should be roughly sewn to one of the pieces passing through the machine; from the shade obtained upon this piece an idea can be formed of the speed required to finish the pieces. When only a slight increase in depth of shade is necessary, it is advisable to run the goods through one vat only for the last run, either by disconnecting on the dark blue machine, or by using the sky-blue vat.

Medium blues usually require about two dippings through the two vats of the dark blue machine; dark blues from three to four; and very dark bronzy-blue shades from four to five dippings. But, if many of the latter shades are required, it is preferable, as saving much time, to set the vats stronger, and to give, consequently, fewer passages.

Finishing the Pieces ready for Printing.—After dipping, the pieces should be allowed to remain piled upon the waggons for a few hours, to allow of the oxidation of the indigo-white into indigo-blue to complete itself.

Sky-blues are merely well washed by passing them through two square beater dye-house washing machines (see p. 60), hydro-extracted, dried, sheared, and wound on centres ready for the printer.

Dark and medium shades of blue are usually passed (before washing, &c., as described for sky blues) through a solution of sulphuric or, better, hydrochloric acid at 2° Tw. contained in a dolly, over the top of which should be a hood to convey into the open air the sulphur dioxide evolved by the action of the acid upon the sulphites contained in the pieces.

The Discharging of the Patterns.—The colour upon the dyed cloth is discharged by the action of chromic acid upon the indigo, oxidising the latter into the substance known as isatin, which is soluble in water and is removed in the processes of washing. The discharge printing colours are prepared with an alkaline chromate, and, if a coloured discharge is required, thickened with albumen, with the addition of the special pigment colour required to furnish the shade desired. After the goods have been printed, they are passed through a hot solution of sulphuric acid, which, by its action upon the alkaline chromate, liberates chromic acid in the parts of the cloth printed with the discharge colours; this chromic acid then acts upon the indigo and discharges it. In the case of the coloured discharges thickened with albumen, the pigment is fixed upon the cloth by the coagulation of the albumen, under the influence of the heat and sulphuric acid during the discharging process, so that, in these cases, the colour on the piece is discharged, and that contained in the printing colour is fixed at one and the same time.

Unfortunately, a hot solution of chromic acid has a tendering action upon cotton, and, unless precautions are taken, this tendering of the cloth will occur to such an extent as to render the printed cloth too rotten for practical use. To guard, as far as possible, against this action, oxalic acid is always used along with the sulphuric acid in the discharging liquor. For a similar reason, it is advisable to use a small proportion of an alkaline oxalate along with the chromate in the printing colour, which will cause oxalic acid to be liberated (by the action of the sulphuric acid upon the neutral oxalate) in the parts chiefly affected. The use of oxalic acid in this connection depends upon the relative resistance to oxidation by chromic acid of the three substances concerned—viz., indigo, oxalic acid, and the cotton fibre—which are sensitive to its action in the order named, indigo being the most easily oxidised. Even when these precautions are taken, the cloth is always weakened, on account of local action taking place, as shown by the following figures. These show the breaking weights of similar pieces of cloth treated in the manner indicated when tested under the same conditions in a cloth testing machine:—

Colours Printed.	*Breaking Weight.*
Cloth dipped dark blue only, ...	178½ lbs.
,, discharged white, ...	118 ,,
,, ,, buff (with iron as colour), ...	139 ,,
,, ,, orange (with lead chromate), . .	55 ,,

All the precautions mentioned above were taken in preparing the samples, and the results given represent the mean of several trials.

The oxalic acid in the discharging liquor also decomposes any chromic acid before it has time to dissolve and mix with the liquor, where it would, if allowed to accumulate, act upon the whole of the piece.

Many other additions, besides oxalic acid, have been suggested for preventing this tendering of the cloth during discharging; but, so far as we are aware, none of them have been used commercially. Brandt, some time ago, suggested the addition of 10 per cent. alcohol to the cutting vats—composed of a mixture of sulphuric acid and oxalic acid—which he found prevented the cloth being tendered through the formation of oxycellulose. Scheurer found that glycerine was quite equal to alcohol in preventing the tendering action, and it has the advantage over alcohol of being non-volatile, or practically so, under the conditions obtaining in practice.

Preparing the Printing Colours:—

No. 1.

White Discharge on Indigo.

1 gallon British gum thickening,
3 lbs. neutral chromate of potash,
1 lb. neutral oxalate of potash.

These ingredients should be well powdered and then dissolved in the British gum thickening. For pale shades of blue, the above discharge should be reduced with a solution of British gum, according to the depth of shade upon the pieces.

No. 2.

White Discharge on Indigo.

1 gallon water,
3¾ lbs. bichromate of potash.
Dissolve ; and add slowly
2 pints liquor ammonia.
Then add, gradually, to
1 gallon British gum thickening (10 lbs. per gallon).

This discharge should also be reduced with plain thickening for pale shades.

No. 3.

Black upon Indigo.

Black is usually obtained by printing upon the cloth the aniline black colour containing vanadate of ammonia described on p. 163.

Occasionally, however, a black is produced by printing a discharge colour containing lampblack, as the following :—

No. 4.

Black Discharge on Indigo.

Work in the mill into a smooth paste
16 lbs. lampblack, with
1 gallon crude glycerine ;
then add, slowly,
3 gallons indigo discharge thickening.

Indigo Discharge Thickening.

Dissolve 3½ lbs. neutral chromate of potash,
1 lb. neutral oxalate of potash, without the aid of heat, in
1 gallon blood albumen thickening.

It is advisable to place the above ingredients in a mill and grind the whole together until the alkaline salts are completely dissolved. This thickening is used for making all the coloured discharges.

No. 5.

Red Discharge on Indigo.

Mix into a smooth paste
10 lbs. vermilion,
with a sufficient quantity of crude glycerine.
Then add, slowly,
1 gallon indigo discharge thickening.

No. 6.

Bright Red Discharge on Indigo.

10 lbs. vermilion,
1 gallon indigo discharge thickening,
1½ ozs. eosine (blue shade),
1 gill water.

The eosine should be dissolved in the water and then added to the vermilion and thickening, mixed as described for recipe No. 5. The shade given by this colour is brighter than is obtained from vermilion alone. The eosine is fixed to the cloth, because of its affinity for coagulated albumen.

No. 7.

Blue Discharge on Indigo.

1 gallon Prussian blue paste,
7 gallons indigo discharge thickening.

No. 8.

Green Discharge on Indigo.

10 lbs. chrome green pigment paste,
1 gallon indigo discharge thickening.

The chrome green pigment is usually sold in the form of a very stiff paste, and this, after weighing, should be worked up into a smooth and thin cream with glycerine, before adding the thickening.

No. 9.

Brown Discharge on Indigo.

1 gallon pigment brown paste,
5 gallons indigo discharge thickening.

No. 10.

Buff Discharge on Indigo.

1 gallon pigment buff paste,
5 gallons indigo discharge thickening.

No. 11.

Yellow Discharge on Indigo.

1 gallon chromate of lead paste,
1½ gallons indigo discharge thickening.

In addition to the pigments mentioned in the recipes just given, a large number of lakes are sold for this purpose, prepared from the artificial colouring-matters, some of which yield useful shades, while others are more or less affected by the discharge. They are applied in a similar manner to that used for the pigments.

Printing the Cloth.—No preparation of the dyed cloth is required before printing. The printing is done in the ordinary manner, brush furnishers being usually fitted in the colour boxes. Owing to the large quantity of insoluble matter contained in these discharge colours the furnisher is revolved against the printing roller, so as to force the colour well into the engraving, and the machine should be run rather slowly. Unless these precautions are taken, the pattern will be barely printed, or, as the printers term this defect, "the colour will stick in the engraving." Colours prepared from vermilion are particularly liable to show this fault.

After printing with these colours the cloth may, especially if there should be any of the vanadium aniline black colour upon the piece, be hung for a short time, after which it will be ready for "cutting."

"Cutting" or Discharging the Pieces.—The "cutting" of the colours printed upon the cloth is accomplished by slowly passing them in the open width through the following cutting liquor, contained in a dolly, at a temperature of from 120° to 200° F.:—

Indigo Cutting Liquor.
12 ozs. strong sulphuric acid, 168° Tw.,
1 gallon water,
8 ozs. oxalic acid.

The pieces are passed through the solution in a continuous manner and at such a speed that they remain in the liquor for from one to two minutes. The temperature of the liquor, and the speed at which the goods should be passed through, should always be found by trials upon fents taken off the pieces; the temperature should be kept as low as possible, and the goods immersed for no longer than is necessary to cut the indigo, in order to prevent unnecessary tendering of the cloth.

Immediately after leaving the cutting dolly, the pieces pass into another dolly filled with cold water for rinsing them; after which they should be thoroughly washed and dried, when they are ready for "finishing."

Messrs. Meister, Lucius, and Bruning have patented a process by which means the azo-colours can be printed as discharge colours on indigo dyed cloth. It will be remembered that in calico printing these azo colours are, by an application of Read Holliday's well-known process, produced by padding the cloth in an alkaline solution of β-naphthol, then printing on a thickened diazo-colour, when the colour is almost immediately developed. The new patent applies this principle to the production of coloured discharges on indigo. Messrs. Meister, Lucius & Bruning pad the blue-dyed cloth in β-naphthol, then print on a diazo-colour thickened in the usual way, and mixed with potassium ferricyanide (red prussiate of potash). After printing, the cloth is passed through a bath of caustic soda of about 8° Tw., washed, soaped, washed and dried. The colours which are obtained are said to be very brilliant and far superior to those which can be obtained by the ordinary process. The following details taken from the patent specification may be of interest. The β-naphthol solution is made by dissolving 29 grammes in 200 c.cm. of hot water and 25 c.cm. of caustic soda of 35° Tw.; to this is then added 100 grammes of Turkey-red oil and sufficient water to make the total volume to 2 litres. The discharge colour is made with 83 grammes of paranitraniline N, 150 grammes of a thickening of starch and tragacanth, and 267 grammes of water. This is mixed with the following:—150 grammes of thickening, 45 c.cm. of hydrochloric acid of 32° Tw., and 305 c.cm. of water. When mixed there is added 300 grammes of the red prussiate of potash and 60 grammes of acetate of soda. This gives a red discharge. The novelty lies in the use of the ferricyanide salt, and in utilising the oxidising power of this for the discharging of the blue in an alkaline bath.

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SECTION IX.

DISCHARGES UPON TURKEY-RED DYED CLOTH.

In the Turkey-red discharge style various coloured patterns are produced by printing upon the cloth, previously dyed red, colours which, as the name denotes, destroy the red colour upon the cloth in the parts printed, and produce upon these parts an entirely different colouring.

The details of the processes adopted for dyeing cloth Turkey red will be found fully described in our companion volumes,* or in any of the manuals devoted to dyeing,† and as we are concerned chiefly with the methods used for producing the designs upon the dyed cloth we will merely give an outline of one of the many methods used; the system described was, we believe, first published by Messrs. Meister, Lucius & Bruning.

The following solutions should first be prepared;—

Oleine Liquor.

2 gallons oleine (40 per cent.),
30 gallons water.

The water should be very slowly added to the oleine, as described for making oleine prepare. When the whole is thoroughly mixed, the liquor should be tested with a piece of litmus paper to see if it is neutral. Should it be alkaline, as is usually the case, acetic or hydrochloric acid should be cautiously added until the liquor is quite neutral to the litmus paper.

Red Mordant.

Solution A.

667 parts sulphate of alumina,
3,120 parts water.
Dissolve; cool; then add
66 parts ammonia soda ash.

Solution B.

160 parts white acetate of lead,
1,130 parts water,
30 parts tin crystals.
Dissolve; and cool.

Mix slowly, with constant stirring, solution B with solution A; allow the mixture to settle; and use the clear liquor only.

Dunging Liquor.

1,000 gallons water,
5 gallons silicate of soda (free from an excess of alkali), 75° Tw.,
25 lbs. phosphate of soda.

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* See *A Manual of Dyeing*, by Knecht, Rawson, and Loewenthal.
† See *The Dyeing of Textile Fabrics*, by J. J. Hummel.

These solutions having been prepared, the goods are treated as follows:—

1. Slop-pad the goods through the oleine liquor, and dry at from 100 to 113° F. When dry, repeat the process.

2. Slop-pad with the red mordant, and hang in the ageing room for twenty-four to thirty-six hours.

3. Pass through the dunging liquor at 100° to 140° F., and wash.

4. Dye the pieces with 10 to 12½ per cent. of 20 per cent. alizarine paste, 2 per cent. of chalk, and 1 per cent. of tannic acid, upon the weight of the cloth. If required, add some acetate of lime and tin liquor to the beck.

The shade of alizarine used depends upon the desired shade of Turkey red; but a mixture of blue and yellow-shade alizarine is generally used.

5. Wash thoroughly after dyeing.

6. Slop-pad with oleine, as in 1, and dry.

7. Steam for an hour at 15 to 20 lbs. pressure in the cottage steamer.

8. Soap at 160° F. for half an hour.

9. Soap in fresh soap liquor at the boil for an hour, wash well, and dry.

The pieces are then ready for printing with the discharge colours.

Chemical Principles Involved in Discharging.—The discharge colours, besides containing the particular colouring-matter to produce the coloured design required, always contain an acid. The acid must be one which can be dried upon the cloth without making it tender; citric, tartaric, and occasionally oxalic acid are usually employed for the purpose. Oxalic acid should, however, be used as little as possible, because it always, to some extent, renders the fibre weaker. These acids are required for the purpose of effecting the discharge of the red colour on the cloth, but they alone have practically no action upon Turkey red. After printing, the pieces are passed through a solution of bleaching powder, containing chalk in suspension. When the acids contained in the discharge colours printed upon the cloth come into contact with the bleaching-powder solution they act upon it, and cause the liberation of hypochlorous acid and chlorine, which bleach the red colour of the cloth in the printed parts. The chalk is used in the liquor to prevent the accumulation of acid, from the goods, in the liquor, and to preserve its neutrality, as, should it become acid, free chlorine and hypochlorous acid would be present in the whole of the liquor, and the colour upon the whole surface of the goods would be affected. The presence of the chalk thus ensures the bleaching action being merely a local one. With some of the discharge colours, notably those containing lead salts for producing yellow shades, the excess of lime always present in bleaching powder, and the added chalk, precipitate the lead upon the pieces, and cause it to remain there in a suitable form for raising to a yellow by treatment with bichromate of potash.

Preparing the Discharge Colours.—

No. 1.—White Discharge on Turkey Red.

1 lb. Indian corn starch,
¼ lb. tapioca flour,
1 gallon water.
Boil; and add
5½ lbs. tartaric acid.

No. 2.—Blue Discharge on Turkey Red.

5 lbs. Prussian blue paste,
2 lbs. oxalic acid,
½ gallon water.
Boil for ten minutes; allow to stand some hours; then mix with
2 gallons water,
3½ lbs. starch,
5½ lbs. tartaric acid,
previously thickened by boiling.

No. 3.—Black Discharge on Turkey Red.

The black is usually produced by the use of the aniline black colour, containing vanadium, mentioned on p. 163, or one prepared from logwood may be used, as given below :—

No. 4.—Black Discharge on Turkey Red.

2 gallons logwood liquor, 12° Tw.,
4 gallons gall liquor, 12° Tw.,
3 gallons water,
9 lbs. starch,
3 lbs. tapioca flour.
Boil well; and add
1¼ lbs. yellow prussiate of potash.
Cool; and add
1½ pints muriate of iron, 55° Tw.,
1½ pints nitrate of iron, 80° Tw.

No. 5.—Black Discharge on Turkey Red.

1 gallon logwood liquor, 4° Tw.,
2 lbs. yellow prussiate,
2 lbs. flour,
1 quart gum tragacanth thickening.
Boil well; and add
5 pints iron liquor, 24° Tw.
Cool; and then add
½ pint nitrate of iron, 80° Tw.

No. 6.—Yellow Discharge on Turkey Red.

1 gallon lime juice, 50° Tw.,
2 lbs. starch,
½ lb. flour,
2½ lbs. tartaric acid,
4 lbs. nitrate of lead.

No. 7.—Green Discharge on Turkey Red.

Green shades are obtained by mixing together, in suitable proportions to yield the shade desired, the blue and yellow discharge colours, Nos. 2 and 6. For example :—

4 gallons discharge yellow, No. 6,
1 gallon discharge blue, No. 2.

When any of these colours, with the exception of the blacks, are required lighter in shade, they should be reduced by mixing with some of the white discharge, and not with thickening only, otherwise the "cutting" will be incomplete.

The yellow and green shades require "chroming" before the shade is developed; this is done in a continuous manner immediately after the cutting of the red.

When the discharge colours have been printed, and the cloth dried, if there should be aniline black upon the cloth, it is hung for a short time; it is then ready for "cutting."

The operations of "cutting," washing, and raising are done in a series of six dollies (see p. 57); the first one contains the bleaching liquor, which discharges the red colour upon which the printing colour is lying; the next three dollies are filled with water for washing the cutting liquor from the pieces; the fifth dolly usually contains a solution of bichromate of soda or potash to raise the yellow and green shades; and the pieces are washed, after this, in the sixth tank, the washing being assisted by the free use of spurt pipes. The pieces are then thoroughly freed from all chemicals by a wash through the ordinary square-beater dye-house washing machines, hydro-extracted, and dried.

The bleaching or "cutting" liquor should be kept at a temperature of about 112° F. It consists of a solution of bleaching powder standing at 8° Tw., to which, as required, chalk and lime in the form of thin pastes are added in suitable quantities. With regard to the quantities of the two latter substances to be used, no definite instructions can be given; but, after a little experience, and judging from the way the liquor works, and from the smell emitted, the quantities will soon be known. For this purpose tubs containing both milk of lime and chalk paste are always placed beside the cutting dolly, and the man in charge of the machine makes additions of these, and also of bleaching liquor, to keep the liquor at about the right strength and in proper condition.

The raising liquor is usually composed as below :—

Chroming or "Raising" Liquor.

4 ozs. bichromate of potash or soda,
1 lb. common salt,
1 gallon water,

and is kept near the boiling point while the pieces are passing through the dolly.

Both the cutting and raising liquors are preserved, and used over and over again, fresh liquors only being prepared when the old ones have become too much contaminated by use to be worth strengthening up again.

In the production of yellow and red, or yellow, red, and green, combinations in this style, it will be found preferable to print discharge white instead of yellow for the yellow parts, afterwards padding the whole of the piece with a thickened solution of nitrate and acetate of lead. After raising, the yellow shades are brighter when done in this way than if the yellow discharge had been printed; but, as the chrome yellow is upon the whole surface of the cloth, the latter should be dyed with a much larger proportion of blue shade alizarine than usual, to compensate for this. The blue colour should be printed, if a green shade is wanted, when this method of working is adopted.

The Caustic Discharges upon Turkey Red.—The caustic discharge process upon Turkey reds is very extensively used for producing blue and red patterns by the use of indigo, the latter being applied by the Schlieper and Baum process. Besides indigo, however, black, white, yellow, and green discharges can be printed to work along with it, but the colours produced are so much dearer than those obtained by the chemic discharge process that they are not very largely employed. The principal use of this process is really for obtaining indigo-blue upon red cloth.

Chemical Action of the Discharging Agent.—The discharging of the Turkey-red alizarine lake is effected by the action of caustic soda under the influence of moist steam. The strong caustic alkali attacks the alumina-alizarine lake, and renders soluble in water both the alizarine and alumina contained in it, so that they are subsequently removed by washing. The preparation with glucose is done for the purpose of reducing the indigo contained in the blues and greens into soluble indigo-white, which then penetrates into the fibres of the cloth, and is re-oxidised into indigo-blue when the pieces are hung, after the steaming process.

The Preparation of the Cloth.—For discharging by the caustic process, the cloth is dyed, &c., exactly as for the chemic process of cutting.

The cloth, if blues or greens are to be printed, requires preparing with glucose liquor at 12° Tw., and, owing to the fact that Turkey red dyed cloth is less absorbent to watery solutions than white cloth (because of its more greasy nature and the waterproofing action of alumina salts in general), the liquor should be maintained at about 120° F.

The cloth is passed through the hot liquor in the preparing machine noticed on p. 61, and then dried on the drying cylinders.

The cloth must be printed upon the same day that it is prepared, because glucose is very hygroscopic; hence, if left long exposed to the air, the pieces will become damp more or less unevenly, and the resulting shades will also be uneven.

Printing Discharge Colours.—

*No. 1.—Caustic Discharge White on Turkey Red.**

12 gallons caustic soda liquor, 24° Tw.,
13¾ gallons light British gum,
14 lbs. white caustic soda,
6 lbs. chlorate of potash,
1 gallon turpentine.

No. 2.—Caustic Discharge Black on Turkey Red.

This may be either vanadium or steam aniline black (see p. 163). The colour is not really discharged by these printing colours, but is developed upon the top of the red.

No. 3.—Caustic Discharge Yellow on Turkey Red.

30 lbs. nitrate of lead,
4½ gallons water.
Dissolve; then add
½ gallon water,
½ gallon caustic lye, 80° Tw.
Then add, with constant stirring,
27 lbs. white caustic soda in powder (Greenbank).
Then thicken with
4½ gallons gum Senegal thickening,
1 quart turpentine.

No. 4.—Caustic Discharge Blue on Turkey Red.

6 lbs. light British gum,
½ gallon water.
Boil; add
3 gallons caustic soda lye, 80° Tw.
Heat slowly to 145° F.; and add
2¼ gallons indigo paste, 30 per cent.,
½ gallon water.

No. 5.—Caustic Discharge Green on Turkey Red.

The green shades are made by combining the blue and yellow discharge colours, varying the proportions to yield the required shade. The following is an example of a colour in actual use:—

1 gallon discharge blue, No. 4,
4 gallons discharge yellow, No. 3.

Printing and Finishing.—The cloth is printed as usual, using leatherine blankets and lapping on the bowl of the printing machine, as the strong alkali would affect the ordinary woollen blanket and

* *The Dyer and Calico Printer*, Jan. 20, 1894.

lapping. Before entering the printing machine the cloth should be passed around a drying cylinder placed at the back of the printing machine, to expel the last traces of moisture from the cloth, and warm it slightly before being actually printed.

After printing and drying, the pieces are passed through Mather & Platt's steam ager, exactly as described for Schlieper and Baum's process of indigo printing (p. 145). When they have been steamed, the goods are hung in a cool, damp place until the blues are oxidised and the caustic soda upon the printed parts has deliquesced to such a degree as to have become almost wet. When this stage has been reached, the red colour of the dyed piece should apparently have been changed, even on the reverse side of the cloth. The goods are then washed in the open width, either in a dolly or, better, by passing them through the open soapers filled with water only.

If the yellow or green discharge has been printed, the lead in these colours is converted into the chromate, by passing them through the chroming liquor used for the chemic discharge colours; but, in other cases, this treatment is not required.

After washing, and raising (if required), the pieces are ready for soaping. When the blue discharge alone has been printed upon the red cloth, the cloth is submitted to repeated soapings until the whole of the removable matter has been displaced, and the red, as also the blue, colours are bright enough; but where the other colours have been printed, it is usual to give a much shorter soaping, or to soap at a comparatively low temperature. After a thorough washing, the goods are ready for drying and finishing.

The blue and green shades produced by this process are fast to soaping, and thus differ from those produced with Prussian blue. They are, however, much more expensive to produce.

SECTION X.

BRONZE OR "BISTRE" DISCHARGE EFFECTS.

Bronze discharge effects are obtained by, first, dyeing the whole of the cloth with manganese bronze and, then, printing upon the dyed cloth printing colours of the various shades required, so prepared that they will discharge the bronze colour and at the same time fix the colouring-matter they may contain upon the parts so discharged. The bronze colours are not used at the present time to a very large extent, but they are occasionally used in all print works for certain styles intended for special markets.

The manganese bronze colour is fast to the action of light and soap, but is very sensitive to the action of acids, even the acids contained in human perspiration will affect the colour. The cloth dyed with manganese bronze has a disagreeable harsh feel. The coloured discharges produced upon manganese bronze are generally of a fugitive character, most of them being loose to soaping as well as destroyed by the action of light; such prints can only be considered loose if coloured discharges are used. Until we are able to effect really fast discharges on this colour, we think that the use of the style should be discouraged by the printer as much as possible.

Dyeing the Pieces.—The bleached cloth is impregnated on the slop-padding machine (see p. 57) with a solution of chloride of manganese diluted to produce the depth of shade required. The chloride of manganese is usually employed of such a strength that it stands at about 30° Tw., that strength producing fairly dark shades of bronze. The manganese chloride occurs in commerce in the form of a liquid standing at about 70° Tw.; it usually contains about 13 per cent. of manganese and various impurities. There is, generally, some lime in the liquor, but this should be as small in quantity as possible, never exceeding 2 per cent., or the shades will be considerably lighter, even if the quantity of manganese in the liquor is the same. Lead is often present to the extent of about $\frac{1}{2}$ per cent.; it has the effect of making the shade darker, but, if present in large quantities, will render the after-process of discharging more difficult to perform.

The pieces, after slop-padding, must be carefully dried over the chests generally used for slop-padded goods, the pieces never being allowed to touch the chests, or to remain so long over them as to become overheated or overdried, which would have the effect of causing the manganese chloride to attack the fibre and make it tender.

As soon as possible after padding, but certainly on the same day, the goods should be passed in the full width through a solution of caustic soda of about the same strength as the manganese liquor used, the solution being placed in a dolly and kept nearly boiling, and the engine run at such a speed that the pieces remain for about two minutes in the liquor. From the soda liquor the pieces pass directly into another large dolly, through which a stream of cold water is allowed to flow, and in which the soda solution is washed away. The pieces are now ready for raising or oxidising.

At this stage of the process the pieces are covered with a hydrated oxide of manganese, which has only a pale brownish colour, but, as the pieces become exposed to the air, they become darker from the absorption of oxygen. The full bronze shade is raised in the next process, which consists in working the pieces for from ten to fifteen minutes in a solution of bleaching powder at 2° Tw., which should be quite free from any undissolved particles. The treatment with chemic solution causes the manganese oxide on the pieces to be oxidised to hydrated peroxide of manganese, to which the colour of the bronze is due. After a final washing and drying, the goods are ready for printing.

Before printing, however, the pieces should be compared with the sample book containing the shade piece, to see if the goods are exactly the right shade. If they are too dark, they can, at this stage, be rendered lighter by working them for a short time in a very dilute solution of tin crystals containing an excess of hydrochloric acid, washing, and drying.

The pieces are then wound on a wooden centre, and are ready for printing.

Printing the Discharge Colours.—The pieces are printed with any of the coloured discharges given below, and dried as usual. They are now hung up for a few hours until the discharging of the bronze is complete, which can only be judged by an inspection of the goods. After hanging, the goods are washed in water in the open width, passed through a mixture of chalk and water, and then thoroughly washed and dried. If the pieces have been printed with a discharge colour containing lead, for the production of yellow or green shades by combination with a blue colour, the pieces are, before the final washing, passed through a solution of bichromate of potash to raise the yellow colour, and then thoroughly washed.

Preparing the Printing Colours.—In preparing the printing discharge colours, the thickening and the other ingredients of the colour, with the exception of the tin crystals, are made up, and the latter added when required for printing.

Red Discharge on Bronze.

½ gallon water,
1 lb. starch,
½ gallon gum tragacanth thickening,
4½ ozs. eosine.
Boil; cool; and, when required for use, add
4 lbs. tin crystals,
4 ozs. double muriate of tin, 120° Tw.

White Discharge on Bronze.

1 lb. starch,
½ gallon gum tragacanth thickening,
½ gallon water.
Boil; cool; and add
3¾ lbs. tin crystals,
1 noggin double muriate of tin, 120° Tw.

Blue Discharge on Bronze.

1 lb. starch,
½ gallon water,
½ gallon gum tragacanth thickening,
8 ozs. cotton blue.
Boil; cool; and add
4 lbs. tin crystals,
1 noggin double muriate of tin, 120° Tw.

Yellow Discharge on Bronze.

1½ lbs. starch,
1 gallon water.
Boil; and add, while hot,
5 lbs. powdered nitrate of lead,
4 lbs. tartaric acid.

For use, take
¾ gallon above,
¼ gallon double muriate of tin, 120° Tw.

This colour requires a passage through a solution of bichrome to raise the colour after the discharge has taken place.

Yellow Discharge on Bronze.

1 gallon water,
1½ lbs. starch.
Boil; and add
1 lb. bichromate of potash.
Then add
4 lbs. white acetate of lead.
Cool well; then add
9 lbs. tin crystals.

This yellow does not require raising, and may be printed on the same piece along with colours which would be injured by bichromate of potash solutions, but is not so fast as the above.

Yellow Discharge on Bronze.

½ gallon best berry extract, 30° Tw.,
½ gallon water,
1½ lbs. starch.
Boil; cool; and add
5 lbs. tin crystals.

Green Discharge on Bronze.

The green shades are produced by mixing together, in various proportions, the blue and yellow discharge colours.

CHAPTER VII.—SECTION I.

THE PRINTING OF COMPOUND COLOURINGS.

When a pattern containing many different colours has to be printed, it is generally necessary for the printer to use printing colours prepared from colouring-matters belonging to various groups, which require various methods of treatment for their application. This is necessary, owing to the limited nature of the shades given by any one series of dyestuffs in the case of the majority of the colourings, and, sometimes, to the fact that certain shades can be better, or more cheaply, produced from another series of dyes than from the series from which most of the colours on the pieces are produced. Again, in some cases, the particular colouring of the pattern could be produced by two, or more, entirely different methods. It is here where the practical experience of the works' manager or colourist proves of value, because the experienced printer will be able to devise or adopt that method which, while being perfectly satisfactory for the market for which the goods are required, will be the most economical in practice. The exact methods used for the production of new styles, or even new combinations of colourings, will always demand of the printer considerable experience, as well as the exercise of inventive genius, if he is to keep pace with the everchanging styles and colourings which now seem to be demanded, particularly now that the various new styles have a shorter period of life than was formerly the case.

When deciding as to what colours shall be used upon the same piece, thought must be given to the behaviour of the various colours in the several processes through which it is intended to submit the pieces after printing. If possible, all the colours should be so selected that they may be all properly fixed upon the tissue by the method used to treat the piece after printing, and, should it be necessary to apply certain metallic or chemical substances to the cloth for the purpose of fixing some of the colours, the shades which do not require such treatment for fixing ought to be of such a nature that they are not injuriously affected by it.

The success obtained in the printing of many-coloured patterns depends to a considerable extent upon the proper arrangement of the engraved rollers in the printing machine, or the order in which the various colours are printed. Upon this point it is impossible to give any really useful information, as it depends entirely upon the design, as also on the number and nature of the colours in the pattern. The blotch or ground is usually, in fact, nearly always, printed last. Should a pale bright shade immediately follow a colour of a dark or sombre shade it is usual to interpose, between the two printing rollers, a plain roller, working in either gum or starch paste, to receive any colour from the piece that would, if this roller were not present, mark off and get into the colour box containing the next shade, which would thereby be reduced in brilliancy, or, in some cases, quite altered.

SECTION II.

CLEARING THE "WHITES," AND "MALTING" COTTON PRINTS.

When the prints arrive in the finishing room, where they are usually passed through the various operations of soaping (open soaper), clearing, and starching, they are usually stained more or less in the "whites," and after the goods have passed through the open soaper (when this is required), they are cleared on the chemicking machine.

The chemicking or clearing is usually done on the ordinary cylinder drying machine, the goods being first passed through a solution of bleaching liquor standing at from $\frac{1}{2}°$ to 2° Tw. The excess of liquor is removed by passing them between sycamore bowls; and the pieces, saturated with the liquor, are then passed over the drying cylinders, the cloth coming out of the machine in a perfectly dry condition. The "whites" in the prints are cleared by the slight bleaching action of the weak solution of hypochlorite of lime, exerted as the piece becomes warm on the drying cylinders, owing to its decomposition by the heat of the tins. Bleaching liquor is to be preferred to a solution of bleaching powder, as it is quite free from solid particles, which would cause the goods to be unevenly cleared. When the pieces are to be "buffed" or "slop-padded" with substantive dyestuffs in solutions containing soap, it will be found preferable to use hypochlorite of soda instead of bleaching liquor, because the salts left in the cloth do not, like the lime salts, form insoluble soaps.

Pieces that require strongly chemicking are passed through a special chemicking machine, which consists of a slop-padding box holding the chemic liquor, above which the ordinary wooden squeezing bowls are placed; the goods pass, first, through the liquor in the box, and then, after being squeezed, through a small steaming chest, where they are submitted to the action of free steam to decompose the bleaching liquor. The pieces then pass over drying cylinders as usual.

Occasionally, the pieces are soaped after being cleared.

In the case of certain styles, the pieces are "blued" at the same time that they are cleared, and in this case the blue is mixed with the chemic liquor, soluble Prussian blue being used for this purpose.

It frequently happens that the goods when finished (*i.e.*, when they are soaped and ready for the application of the actual stiffening or finishing sizes) are too stiff in the parts printed, so much so, that the pattern can be felt by the stiffness of the cloth in the printed parts, which would be still more evident after the pieces had received the finishing size. This stiffness is very undesirable when the pieces are required to be as soft as possible, or finished with a "clothy" finish. In some cases this harshness of feel can be removed by soaping the pieces; but with many colours it is not possible to resort to this course, as the colours would be reduced too much in depth. In these cases it is usual to submit the pieces to the action of a weak infusion of malt to convert the starch, which is the cause of the stiffness, into soluble compounds, by the action of the diastase contained in it. To carry this into practice the following infusion should be prepared:—

Malt Infusion.

1 lb. crushed pale malt,
16 gallons water.

The temperature of the water should be raised to about 160° F., and the malt, contained in a muslin bag, placed in it and well worked, to extract the whole of the soluble products. The goods are then entered into the liquor, and when they have been well worked through it the pieces should be covered over with a cotton cloth, and stones placed upon this to keep them under the surface of the liquor. The pieces are generally allowed to remain under the surface of the liquor overnight, and sent through a washing machine in the morning. The malting is done in one of the stone pits described in Part I.

SECTION III.

SHADING TO PATTERN.

It frequently happens when a batch of cloth has been printed that the colours upon the pieces are nearly, but not exactly, of the same shade as the bits upon the order sheet, which are the shades the buyer will compare them with when they arrive at the warehouse. Slight variations in shade are very liable to occur with pale pads, blotches or covers; and such defects often require to be corrected before the goods leave the works.

As the causes producing this alteration of shade are very various in character, so no definite method can be given for effecting the desired change; hence, it is necessary, in every case, to make small trials upon fents to fix the particular treatment required.

First of all, the effect of soaping and "chemicking" should be tried, if either are permissible. Should these not produce the alteration in colour, small fents from the pieces should be treated with weak solutions of alkaline salts or weak organic acids, and the solutions dried upon the cloth (because it is usually necessary to apply them on the mangle attached to a drying machine), until a substance is found which alters the shade without producing any undesirable results. When this substance is found a few trials should then be made to ascertain the proper strength of the solution to use. The whole of the pieces are then treated with this solution.

The following substances will be found useful for this purpose:—

Acetic acid.	Borax.
Citric acid.	Soda crystals.
Tartaric acid.	Ammonia.
Bisulphite of soda.	Peroxide of soda.
Tartar emetic.	Bleaching liquor.

Chlorate of potash.

PART IV.

THE PRINTING OF WOOLLEN GOODS.

SECTION I.

THE PRINTING OF WOOLLEN GOODS.

In comparison with calico printing, the printing of woollen goods is a far less complicated matter, as, owing to the nature of the fibre itself, only a few of the methods used in cotton printing can be applied. Wool prints are generally produced by the steam style, either printed upon the white, but prepared, cloth, or on cloth that has been uniformly dyed previous to the printing; and in the latter case, in some instances, the pattern is produced by discharging the ground colour.

The colours chiefly employed for wool printing are those known as the acid colours; the basic colours and the direct cotton-dyeing colours (like those of the benzidene class) being also used, but to a less extent. The natural colouring-matters, and those, like alizarine, which require the use of mordants, are employed, but to a much less extent than either of the before-named classes of dyestuffs.

Scouring.—Woollen goods received by the printer are generally in a fairly clean condition, usually bleached, and do not require much scouring. Usually the pieces are worked for about twenty minutes in a lukewarm solution of soda ash (containing 3 ozs. of 90 per cent. soda ash per gallon of water), left for three to five hours, washed, and dried. This process is generally carried out in one of the stone pits, the cloth being worked over the wince situated above the pit; but it may also be done on the slop-padding machine in the following way:—The rollers of the machine are well wrapped with covering cloth to ensure the piece being evenly squeezed, and to protect the cloth from contact with the copper roller, which is liable to cause stains that show in the piece as greenish patches, especially when the prints are finished. The liquor box is then filled with the scouring liquid, and heated to about 120° F., being kept to that temperature by means of a steam pipe, preferably a closed one, because, if the steam enters directly into the liquor, the bulk of the liquid will be gradually increased, and the pieces will be unevenly scoured, owing to the liquor becoming gradually weaker in soda. The goods having been wound on a wooden centre, are placed at the back of the machine, being supported upon bearings by means of an iron rod passing through the centre of the wooden shell. The end of the cloth is now taken and threaded under and over the rollers in the liquor box, passed between the squeezing rollers, and then passed around a wooden centre that has previously been covered with several thicknesses of calico in order to prevent the cloth impregnated with the alkaline solution from coming into actual contact with the wood, which would be liable to produce yellow stains. The cloth is now passed slowly through the liquor, the excess being expelled by the rollers (the pressure being regulated by adjusting the screws working in connection with the weighted levers), and being wound on to the cloth-covered centre. When the whole of the cloth has been passed through the scouring liquor, and carefully wound on to the centre, the wet pieces are carefully covered up with cotton cloths to prevent the outside layers from drying, and the whole left in this condition for about four hours. When the cloth has stood for the time specified, the pieces are well washed and dried in the stentering machine.

The above treatment is suitable for comparatively clean wool; if the wool is very dirty or greasy, the above process may be repeated, the scouring liquor warmed to a higher temperature, and the pieces soaped before, or after, the application of the soda ash.

Bleaching.—If the cloth has already been bleached and is intended for dark or dull shades, with only small portions of white showing in the finished print, the cloth will probably be white enough for printing without any further bleaching; but for pale and bright shades, and for very open patterns, the cloth may require bleaching before it is printed. This can only be determined after an inspection of the goods and comparing them in colour with a piece kept as a standard.

The old process used for bleaching woollen goods for printing, and which is now generally used for bleaching them when required to be delivered in the white condition to the market, consists in exposing the goods to the fumes of burning sulphur in an apparatus known as the "stove," the colouring-matter of the wool fibre being bleached by the action of the sulphur dioxide evolved from the burning sulphur. After they have been stoved, the goods are passed through a weak solution of sulphuric acid, washed, and dried. This process never bleaches the cloth perfectly, and the yellow colour of the unbleached cloth is liable to return in the course of time; this is probably due to the bleaching resulting from the reducing action of the sulphurous acid, the colouring-matter being, to some extent, reproduced by the action of the oxygen contained in the atmosphere. Wool bleached in the stove generally becomes discoloured during the steaming necessary for the fixation of most of the colours after printing.

The following process (in which peroxide of hydrogen is the bleaching agent) is now generally employed for bleaching wool intended for printing. The pieces are first thoroughly wetted out, after which they are run through the following solution :—

Peroxide of hydrogen, 10 vols.,	1 gallon,
Silicate of soda, 20° B.,	1 quart,
Water,	2 to 10 gallons.

The quantity of water used in the mixture depends upon the colour of the wool before bleaching and must be found by trial.

The pieces are passed through the above liquor, on the same machine and in a similar manner to that described when dealing with the scouring of the wool, rolling up the pieces saturated with the bleaching liquor as described. When about thirty pieces have been wound on to one centre, this centre is removed and another one substituted, and so on until the pieces are done. After covering the goods up with cloths, to prevent the outside folds from drying, they are laid aside for twenty-four hours. It will be noticed that the temperature of the goods rises considerably after a short time and, unless they are well covered, the outside layers will become dry. After the expiration of the time named, the goods, without washing, are passed through—

Bisulphite of soda,	1 gallon,
Water,	10 to 20 gallons,

and wound up in the wet state, as before. When they have stood for about twenty-four hours, they are washed and dried in the stentering machine.

By this process a much purer bleach is obtained than is possible with the stove process, but it is obviously more expensive, and by no means perfect.

Delmant, in his treatise on *Wool Dyeing*, gives the following process for the bleaching of wool :—One part of commercial peroxide of hydrogen is diluted with five parts of water, and then rendered slightly alkaline with liquor ammonia. The goods are immersed in the liquor for from six to ten hours and then washed. If the pieces are intended to remain white, they are then "blued," or rather tinted, with methyl violet and dried. Instead of liquor ammonia, silicate of soda or borax can be used.

It is cheaper to make the hydrogen peroxide in the works from peroxide of sodium than to buy it ready-made. It is prepared from the sodium salt by dissolving it in water containing sulphuric acid, in the following way :—

10 gallons cold water,
2 pints strong sulphuric acid.

Mix well together, then add, slowly and in small quantities at a time,

9 lbs. peroxide of soda.

When this quantity has been added and the whole well mixed, test with litmus paper, and then, very slowly, add more peroxide until the solution shows a slight alkaline reaction. The solution can then be used in the way described for the usual peroxide of hydrogen commercial solution.

The peroxide of hydrogen system of bleaching is often used in conjunction with the old method of stoving, the goods being first stoved and the bleaching afterwards completed with peroxide of hydrogen.

Wool can be bleached by the use of permanganate of potash, in the following way:—The pieces, after being thoroughly saturated with water and squeezed, are passed through a solution of permanganate of potash, preferably mixed with chloride of magnesium, and wound up in the wet condition. The pieces are, by this treatment, turned to a dark brown colour from deposition of a hydrated oxide of manganese, and, at the same time, hydrate of potash (caustic potash) is formed, which, like all caustic alkalies, has a tendency to destroy the wool fibre. For this reason, chloride of magnesium is mixed with the liquor, the resulting hydrated oxide of magnesium having no destructive action on the fibre.

The goods are now worked in a solution of bisulphite of soda, or a mixture of bisulphite of soda and sulphuric acid, until the whole of the brown colour has disappeared, after which the goods are well washed and dried.

We are not aware that the permanganate method is used on the large scale, and we do not find from our own trials that it is so good a method as the peroxide system, for, if the solutions are strong enough to produce a good bleach, or if weaker solutions are used, and the process repeated several times until a good white is obtained, we find the fibre is made very rough, and the cloth has a disagreeable, hard feel. It is said that when the cloth is bleached with permanganate the usual treatment with chlorine prepare can be dispensed with, and full shades obtained.

Preparing.—For many of the colours no preparation of the cloth is necessary, and they can be printed direct upon the scoured and bleached wool; but, for the great majority of colours, it is absolutely necessary that the fibre be treated with a preparing solution, otherwise the shades would be deficient in depth, probably bare and uneven, and would lack brilliancy and clearness.

There are, practically, three prepares in common use, viz.:—

(1) Chlorine prepare,
(2) Tin or stannate prepare,
(3) Chlorine-tin prepare.

Chlorine Prepare.—The first-named process is that generally used, and is carried out in two ways—viz. (1) by passing the pieces through a mixture of hypochlorite of soda or lime and an acid, generally sulphuric acid; and (2) by first passing the goods through a solution of the acid, followed by a passage through the hypochlorite solution. The former method is generally preferred, and is applied in the following way:—

The plant used consists of three small dollies (see *Machinery Section*, p. 57), the first one containing the preparing liquor; the other two being filled with water. On account of the irritating nature of the gas evolved from the preparing liquor, it is necessary that a hood be placed over the dollies to carry away the fumes, and that the room itself in which they are situated should be well ventilated; otherwise, the health of the workmen will be injuriously affected. The pieces pass, first, through the preparing liquor, and then through the two water dollies, where the preparing liquor is washed off; they are next wound on wet, well washed, and dried. The strength or degree of concentration of the preparing liquor is varied in accordance with the kind of colours to be printed, the rule being to use the prepare as weak as possible for the colours in hand, because the chlorine prepare always turns the tissue to a more or less yellow colour, according to the concentration of the liquor.

As examples of strong prepares, we give the following recipes:—

(1)	Chloride of lime (bleaching liquor), 12° Tw.,	1 gallon,
	Hydrochloric acid, 30 Tw.,	1 gallon,
	Water,	40 gallons.

Mix; and use for feeding the first dolly, as required.

(2)	Hypochlorite of lime (bleaching liquor), 12° Tw.,	6 gallons,
	Sulphuric acid,	3 gallons,
	Water,	200 gallons.

Mix; and reduce to 2½° Tw., and use, as required, for the first dolly.

The first dolly is filled with the necessary quantity of water, the requisite volume of the preparing solution is added and well stirred, and the pieces passed through the liquor; the latter is replenished by the addition of strong prepare, in accordance with the number of pieces passed through it and the strength of the prepare required. The exact amount of liquor to use can soon be found from trials with the pieces, and an experienced operator almost instinctively knows how much liquor to use for first preparing the beck and for afterwards keeping it up to the proper strength.

In the other system of applying the chlorine prepare the pieces are passed through a solution of sulphuric or hydrochloric acid, about 1° to 2° Tw., at a temperature of about 160° to 170° F., placed in the first dolly, then run through a solution of bleaching powder, or, preferably, hypochlorite of soda, standing at 1° to 2° Tw., washed, and dried. If this process is used, care must be taken that the bleaching powder solution is clear and free from solid particles or the goods will be prepared in an uneven manner.

Tin or Stannate Prepare.—To prepare the wool with tin in the form of stannic oxide (SnO_2) the goods are slop-padded with a clear solution of stannate of soda, and wound on a wooden centre in the wet state. After standing for an hour or so in this condition they are evenly passed through a dilute solution of sulphuric acid, 1° to 2° Tw., thoroughly well washed, and dried.

By this treatment the tissue has a hydrated oxide of tin or stannic acid deposited in and upon its fibres, as shown by the following chemical equation :—

$$\underset{\text{Stannate of soda}}{Na_2SnO_3} + \underset{\text{sulphuric acid}}{H_2SO_4} = \underset{\text{stannic acid}}{SnO(HO)_2} + \underset{\text{sodium sulphate.}}{Na_2SO_4.}$$

This method is rarely used alone, except for a few special colourings; but where it is found that tin has an influence upon the fastness or brilliancy of the shade, the combined tin and chlorine prepare is generally used.

Chlorine-Tin Prepare.—To apply this process the goods are slop-padded through a solution of stannate of soda; the operation generally being performed twice. The strength of the stannate of soda solution is varied to suit the class of colours and depth of shade to be printed, and is usually 4° to 8° Tw. The pieces, after padding, are taken in their wet condition to the preparing dollies and passed through the usual mixture of acid and hypochlorite of lime, washed, and dried. The wool in passing through the chlorine dolly is "chlored," or chlorine-prepared, and, at the same time, the tin is precipitated by the action of the acid in the liquor on the stannate of soda contained in the goods.

This process is largely used for full dark shades and blotches.

Printing of Woollen Goods.—The colours are printed on the machines used for calico printing, a soft blanket being employed. Generally speaking, the rollers used are similar to those employed for printing cotton, but, if they are specially engraved for wool printing, it is better to have them somewhat more deeply engraved than is really necessary for cotton printing. The method of drying after printing is exactly the same as that described for cotton, but care should be taken that the pieces are not allowed to remain for too long a time on the chests so as to become overdried, or "baked"; all that is necessary is that the colours be dry enough to stand rolling or piling up without danger of marking off; further drying than this has the effect of considerably increasing the length of time that it is necessary to hang the goods before they can be steamed.

Hanging after Printing.—In order that the colours shall be properly fixed in and on the fibres of the woollen fabric during the comparatively short steaming process to which they are generally submitted, it is necessary that the thickening material used to print the colour and to prevent it from running on the piece be so softened that the colouring-matter will readily unite with the fibre. This is generally done by hanging the pieces in a cool room provided with a false or perforated floor, the ground underneath which is kept wet. The pieces are hung from a wooden grating situated near the ceiling in festoons, a current of cool air being allowed to enter underneath the false floor and to pass out of the apartment near the top. The pieces are allowed to hang in the hanging room until the thickening material is sufficiently softened, the length of time necessary depending upon the strength of the rollers used for printing (*i.e.*, on the depth of the engraving), the nature of the thickening material, and upon the composition of the printing colour. In order to prevent many colours from being overdried on the chests, after printing, and to reduce the length of time required for hanging, glycerine is occasionally added to the printing colour. The time required is generally from eight to twelve hours, in the case of light patterns; up to twenty-four hours when heavy blotches are in hand.

In some cases the goods are steamed between damp blankets, in addition to having been previously hung. Care should be taken not to damp the pieces too much, or the colours will run when in the steamer.

Steaming.—The pieces are generally steamed in the cottage steamer (see p. 46) for a period varying from half an hour to one hour, no pressure, or very low pressure, being used. The steaming operation is often divided into two parts, the pieces being re-arranged inside the steamer between the two steamings.

Hanging after Steaming.—After removal from the steamer the pieces are either washed at once or they are allowed to hang for some time in the hanging place before they are sent for washing.

Washing.—The pieces are now ready to be washed, to remove the thickening materials and the various other chemicals that were added to the printing colour, either to assist the colour to combine with the fibre, or to increase the solubility of the colouring-matter in the case of some of the darker shades. In this operation the colour that is not fixed to the fibre is washed away, which in the case of some dark shades, as, for example, in the cases of blacks and dark blue blotches, is a considerable quantity, rendering the washing a rather difficult operation to successfully perform, owing to the liability which such colours have of marking off, and thus soiling the parts that should remain white in the finished print.

In some few cases, where the printing works are situated on the side of a stream of clear water, a condition of things gradually decreasing, the goods are placed in a cage or framework and lowered into the stream, the loose colouring-matter is then dissolved and washed away by the flowing water, and very little trouble is experienced with the colours marking off; after which they are removed from the cage and washed on the ordinary washing machine.

Generally, however, the goods must be washed inside the works, and this is done by constantly changing the water in a large pit, the pieces being placed separately on the wince, made of a specially large size, usually about 4 to 5 feet in diameter. These pits are generally placed side by side in a row, and each wince, over each separate pit, will take from 10 to 20 pieces, the latter being kept separate from each other by means of pegs placed on rails situated both at the back and front of the wince, fixed in position to the frame holding the bearings that carry the wince itself. The pieces are thrown over the wince and their ends sewn together roughly by hand, thus forming an endless band which is continually made to travel through the water in the pit by the movement of the wince. The wince is revolved by power, a clutch being provided for the purpose of putting it in or out of gear. The clean water enters the pit from the bottom, and there is a pipe near the top that carries away the overflow.

The time required for washing varies with the nature of the colours on the pieces, particularly with regard to the thickening material used, but is usually of about one hour's duration. If the goods are not washed enough the printed parts will have a harsh feel, as the thickening, not having been completely removed, will act as a stiffening agent, after the nature of a finishing material; in the case of dark colours, the goods may also have an unpleasant "bronzy" appearance.

It is sometimes necessary, in order to remove the metallic appearance of some dark shades, dark blues and blacks especially, to submit the pieces to the action of a cold soap solution in a pit, and, when this is done, special care is required to prevent the colours marking off, as also to prevent the soap solution from taking the dye from the printed parts of the goods and soiling the parts that are not printed.

If a cold soap solution can not be used, and if the fabric is still stiffened by the thickening after mere washing, the thickening can be removed by placing the goods in a pit containing a weak infusion of malt (about ½ oz. per gallon), entering the pieces at about 160° F., and allowing them to remain under the surface of the liquor overnight. In the morning the pieces are washed and dried.

Drying.—The superfluous water is removed by means of a hydro-extractor, and the pieces are then thoroughly dried, either by hanging in a heated room or on the stentering machine.

Composition of the Colours.—As mentioned above, several classes of colours are used for printing woollen goods, but they are all treated in the same way after printing, so far as the steaming is concerned, and thus they may all be classed together as the "steam style." We shall now describe the preparation of the various colours under the different heads named on p. 240, leaving discharges upon dyed or printed fabrics for consideration afterwards.

Acid or Wool Colours.—This class includes by far the most important colours used for this kind of work. These colours have an affinity for the wool fibre, and will fix themselves upon the fibre without any mordant. In addition to the thickening material, it is usual to add an acid, generally an organic acid like acetic or tartaric acid, to the colour, for the purpose of assisting the combination of the dye with the fibre, or, in some cases, in order to keep the dye in solution. Occasionally, oxalate of ammonia is added to the printing colour for the same purpose.

The thickening materials used for these colours are usually dextrine, British gum, gum tragacanth, and sometimes starch. Dextrine is the thickener chiefly used, as it is easily washed away after steaming, leaves the fabric quite pliable, and allows it to retain its woolly feel. The colours thickened with dextrine have a solid appearance when finished, but more colouring-matter per gallon of printing colour is required to produce a certain depth of shade than when they are thickened with starch or gum tragacanth. For very pale shades, a mixture of white and brown dextrine is used.

British gum is used in a similar manner to dextrine, but it does not leave the fabric quite so soft after washing. British gum is composed partly of dextrine, but, if light British gum is used, it also contains a large amount of unconverted starch, which may be the cause of the harshness of feel possessed by the fabric after washing. Dark British gum is rarely used alone, because its colour is too deep, and because it is partially fixed on the wool and impairs the brightness of all shades, except those of a very sombre hue.

Gum tragacanth, or, as it is commonly called, gum dragon, is largely used in thickening colours for woollen delaine printing; it is used both alone and in combination with dextrine, British gum, and starch paste. When used alone it is employed principally for thickening pale shades intended for padding. Gum dragon does not affect the feel of the cloth after washing to any appreciable extent.

Starch paste, either alone, or mixed with a certain proportion of gum tragacanth paste, is used for very dark shades and for fine patterns. It has a tendency, especially when used without the addition of any other thickening material, of rendering the fibre brittle or crisp to the touch, and, when the pattern is large, it may be necessary to take out the starch in the piece, after washing, by the use of malt infusion.

The manner in which the colours are made is generally as follows:— The dextrine, or other thickening material, is placed in the copper-cased colour pan, and mixed with the requisite quantity of water. The colouring-matter is mixed with its solvent, usually weak acetic acid or water, and dissolved in a separate pan of suitable size. When the colour is dissolved, the solution is passed through a sieve, composed of fine silk cloth, into the mixture containing the thickening material, and the whole brought to the boiling point and maintained there for the required time, the stirring apparatus being worked the whole of the time. The steam is then turned off, and the colour cooled in the pan by the circulation of the cold water through the outside casing. When the colour requires the addition of substances like tartaric acid, oxalic acid, or oxalate of ammonia, they are added to the colour, either as soon as it has been boiled and the steam turned off, or when it has been cooled to a lower temperature. When the colour is quite cold, it is strained in the usual way ready for the machine. Generally, a strong stock colour or standard is prepared, and the lighter shades made from it by mixing it with more of the thickening material in solution; this operation requires considerable practice, especially with some colours, in order to make the light shades uniform, there being a tendency to the formation of "specks," due to the improper mixture of the colour with the reducing solution. For this reason, very light shades are rarely made by reducing strong standards; the dark shades are prepared, and the medium shade made from these; but the very light shades are made from a very much weaker standard stock colour.

PRINTING COLOURS ON WOOL.

Blacks.—Naphthol Black.—Of all the colouring-matters used for the production of various shades of black on wool, naphthol black is by far the most largely used. It is, however, rarely used alone, the shade generally being modified by the addition of other colours. The dyestuff is made in several shades, each being issued under various distinguishing letters such as B, 3B, 6B, and naphthol blue black. For the production of full shades it is absolutely essential that the tissue be well prepared with chlorine or chlorine-tin prepare; the colour taking very feebly to unprepared wool. This is probably due to the presence in the unprepared wool of some substance having a reducing action on the black; hence one of the alkaline chlorates is frequently added to the printing colour with the object of guarding against such reduction.

The following recipe will be found to give a good full black :—

Black.

1 lb. naphthol black B (Cassella),
5 pints water.
Mix ; and add gradually
½ gallon thick British gum thickening.
Then add
½ lb. alum
dissolved in
3 gills of hot water,
and finally
12 ozs. chlorate of soda
dissolved in
1 pint hot water.
Mix thoroughly and strain for use.

The naphthol black B rarely gives the exact shade of black required by the printer, and it is usual to turn the shade by the addition of other colouring-matters. If a little Indian yellow is used in the colour the bluish tone is taken from the colour; and the same end can be served by the use of acid green. Thiocarmine R paste is also largely used for this purpose. We append a recipe, which will give a general idea of the quantity of these colours required to shade the naphthol black and how it is added to the printing colour.

Black.

5 lbs. acetic gum thickening,
1 lb. naphthol black B,
7 lbs. water.
4 ozs. Indian yellow,
1 lb. water.
8 ozs. oxalic acid,
1 lb. water.
8 ozs. chlorate of soda,
1 lb. water.
4 ozs. alum in fine powder.

Each ingredient is mixed with the quantity of water given and mixed very gradually with the thickening, in the order shown. The powdered alum can be added gradually and the colour well stirred, or it may be dissolved in water and then added.

Pieces printed with naphthol black require to be hung in the hanging room for a sufficient length of time to enable the colour in the piece to become slightly damp, but not so damp that the colour will run, or "spring," while the pieces are being steamed. If the goods are not hung long enough, the colour is not properly fixed by the steaming operation, the colour leaves the tissue on washing, and the resulting shade is flat and poor. The pieces should be steamed in the cottage steamer, without pressure, for an hour. As goods printed with naphthol black bleed very badly during the operation of washing, too many pieces should not be washed together in the same machine, otherwise, the water becomes so charged with colour as to soil the unprinted parts of the fabric. The pieces should be washed for at least an hour, or until the colour ceases to leave the pieces.

The blacks given by naphthol black are fast to light, but only moderately fast to soap.

Acid Black B (Read Holliday & Son) yields a very good fast black, and it can be altered in tone by the addition of any of the acid colouring-matters. It is applied in the same manner as naphthol black B; the same precautions with regard to the hanging, steaming, and washing being observed.

Victoria Black B (F. B. & Co.).—Victoria black B is used by some printers; it can be shaded as described for naphthol black.

Starch is generally used for thickening this colour, the following being a good recipe:—

Victoria Black B.

6 lbs. Victoria black B,
7 lbs. wheat starch,
7½ gallons water,
½ gallon acetic acid, 9° Tw.
Mix well in a colour pan; boil; and add
¾ gallon tartaric acid solution.
Cool and strain for printing.

The tartaric acid solution is kept in the colour shop for use with various colours, and is made by dissolving 2 lbs. of tartaric acid in 1 gallon of water.

The cloth should be prepared, before printing, with chlorine. After printing, the pieces should be hung and steamed for an hour under slight pressure, washed and soaped in a solution containing about 1 oz. of soap in 8 gallons of water, for twenty minutes, at a temperature of 80° to 90° F. Some printers, in addition to hanging the pieces before steaming, wind the piece between damp cloth, and put the whole inside the steamer to ensure the cloth being kept sufficiently damp during steaming.

Anthracite Black B (Cassella) gives a black with a very bluish tone. It is used for blue-black shades on delaine goods, and, owing to its extreme fastness to milling, far excelling naphthol black in this respect, it is very largely used for printing slubbings. Anthracite black is, however, more expensive than naphthol black; hence the latter is chiefly used for piece goods:—

Anthracite Black B.

6 lbs. anthracite black B,
18 gallons water.
10 lbs. oxalate of ammonia,
3 gallons water.
10 gallons British gum solution,
5 lbs. chlorate of potash,
1 gallon water.
160 lbs. British gum.

The various chemicals, &c., are each dissolved in the water given, and gradually mixed in the order shown. The British gum solution is made by boiling 10 lbs. of light British gum in 1 gallon of water. When all the ingredients have been added, the whole is brought to the boiling point to dissolve the British gum, cooled, and strained.

Anthracite black must be printed on chlorine-prepared cloth or chlorine-tin prepared cloth. When printed on either unprepared or tin-prepared cloth the shades are weak and poor in appearance.

Wool Printing Black W (Leonhardt).—This black, which is very largely used by woollen printers, is used in the same way as acid black. The cloth should be prepared with chlorine-prepare, and the goods steamed for one hour after hanging. This colour is shown in pattern No. 51.

Brilliant Black B & E (B. A. & S. F.) is also useful for producing a good full black on wool. It is printed upon chlorine-prepared wool, with the addition of chlorate of soda and tartaric acid to the printing colour.

The following is a recipe for producing good full shades, with either of the brands named :—

10 lbs. brilliant black B or E,
30 lbs. British gum,
1 lb. chlorate of soda,
2 lbs. tartaric acid,
5¾ gallons water.

The pieces, after printing, should be hung in a damp place, or rolled up in damp greys for a few minutes, to uniformly damp them, steamed for an hour without pressure, hung up to dry, and thoroughly washed.

The shade can be turned by the addition of other colouring-matters that are applied in a similar way.

Azo Acid Black B & G (M., L. & B.).—These two new acid blacks can be used for printing wool, the B mark producing blacks of a bluer shade than the G shade. They are printed on chlored wool, using the recipe appended :—

4½ lbs. azo acid black B or G,
1½ gallons water,
20 lbs. dextrine,
1 lb. crude glycerine,
3 noggins turpentine,
2 lbs oxalic acid.

After printing, the wool is hung, steamed two hours, and washed.

Blues.—For the production of blue shades on wool there are a very complete range of colouring-matters available.

The dark shades or indigo blues are produced with the indulines (fast or solid blues) as the basis of the shade, the latter being generally modified by the addition of the water or alkaline blues, which are brighter in tone. The fast blues, although varying considerably in shade, are generally too sombre in tone for use alone; hence this addition of other colours to brighten the shade.

The bright blues are produced with either the alkaline or patent blues, and these are made in shades varying from bright greenish-blues to reddish-blues.

Speaking generally, the cloth is prepared with chlorine, but the shades are somewhat brighter when there is some tin in the prepare or in the colour. The combined tin and stannate-prepare is the best for the majority of the colours, and it is better to introduce the tin in the prepare than to add it to the printing colour, as this is liable to cause the shades to be uneven.

Some of the blue colouring-matters are liable to be reduced during the steaming; in order to prevent this it is sometimes advisable to add an alkaline chlorate to the printing colour.

It will be found, on practical trial, that there are some makes of these colours that yield uneven shades under the conditions which control the printer, so that it is necessary to select them by practical trials on a fairly large scale, varying the composition of the printing colour, the prepare, and the other parts of the manipulation, until a series of blues are selected which enable the printer to prepare all his required shades, and yet work evenly under the treatment to which they are submitted.

In carrying out these trials one ingredient of the prepare, colour, or one part of the process should be varied at a time, otherwise no definite conclusion can be arrived at with regard to the cause of the unevenness of shade.

The Indulines.—The class of blues of various shades, known as the indulines, is made by nearly all colour makers, each manufacturer affixing to his particular brand some special mark or, in many cases, calling the dyestuff by a special name. For example, this class of colouring-matters is sold under the following names:—Fast blue, R and B, nigrosine, Coupier's blue, fast blue-green shade, and many others, besides the name induline with certain letters affixed, to denote either the shade or the maker.

These colours are best printed with a printing colour prepared with the addition of an acid, but they can be printed from an alkaline colour containing ammonia, but do not yield as good shades. The acid used in the printing colour may be either acetic, oxalic, or tartaric acid, preferably the latter.

The induline blues give shades that are satisfactory in their fastness to light and soaping, and there is such a large number of brands of blues in this series that almost any shade of dark blue can be matched almost exactly, while, if necessary, the shade can be brightened by adding some of the brighter blue colouring-matters.

The chief difficulty that occurs in the application of the indulines is their tendency to produce uneven shades, especially in dark blotches. On this account, particular attention should be given to the preparing of the cloth, and to the thorough hanging of the pieces before steaming, the shade depending considerably upon the cloth being properly damped previous to steaming. With this object, glycerine is frequently added to the printing colour to guard against overdrying on the chests, and to assist the cloth to absorb sufficient moisture while hanging. Some marks and makes of indulines are more subject to unevenness than others; if any difficulty is experienced in this direction several makes should be selected, and practical trials made under the special conditions the printer is working. These trials should be made on full pieces, using a heavy blotch roller for printing; small trials on fents are absolutely worthless and misleading.

We will now give several recipes that can be taken as types for using with this class of colouring-matters.

No. 1.

5 lbs. induline.
5 gallons water,
30 lbs. dextrine,
⅛ gallon acetic acid, 12° Tw.

Dissolve the colouring-matter in some of the water and the acetic acid; then add the dextrine; boil; then cool and strain for use.

No. 2.

3 lbs. induline,
25 lbs. British gum,
1 lb. chlorate of soda,
¾ gallon acetic acid, at 12° Tw.,
5 gallons water.

The chlorate of soda should be added after the colour has been boiled and cooled to about 160° F.

No. 3.

9½ ozs. induline,
1 gallon water,
2½ gallons dextrine solution (10 lbs. per gallon),
2½ pints saturated solution of alum.

The dyestuff should be dissolved in the water in the colour pan, and the dextrine solution then worked in. When the colour is quite cold, the alum solution is added, and the whole thoroughly mixed.

No. 4.

5⅛ lbs. colouring-matter,
5 gallons water,
30 lbs. British gum,
3⅛ lbs. tartaric acid,
1 gallon water.

Dissolve the colouring-matter in the water, add the British gum and boil; then add the tartaric acid, previously dissolved in the gallon of water, and cool.

No. 5.

Instead of tartaric acid in the last recipe, oxalic acid can be substituted, using about half the quantity stated. In this case the acid solution should be added when the colour is nearly cold. If it is added when the mixture is hot the colour will be made very much thinner in consistency.

The prepare best suited for the induline colours is the chlorine prepare, but the shades are rendered somewhat brighter when the combined tin and chlorine prepare is employed. For very dark blues the cloth requires to be strongly prepared, and is generally passed several times through the preparing liquors.

On tin-prepared cloth alone the colours are fixed, but are very much paler in shade with the same proportion of colouring-matter in the printing colour.

We will now give some details respecting some of the colours applied as given above. It will be obvious that it is impossible to notice every mark and colouring-matter that is in the market; but the principal shades will be noticed.

Induline L (Leonhardt).—This is shown printed on wool in pattern No. 52. This pattern was printed with a colour prepared according to the recipe marked No. 1, given above, upon cloth prepared with chlorine only. The shade obtained with this colouring-matter is rather dull, and, when required for dark blues, is brightened by the addition of one of the brighter water-blues, as, for example, water-blue L S. Mixed with other colours, it is useful in obtaining various shades of greys, modes, &c., and the colours are fairly fast to soaping and light.

Fast Blue R R (B. A. & S. F.)—Fast blue R R gives on wool prepared with chlorine good deep shades of a reddish tone. When reduced with thickening, the pale shade is much bluer, and in very light shades the colour is of the bluish-grey tone so commonly seen in home trade prints. Dextrine forms the most suitable thickening material to use with this colour, but British gum, and starch mixed with gum tragacanth, may be used. The colours thickened with dextrine and British gum are far more solid and even than when starch is used, and for this reason they are employed when blotches are being printed.

The shades obtained with a colour thickened with dextrine are, however, very much lighter than with a starch thickening when the printing colour contains the same proportion of dyestuff; hence for small sprig patterns the latter is sometimes used, as any roughness or want of solidity is not easily perceptible when the surface is small, British gum stands midway between starch and dextrine in the depth of shade produced.

Fast blue R R should be printed from a colour containing acetic acid or tartaric acid, and it is advisable to add some chlorate of soda to the colour to guard against the colour being reduced during steaming. Recipe No. 2 is very well suited for printing this colouring-matter, and gives a full dark shade of blue. A medium shade is obtained by reducing the strength of the colour with twice its bulk of thickening.

Fast Blue R (B. A. & S. F.).—This colour in its method of application resembles fast blue R R, but the shades obtained are very much bluer in tone. The shade, or depth of colour, obtained with the same proportion of dyestuff is rather lighter than that given with the R R mark. The difference in tone between these two marks is very much more evident in the pale shades, the R mark being bluer and brighter. This colour is useful in preparing dark blues, and for printing dull bluish-greys.

It is also very largely used in making compound shades.

Fast Blue 5 B and **Fast Blue Extra Green Shade** are considerably bluer and brighter than either of the two marks previously noticed, the extra green shade approaching almost to a peacock blue.

The number of shades that can be obtained from the various fast, or, as they are frequently termed, solid blues, is so great that it is quite impossible to notice them, varying as they do from a greenish-blue to shades almost approaching a violet. These colouring-matters, however, give rather dull shades; when brighter shades are required, the alkaline and patent blues are made use of.

Alkali Blues.—The alkali blues are largely used in printing, being chiefly employed in altering the shade of other colours.

They are best printed from a colour containing either acetic or tartaric acid, as given below, or they may be printed along with acetic acid and chlorate of soda.

Printing Colour for Alkali Blues.

10 lbs. alkali blue,
¾ gallon acetic acid, 12° Tw.,
2½ gallons water,
7 gallons dextrine solution (10 lbs. per gallon).

The cloth should be prepared with tin and chlorine, as the tone is brighter than if done on chlorine prepare only.

The pieces should be hung, after printing, and steamed for an hour without pressure. After steaming, wash and dry.

The brighter and bluer shades of alkali blue are most useful to the woollen printer, as, for example, alkali blue 5 B.

The alkali blues are sometimes known as Nicholson's blues.

Water Blues (Cotton Blue, Soluble Blue).—These colouring-matters are obtainable in a large number of shades, from reddish to pure blues. They can be printed with the addition of either acid, alum, or, preferably, along with some oxalic acid and chlorate of soda, as shown in the following recipe:—

Printing Colour for the Water Blues.

2 lbs. water blue,
35 lbs. British gum,
1 lb. chlorate of soda,
1 lb. oxalic acid,
6 gallons water.

Print on tin-chlorine prepared cloth, steam for an hour, and wash.

Water Blue 7 B is shown in pattern No. 55.

Cotton Blue 4 B is shown in pattern No. 53, and is one of the bluer shades of this colour, a redder shade being shown in pattern No. 54 of water blue R. These two patterns have been printed with the following colour, using cotton blue 4 B and water blue R respectively:—

3½ lbs. colouring-matter,
3¼ gallons water,
5½ gallons dextrine solution (12½ lbs. per gallon),
½ gallon tartaric acid solution (10 lbs. per gallon),
½ gallon alum solution, 10 per cent.

Water Blue R R R is considerably redder in shade than the R mark, and yields a good deep shade with 2 per cent. of colour in the printing mixture. The deep shades have quite a purple tone.

Wool Blue S.—This dyestuff gives a good blue of rather a neutral tone. The colour is printed with oxalic acid, see "Practical Recipes." The cloth should be well prepared with chlorine and the steaming done without pressure.

Patent Victoria Blue.—This dye is made in several shades from a pure blue, mark B, to quite a violet toned blue, mark R R R R. Tartaric acid is the best assistant to use with the Victoria blues, the wool being chlorine prepared.

These colours are fast to light and moderately so to soap.

Patent Blues (M., L. & B.).—These blues are made in several brands, and various shades can be obtained by their use. Perhaps the most useful is that obtained with "patent blue superior," which yields an extremely brilliant greenish shade of blue.

If the wool is well prepared with chlorine there will be no necessity to add any chlorate or other oxidising agent to the printing colour, and more regular results will be obtained.

Should the wool not be sufficiently prepared, the colouring-matter will be more or less reduced on steaming, and lighter shades will be produced, in patches occasionally.

Thiocarmine R Paste (Cassella).—This colouring-matter resembles in shade indigo carmine; hence, we suppose, its name. Unlike indigo carmine, however, it is not discharged by steaming in the presence of chlorates and acid; consequently, it can be used for altering the shade along with colours containing these substances.

The fixation of the colour should be assisted by the addition of oxalic acid and chlorate of soda to the printing colour.

The colour fixes equally well on either tin or chlorine-prepared cloth.

Spirit Blues.—These blues are best prepared for printing by dissolving them either in acetine, or in the substitute for acetine now sold for this purpose. The solvent should be boiled with the colouring-matter, and then a solution of dextrine or British gum (10 lbs. per gallon) gradually added until it is made up to the bulk required to give the shade.

The colour is then printed on chlorinated wool and treated as usual.

There are several of these blues on the market which only require the addition of the thickening material, being ready dissolved in the solvent.

Violets.—Violet shades are chiefly obtained from the various marks of acid violet, which can be obtained varying in shade from an almost magenta shade to quite a bluish shade of violet.

The acid violets are printed from a colour acidified with acetic, tartaric, or oxalic acid. Occasionally, alum is added to the colour.

The acid violets give fast shades, and are used in the preparation of lilac and helitrope shades, as well as by themselves.

The colours should be printed on chlorine or chlorine-tin prepared cloth, steamed without pressure for an hour, washed and dried.

The violets go on the fibre fairly evenly in medium and dark shades, but there is a tendency for the colour to come up uneven in very light shades unless great care is taken.

Pattern No. 56 shows one of the blue shades of the violet, acid violet 7 B, and is printed with the following colour on chlorine-prepared wool :—

Acid Violet 7 B.

5 lbs. acid violet 7 B,
6½ gallons water,
5½ gallons dextrine solution (12½ lbs. per gallon),
1 gallon tartaric acid solution (10 lbs. per gallon),
1 gallon alum solution, 10 per cent.

Many of the R shades of these acid violets are so red in tone that they are more correctly described as magenta and rose shades.

Patent Alkaline Violet.—This colour, giving a blue shade of violet, is merely thickened for printing. The cloth should be prepared with chlorine and the goods steamed for an hour with, practically, no pressure. Wash and dry.

Formyl Violet S 4 B.—This dyestuff yields fine violets of a medium tone. The colour prints evenly, even in very light shades, while the dark shades do not spring or bleed during the processes of steaming and washing, consequently, the prints are obtained with clear cut edges. The colour is acidified with acetic acid, thickened with a mixture of dextrine and British gum, and printed on cloth prepared either with chlorine or with tin.

The steaming and washing is done in the usual way.

Formyl violet is as fast to light as the corresponding shades of the acid violets and it is superior in fastness to soaping and the action of alkalies.

Instead of acetic acid, oxalic or tartaric acid can be used in the colour.

Green Colours.—The various shades of acid green are the most largely used for producing green shades by printing on wool. There are several shades in commerce, and when the shade is required either bluer or yellower, some of the patent blues on the one hand, or tartrazine on the other, is mixed with it.

Pattern No. 57 is printed with acid green G G, the following being the recipe used:—

3 lbs. acid green G G,
2 gallons water,
6 gallons dextrine thickening,
⅜ gallon acetic acid, 8° Tw.

Print on chlorinated wool, steam for an hour without pressure, wash, and dry.

Sulpho Green S, Light Green S F, and Blue Green S are applied in the same way as acid green G G, but with the two latter a little chlorate of soda should be added to the printing colour to prevent reduction.

Guinea Green B and G.—These two colours resemble in colour acid green G G, being, if anything, slightly yellower in tone, especially the G shade. They can be printed in a similar manner to that used for acid green G G, but it is advisable to add some sulphate of alumina to the colour.

Naphthol Green B (Cassella).—Naphthol green B gives, when printed on wool, rather dull shades of green, inclining to myrtle.

It is very fast to light, even in pale shades.

The colour is printed according to the following recipe:—

Naphthol Green B.

6½ lbs. naphthol green B,
4½ gallons water,
32 lbs. British gum,
¼ gallon acetic acid, 8° Tw.,
3 lbs. chlorate of soda,
3 quarts water.
Boil; cool; and add
1 quart iron liquor, 23° Tw.

The colour should be printed either on chlorine or chlorine-stannate prepared cloth, steamed for half an hour without pressure, washed, and dried.

Orange Shades.—The orange shades are produced by the use of the large series of oranges for wool, one of which we show in pattern No. 58. Orange 11 B is one of the intermediate shades of the oranges, yellower and redder shades being obtainable.

They merely require thickening, and the addition of a little acid for their fixation, and they will develop on any of the prepares described on p. 243.

The acid generally used for these colours is either acetic or tartaric acid, but they are sometimes printed with a mixture of acetic acid and phosphate of soda, as shown in the recipe given below.

Pattern No. 58 has been printed on chlorine-prepared wool with the annexed recipe :—

Orange 11 B.

2 lbs. orange 11 B,
3 gallons water.
Dissolve ; and thicken with
6 gallons dextrine solution (10 lbs. per gallon).
Then add
3 quarts acetic acid, 9° Tw.

The printed pieces are hung, steamed for an hour, and washed.

With some of the redder shades of the oranges—as, for example, orange R—it will be found better to use tartaric acid, instead of acetic acid, for acidulating the printing colour.

We give the following as an example of the use of the mixture of phosphate of soda and acetic acid used for assisting the fixing of these oranges :—

Orange Extra.

4½ lbs. orange extra,
4 gallons water,
3 lbs. phosphate of soda,
3 quarts water,
38 lbs. dextrine,
1 gallon acetic acid, 9° Tw.

Patent orange G, croceine orange E N, orange G G, Kermesin orange A, mandarin R and G, and Ponceau 4 G R (which gives an orange shade) can all be printed in the above manner.

Red and Scarlet Shades.—The number of red and scarlet colouring-matters available for printing woollen goods is particularly large, and they practically all belong to the acid series of dyes.

For the red shades, probably the fast reds B and A and azorubine are the most useful, as with these we can produce other shades by the admixture of the brighter scarlet colours, or turn them to a more claret shade by adding some of the bluer-toned colours.

The reds are printed with the addition of oxalic or tartaric acid, some printers using a mixture of alum and tartaric acid in the colour.

The cloth is best prepared with the combined tin and chlorine prepare, as it yields much brighter, and quite as full, shades as the chlorine prepare.

Pattern No. 59 shows an example of an acid red.

The scarlet shades are done with the many shades of Ponceaus or scarlets.

It would serve no useful purpose to multiply the number of recipes for these colours, as they can all be applied in the same way. Pattern No. 60 shows one of these scarlets, and is a medium shade; redder and yellower shades can be got if desired.

Brilliant Ponceau 5 R.

3 lbs. brilliant Ponceau 5 R,
30 lbs. British gum,
6 gallons water.
Boil; and add
3 quarts acetic acid, 9° Tw.
Cool, and strain.

The pattern was printed on chlorinated wool, steamed for an hour without pressure, washed, and dried.

The milling and diamine reds and scarlets of Messrs. Cassella & Co. yield shades similar to the fast reds and Ponceaus, and are equally fast to light. They have the further advantage of being very much faster to soap than the latter, and are thus particularly adapted for the printing of slubbing as well as piece goods.

The milling colours are printed with a mixture of phosphate of soda and acetic acid, as given on p. 260, the diamine colours requiring merely the addition of acetic acid after dissolving and thickening.

Yellow Shades.—The yellow shades may be divided into two classes, viz.—bright and dull yellows.

The bright shades are usually printed with tartrazine or one of the brilliant yellows for wool. The brilliant yellows vary considerably in tone, according to the particular mark or maker. Brighter, but more fugitive, shades than either of the above-named colours can be obtained by using either fluoresceine or quinoline yellow; but it may be mentioned that the shade given by tartrazine is the brightest, which may be considered fast, obtainable from the colouring-matters for wool printing that are at our disposal at the present time.

Tartrazine.

4 lbs. tartrazine,
35 lbs. British gum,
6 gallons water.
Boil; and, when lukewarm, add
2 lbs. oxalic acid.

The kind of prepare used for these yellows does not very much affect the shade, but, as a rule, it is better to use the combined stannate and chlorine prepare.

Brilliant yellow is shown in pattern No. 61, and is printed with the following printing colour, upon chlorine prepared wool, steamed for an hour without pressure, washed on the wince, and dried.

Brilliant Yellow.

2½ lbs. brilliant yellow,
14½ ozs. caustic soda liquor, 76° Tw.,
3½ gallons water,
6 gallons dextrine solution (10 lbs. per gallon),
3 lbs. tartar,
3½ ozs. water.

Fast Yellow (B. A. & S. F.).—Fast yellow gives a yellow of a dull shade, being rather brown in tone. This dyestuff should be printed in a colour containing some chlorate of soda, to guard against reduction during steaming. It is a very useful colour to use for the preparation of holland shades, mixed with other colouring-matters.

Milling Yellow O (Cassella) yields a fairly bright shade, and it is particularly fast to the action of light and alkalies, which renders it specially valuable for printing slubbing, and washing flannels. The assistant used to fix this yellow is usually oxalate of ammonia, either alone or mixed with acetic acid. Any of the prepares may be used for this colour.

Anthracene Yellow C (Cassella) is much duller in shade than milling yellow, but, like it, is fast to light and alkalies, and is used for printing the same kind of materials when a dull yellow is required. Like milling yellow O, it is printed along with oxalate of ammonia and acetic acid.

Indian Yellow is also largely used, and it is printed in the same way as tartrazine.

Brown Shades.—The acid browns are used to a large extent on wool, but they are, in our experience, liable to give uneven shades, and for this reason, we believe, many printers use the basic brown colouring-matter sold under the names of Bismarck brown, vesuvine, &c., using the acid browns only when it is absolutely necessary to do so.

The application of the acid browns to printing wool is very simple, the colours merely requiring to be dissolved, thickened, and an acid added to assist in their fixation. We give below a recipe which can be used with any of the acid browns.

Acid Brown.

4 lbs. colouring-matter,
4½ gallons water,
42 lbs. dextrine,
½ gallon acetic acid, 9° Tw.

The colour should be printed on chlorine-prepared cloth, steamed for an hour, and washed.

Instead of acetic acid, oxalic or tartaric acid can be used, and there are some makes of acid brown which print well, even without the addition of acid.

The following are some of the best known brown colouring-matters that can be employed in the above manner:—Acid brown and acid brown D (Cassella), naphthol brown (Leonhardt), sulphon brown R (Bayer), and all the other dyes sold under the name of acid brown by the actual manufacturers. We say manufacturers advisedly, as the names given to dyes by drysalters and chemical agents are frequently given without thought or knowledge of the nature of the colour.

Chocolate and Claret Shades.—The number of claret and chocolate shades used in practice is very large indeed, and very few of the printing colours are prepared with one colouring-matter, most of the shades being obtained by mixing several colours to the required shade.

There are, however, certain colouring-matters of a more or less claret and chocolate tone which are used as the bottom or chief colour in these mixtures, and these we will now notice.

Amaranth (Cassella).—This colour is very useful for preparing either chocolate or claret shades, being turned in shade by admixture with other colours. The colour merely requires the addition of acetic acid and thickening to prepare it for printing. The cloth should be prepared with chlorine, but, for very bright shades, better results are obtained by using the chlorine-stannate prepare. The steaming of the pieces should be done without pressure, the pieces being previously hung in the damp hanging room.

Brilliant Croceine B of the same firm is applied in a similar manner, and is not so liable to yield uneven shades as some of the other colours of this shade.

Acid Bordeaux (Leonhardt) yields a shade more of a chocolate tone than either of the above colours, and is duller. It is used for producing chocolate and dark claret shades. This dyestuff is usually printed on chlorine-prepared wool.

The following recipe will work satisfactorily with any of the above colours :—

5 lbs. colouring-matter,
5 gallons water,
30 lbs. dextrine,
½ gallon acetic acid, 12° Tw.

Rose, Pink, and Magenta Shades.—These shades, which we will take together, as they are all done with the various marks of practically the same class of colouring-matters, are generally obtained from the acid colours like rhodamine S, or the acid magentas, or from the resorcine dyes.

They are printed under the addition of acetic or tartaric acid, and for medium shades are usually thickened with brown dextrine; but a mixture of white and brown dextrine is used for very bright shades. For pale pad pinks and roses the thickening is often composed of a paste made of gum tragacanth or dragon (5 ozs. per gallon), but it does not give so solid and even shades as dextrine. Occasionally a little alum solution is mixed with the colour, but we could never discover any advantage arising from its use.

For rose shades rose Bengal, rhodamine B and S, anisoline, and some of the bluer shades of chromotrop are chiefly used in addition to the acid magentas and the red shades of acid violet.

For pink and salmon shades we have a large number of shades of eosines, erythrosines, and phloxines, and, in addition to these, a fine pink from chromotrop 2R, which gives the fastest pink on wool with which we are acquainted. All the resorcine colours when printed on wool are very loose to light, but are used on account of the brilliancy of their shades.

All these colours should be printed on chlorine-tin prepared wool, but when using chromotrop, particular care should be taken that the pieces do not come into contact with a metallic copper surface, or the pieces will, when printed and steamed, be covered with dark stains.

Pattern No. 62 is printed with eosine OO, and No. 63 shows the shade obtained with rose Bengal B.

Greys.—Grey shades on wool are principally obtained by combining several colours to produce the required shade, but there are several marks of the indulines—*e.g.*, nigrosine W extra, and WG—which are also used. These, however, in common with naphthol black, when reduced to a grey, are very liable to develop unevenly on the fibre, consequently we consider it preferable to produce the grey shades by mixing, using water blue or one of the bluer shades of induline or spirit blue as the base, and adding a little tartrazine, orange 11, or acid green, as required.

Basic or Tannic Colours on Wool.—All the basic coal-tar colours can be used for printing wool, but, on account of the difficulty of obtaining even shades with them, only a few are used in practice.

The basic aniline colours that are used to any extent for printing wool are Bismarck brown, occasionally brilliant green, and rhodamine B, which has both basic and acid properties.

Bismarck brown, also known as vesuvine, is used for browns in medium shades, and, when mixed with other colours, for producing holland and buff shades.

The colour should be printed on cloth prepared with chlorine, and steamed in the usual manner.

Bismarck brown can be printed from a colour merely prepared by thickening the dissolved colour, but it is better to add a little acetic acid to the colour. An example of a printing colour prepared with this colouring-matter is given below :—

Bismarck Brown.

1 lb. Bismarck brown.
Dissolved in
2½ gallons water,
and thickened with
5 gallons British gum solution (10 lbs. per gallon).

Rhodamine B (for pink and rose shades) and **Brilliant Green** should be printed on chlorine-tin prepared cloth, with the addition of tartaric acid to the printing colour, as shown in the following recipe :—

Brilliant Green and Rhodamine B.

2 lbs. colouring-matter,
30 lbs. dextrine,
2 lbs. tartaric acid,
6 gallons water.

SECTION II.

THE DISCHARGE STYLE ON WOOL.

In this style we produce white or coloured patterns upon cloth previously dyed a uniform colour.

The discharging agents generally employed are stannous chloride, or tin crystals, and a mixture of zinc powder and bisulphite of soda, the discharging effect being obtained in the latter case by the action of the hydrosulphites, prcduced by the action of the zinc powder on the bisulphite of soda, on the colouring-matter with which the cloth has been dyed. As, however, there is always an excess of zinc used in the printing mixture, the metallic zinc in the fine state of division may also have some influence.

The particular discharging agent employed depends upon the nature of the dyestuffs used in dyeing the pieces. Some colouring-matters that are perfectly discharged by one of the discharges named, may resist the effect of the other, consequently, in dyeing mixed shades, due attention should be taken that only dyestuffs dischargeable by the one agent are used in dyeing to obtain the required shade.

With regard to the dyeing of the piece previous to printing, we would refer the reader for full details to the recent books on dyeing, and the instruction sheets issued by the various manufacturers of the dyes, as it is rather outside our province in this place.

On p. 268 will be found a list giving the names of the colours that are discharged by the disharging agents above-named respectively, but we would advise that each printer should try for himself the action of the discharges on the various dyes he uses, an operation very quickly performed, as a large number of fents dyed with the several colours can be stitched together, and the whole printed with two kinds of discharges off the doctor at one operation.

The discharges prepared ready for printing are given below, and they should be prepared fresh daily, as they deteriorate by long exposure to the air:—

Tin Discharge.

1 lb. tin crystals,
½ lb. acetate of soda,
1 gallon British gum thickening.

Zinc Discharge.

3 lbs. zinc powder,
2 noggins crude glycerine.
Work up into a paste; then add
1 gallon gum thickening.
Stir well; and add, gradually,
2¾ pints bisulphite soda solution, 48° Tw.
Stir well; and add
1 noggin ammonia.

Allow the mixture to stand for about two hours, then strain for printing.

The tin discharge is chiefly used for producing coloured discharges, the various colours being obtained by adding various colouring-matters to the discharge. The tin discharge does not yield so good a white as can be obtained by the use of the zinc discharge, consequently, the latter is principally used for white discharges; and the tin discharge, mixed with the respective colouring-matter, is used for coloured discharges.

The dyestuffs that are mixed with the tin discharge should be of such a nature that they will not be affected by the tin in the printing colour, and they should be capable of being properly fixed to the fibre in the presence of the tin salt.

The pieces, after printing, should be steamed under slight pressure for an hour, and, if zinc has been used in the printing colour, they should be passed through a weak solution of sulphuric or acetic acid, and then well washed on the wince in the usual manner. When the tin discharge alone has been used the pieces are generally well washed, after steaming, on the wince, slightly soaped and dried.

Having now spoken generally with regard to this style we will give some examples, illustrated by patterns:—

Pattern No. 64 has been dyed from a bath containing—

3 per cent. fast red A,
10 per cent. Glauber salts,
3 per cent. sulphuric acid.

After dyeing and drying, the pieces are wound on centres and printed with the following discharge colour:—

5 gallons gum solution,
12 lbs. acetate of soda,
8 lbs. water,
30 lbs. tin crystals.

Pattern No. 65.—The cloth was first dyed with—

3 per cent. benzoazurine G,
10 per cent. Glauber salts,
5 per cent. strong solution acetate of ammonia.

After dyeing, the cloth was printed with a colour containing acridine orange R extra, as follows:—

3 lbs. acridine orange R extra,
12 lbs. acetic acid,
15 lbs. water,
55 lbs. gum solution (10 lbs. per gallon),
15 lbs. tin crystals.

Pattern No. 66.—This pattern has been dyed with 4 per cent. of its weight of brilliant Congo R, along with the same proportion of Glauber salts and acetate of ammonia as in pattern No. 65.

The discharging colour was composed of:—

1½ lbs. fast blue, No. 11,473,
½ lb. water,
½ ozs. bisulphite of soda, 38° B.
Allow to stand twenty-four hours, then add
5½ lbs. dextrine thickening,
½ lb. acetate of soda,
2 lbs. tin crystals.

The colour so produced is very fast to the action of soap.

Pattern No. 67 is an example showing a red discharge printed on a yellow bottom, and is obtained in the following way:—

The cloth was first dyed from a bath containing

2 per cent. azo yellow,
10 per cent. Glauber salts,
4 per cent. sulphuric acid.

After washing and drying, the piece was printed with the discharge red prepared with pyronine as below, the goods steamed and treated as described above.

Discharge Red.

3 lbs. pyronine G.
9 lbs. acetic acid.
18 lbs. water.
60 lbs. thick dextrine thickening.
10 lbs. tin crystals.

Pattern No. 68 has been produced by first dyeing the fibre in either a wooden or enamelled dye-beck—copper or tin vessels should not be used for this particular colouring-matter—with the following mixture:—

2 per cent. Chrysoin GO,
4 per cent. sulphuric acid,
10 per cent. Glauber salts,

and afterwards printing upon the dyed fabric the green discharge colour prepared with acid green B.

Green Discharge Colour.

1 lb. acid green B,
6½ lbs. water,
13¾ lbs. dextrine thickening,
3¾ lbs. tin crystals.

We are indebted to Messrs. A. Leonhardt & Co., of Muhlheim-on-Maine, Germany, for the patterns used to illustrate our remarks on the discharge style of wool printing.

An extremely useful list of colours that are useful in this style, both for first dyeing the fabric and afterwards making various coloured discharges by mixing the various colours named with the two kinds of discharges given on pp. 265 and 266, was published in the *Dyer* by C. F. S. Ruhhg,* which we reprint below :—

The colours given under the headings 1 and 3 are of course available for dyeing the ground colour, while those under 2 and 4 can be used for producing the coloured designs on such grounds.

1. Colours Discharged by Zinc Dust.

Blues.—Alkali blues ; the colour is quite discharged.
Opal blues.
Soluble blues.
Guernsey blue.
Alkali violet.
Victoria blue.
Diamine blues ; the results are fairly good.
Benzo blues.

Reds.—Chromotrops.
Amaranth.
Acid magenta.
Victoria rubine.
Victoria scarlets.
Crystal scarlets.
Croceines.
Azo rubine.

Oranges and Yellows.—
Orange extra.
Croceine orange.
Tropeolines.
Anthracene yellow C.
Diamine yellow N.
Diamine gold.
Victoria yellow.

Violet.—Formyl violet S 4 B.

Green.—Acid green.

Blacks.—Naphthol blacks, Diamine blacks } only a good discharge with light shades.

2. Colours Not Discharged by Zinc Dust.

Reds.—Eosines, and allied colours.
Amaranth (Cassella).
Safranine.
Diamine fast red F ; cannot be disharged unless the shade is pale and the discharge very strong.
Diamine scarlet B ; same as the last.

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* *The Dyer and Calico Printer*, Oct. 20, 1893.

Yellows.—Milling yellow O.
Thioflavine T.
Thioflavine S.
Phosphine.
Blue.—New methylene blue N.
Green.—Naphthol green B.

3. Colours Discharged with Tin Crystals.

Reds.—Brilliant scarlets.
Crystal scarlet.
Brilliant croceines.
Azo rubine A.
Amaranth.
Archil substitute.
Milling reds.
Claret reds.
Cloth reds.
Chromotrops.
Most scarlets.
Benzo purpurine.
Diamine red NO.
Diamine scarlet B.
Hessian purples.
Azo Fuchsine G.
Fast red E.
Azo Bordeaux.
Azo cochineal.
Azo eosine.
Carmoisine B.
Blues.—Sulphon azurine.
Brilliant sulphon azurine.
Benzo azurine.
Benzo cyanines.
Benzo blues.
Diamine blues.
Oranges and Yellows.—
Orange extra.
Croceine oranges.
Tropeolines.
Milling yellow O.
Diamine yellow N.
Mikado yellows.
Azo yellow.
Victoria yellow.
Fast yellow.
Greens.—Diamond green.
Acid green.
Naphthol green B.
Diamine green B.
Violets.—Victoria violets.
Congo corinth.
Azo acid violets.

Blacks.—Diamond black.
Victoria blacks.
New Victoria blacks.
Diamine blacks.
Naphthol blacks. Good results with the last two classes of blacks are only obtained with light or medium shades.

4. Dyestuffs not Discharged by Tin Crystals.

Reds.—Safranines.
Eosines.
Rhodamines.
Acid magenta.
Pyronine.
Rosinduline GG.

Oranges and Yellows.—
Auramine.
Quinoline yellow.
Thioflavine S.
Thioflavine T.
Primuline.
Oxyphenine.
Phosphine.

Greens.—Acid green.
Fast green bluish.

Blues.—New blues.
New methylene blues.
Fast acid blue B.
Indophenol.
Methylene blue.

Violets.—Fast acid violet 10B.
Acid violet 5B and 6B.
Methyl violet.
Fast neutral violet B.

These lists do not pretend to be at all exhaustive, but simply to include such colours as have come under the writer's notice as possessing the properties in question.

From the list given above of the behaviour of the various well-known colours towards the discharging agents almost any required shade may be produced, either for the ground colour or in the discharge.

SECTION III.

THE PRINTING OF HALF-WOOLLEN GOODS (UNIONS).

Half-woollen goods, or unions, are composed of cotton and wool, and the printing of such fabrics offers considerable difficulty, owing to the widely differing behaviour towards colouring-matters of these two fibres, which tends to the production of uneven shades, or, as a printer would say, to the production of colours of a "bare" or "unsolid" character.

If the cloth is printed in the bleached condition—*i.e.*, without any preparation previous to printing—the cotton is liable to give the deeper shade in the finished print; hence it is usual to pass the fabric through the tin and chlorine prepare, as in the case of pure woollen tissues, to overcome this resisting tendency on the part of the wool. If, however, the prepare used should be too concentrated, the wool in the mixed fabric will attain too dark a shade in the print; consequently, it is absolutely necessary to adjust the strength of the preparing liquor so that the two kinds of fibres will take the colour evenly, and this can only be ascertained by trials upon fents taken off the pieces to be printed.

The printing colours used are those employed for the printing of cotton, comprising the tannic or basic colours, and the substantive colours especially, with the use, when necessary, of the adjective steam colours; the two former groups have affinities for both the fibres contained in union.

When the basic colours are used, the printing colours are prepared in the same way as for cotton, but it is found that the colours are rendered brighter, without affecting the fastness of the resulting shades, if rather less tannic acid is used than would be advisable if the fabric was composed entirely of cotton.

The substantive colours are used in precisely the same way as described for cotton; care being taken to avoid the use of alkalies that have a destructive action on wool, which points to the use of phosphate of soda wherever possible, or a substance similar in nature.

When the adjective colours are used, they are prepared for printing in the same way as for cotton goods, and call for no special remarks.

After printing, the goods are hung, as in the case of woollen fabrics, steamed, and then washed on the large winces used for wool prints, so as to avoid, as far as possible, staining the white parts of the prints by the detached and soluble colour. The finished prints are then dried on the stentering machine.

PART V.

THE PRINTING OF SILK GOODS.

CHAPTER I.

THE PRINTING OF SILK GOODS.

SILK printing has not received the attention in England it deserves, the vast bulk of the prints upon silk cloth being produced in France or Germany. We believe that there is a fair trade capable of being done in this country with these goods, fashions being favourable or created by the active "pushing" of these prints. The similarity in the methods of application of the printing colours between wool and silk should be some inducement for the printer of woollen goods to take up this branch of the work. We feel sure that, if worked well, it would lead to satisfactory financial results.

Silk tissues when received by the printer are usually bleached or scoured, and in this case they merely require scouring and preparing before printing. The scouring should always be done by the printer, even when the goods have been so treated before arrival at the works, as it is a safeguard against uneven or "patchy" results.

Scouring the Pieces.—The pieces are carefully worked for a period of from one to two hours—according to the weight of the material—in a solution of olive oil soap at about 95° F., after which they should be well washed, and are then ready for preparing. The amount of soap required varies from 10 to 15 per cent. upon the weight of the fabric, and the soap should be of good quality and quite free from free caustic alkali. The soap should always be tested before use for free caustic alkali by placing a little calomel—mercurous chloride—on a white porcelain tile, and working, by means of a spatula, some of the soap cut up into fine slices with it. There should be no trace of blackening or darkening of colour if the soap is quite free from caustic alkali; caustic alkalies turn calomel black. The calomel should be prepared by precipitating a solution of mercurous nitrate with hydrochloric acid, filtering, and well washing the precipitate until it is quite free from free acid; the precipitate should then be collected and preserved in the form of a thin paste in a wide-mouthed glass-stoppered bottle, ready for use. It is particularly important that all free acid should be removed by washing, because, if any acid remains in the paste, it will neutralise the necessarily small quantity of free alkali which may be present in the test pieces of soap, and thus mislead entirely.

Special soaps are made for "boiling-off" or scouring silks, and one of these should be employed.

Preparing the Tissue.—The tissue may be printed upon without any previous mordanting or preparation, as, although some colours yield equally good results upon unprepared and prepared cloth (and, in a few rare cases, better results upon unprepared cloth), by far the larger number of printing colours produce more brilliant and faster shades when the tissue has been prepared with tin; hence, as a general rule, the pieces are always so prepared before printing.

The pieces are prepared by working them, after scouring and washing, in a solution of either oxymuriate of tin or the so-called sulphomuriate of tin. After they have been thoroughly impregnated with the liquor, the pieces are either allowed to remain under the surface of the liquor, or wound wet on to a cloth-covered wooden centre, and allowed to remain in either condition for two to four hours, in order to allow time for the tin to be precipitated or to act upon the silk fibre. After the time named has elapsed, the goods are thoroughly washed in running water (to remove the excess of preparing liquor and all trace of free acid), and dried on the "stentering" or "tentering" machine, and they are then ready for printing.

The two preparing liquors are made as follows, and are used at the strengths given:—

Oxymuriate Preparing Liquor.

No. 1.

1 gallon oxymuriate of tin, 120° Tw.,
60 gallons cold water.

Place the oxymuriate of tin liquor in the tank, and, as the water is running in, stir the whole with a wooden paddle until the tank is filled up to the 61-gallon mark.

Sulphomuriate Preparing Liquor.

No. 2.

2 lbs. tin crystals,
1½ gallons water.
Dissolve; and add slowly
2 lbs. oil of vitriol, 170° Tw.
Stir well; and then add water until the liquor stands at 2¼° Tw.

Bleaching Silk Tissues.—Sometimes the pieces, after soaping, as described above, are found to be insufficiently bleached to yield a good white in the finished print. If this is found to be the case, the goods are, at this stage, bleached with a solution of peroxide of hydrogen, applied as below.

The scoured cloth is washed, and then worked backwards and forwards in a stone pit through the bleaching liquor given. When the goods are thoroughly saturated, they may be allowed to remain in the liquor for three to five hours, and then well washed. The cloth should be kept underneath the liquor by throwing a piece of cotton cloth on the surface of the liquid and slightly weighting this with pebbles to force it just under the solution; if this is not done the bleaching will be incomplete where the cloth is exposed to the air.

Bleaching Liquor for Silk.

1 gallon peroxide of hydrogen, 10 vols.,
5 gallons water.
Mix together; and, just before use, add liquor ammonia cautiously until the liquor is slightly alkaline.

Instead of doing this operation in the pit, as described, the bleaching solution may be used stronger—using a less quantity of water—and applied to the cloth on the slop-padding machine, passing the goods in the open width through the liquor twice. After the pieces have been padded, they are wound on to cloth-covered wooden rollers or centres, covered up with damp (not wet) cloths, and allowed to lie for about five hours, afterwards being washed as before.

Pieces which have been bleached are prepared exactly as described above before printing.

Printing the Patterns.—The printing of the patterns is done, principally by hand, by means of blocks having the patterns engraved upon them in relief; hence, it is called "block printing" (see p. 41). The printing machine, so largely used for printing upon cotton and woollen goods, although used to a certain extent for silk, takes a second place in this kind of work, probably on account of the fact that very much shorter runs (smaller quantities for one colouring) are usual with silk than in the case of cotton goods, and that in printing with the machine upon silk there is a far greater tendency for the colours to "streak" or "smear" than with the other fibres; and, as the colours can rarely be effectively discharged, there is a larger proportion of spoiled pieces. The process of block printing is described on p. 41, and it will only be necessary for us to make a remark concerning it. For "heavy" silks no difficulty will be found to arise when the pieces are merely stretched across the printing table and impressed with the colours from the blocks (as described); but, in the case of very fine, light, or "gauzy" silk tissues, it will be found that the fibre adheres to the colour block after impression, and causes the piece to become disarranged. In order to overcome this difficulty such tissues are, before printing, attached by means of starch paste to a piece of madder bleached calico, and this calico accompanies it throughout all the various operations until it is washed, when the starch is washed away and the two pieces become separated.

Styles of Silk Printing.—There are practically only three styles of silk printing, the principal one being the "steam style," and the other two, which are used to a much more limited extent, are known as the "reserve" and "discharge" styles respectively.

The steam style is practically the same in the nature of the colouring-matters, the composition of the mixtures used for printing and treatment after printing as used for woollen goods; we, therefore, refer the reader to that section of our work for fuller details with regard to the shades obtainable and method of treating the goods after printing. At the same time, we will give a number of recipes specially suited for silk printing made from artificial and natural dyestuffs, the latter kind being used to a far larger extent in silk printing than for woollen goods, owing, no doubt, to the more conservative nature of silk printers generally rather than to any superiority of the colours themselves.

Printing Colours for Silk.—Steam Style.

No. 1.—Black.

2 gallons logwood liquor, 14° Tw.,
1 lb. starch,
3½ lbs. British gum.
Boil; cool; and add
1¼ lbs. nitrate of copper, 80° Tw.,
1 lb. nitrate of iron, 80 Tw.

No. 2.—Black.

1 lb. acid blue black B (Leonhardt),
1 gallon water.
Dissolve; and mix with
2 gallons British gum solution (10 lbs. per gallon),
3 lbs. oxalic acid.

There is quite a large number of acid blacks now made by the various colour manufacturers, all of which may be used upon silk in a similar manner to the above colour; they vary in shade from a reddish-black to bluish-black.

No. 3.—Grey.

1 lb. new fast grey (F. B. & Co.),
2¾ gallons water,
3 quarts acetic acid, 8° Tw.
Dissolve; and add to
6½ gallons dextrine thickening.

No. 4.—Violet.

8 ozs. acid violet,
1 gallon hot water.
Dissolve; and add
2½ gallons dextrine thickening (12 lbs. per gallon),
2 pints saturated solution of alum.

The acid violets range in shade from a very red shade of violet to bluish-violet, thus enabling us to obtain a large number of shades. They are practically fast to light and washing.

No. 5.—Violet.

2 lbs. azo acid violet (F. B. & Co.),
2¾ gallons water,
3 quarts acetic acid, 8° Tw.
Dissolve; and thicken with
6⅛ gallons dextrine thickening.

No. 6.—Violet.

1 lb. formyl violet, S 4 B (Cassella),
1⅛ gallons water,
8 lbs. dextrine,
1⅛ lbs. acetic acid, 8° Tw.

No. 7.—Blue.

2¾ lbs. indigo extract paste,
¾ lb. tartaric acid,
1 gallon water.
Dissolve; then add
5 lbs. ground gum Senegal.
Dissolve; and add
⅛ lb. alum.

No. 8.—Blue.

6 lbs. yellow prussiate of potash,
2¾ lbs. tartaric acid,
2 gallons water.
Dissolve; cool; and thicken with
14 lbs. ground gum Senegal.
Then add
5 lbs. oxymuriate of tin, 80° Tw.

No. 9.—Blue.

2 lbs. fast acid blue B (F. B. & Co.),
7 gallons water,
25 lbs. British gum.
Boil; cool; and add
2 lbs. vitriol, 15° Tw.

No. 10.—Blue.

1½ lbs. silk blue B E S,
5 quarts water,
3 pints acetic acid, 12° Tw.
Dissolve; and add to
3¼ gallons dextrine thickening.

No. 11.—Blue.

1⅓ lbs. induline 6B,
12 lbs. British gum,
3 gallons water,
3 pints acetic acid, 8° Tw.
Boil well; and cool.

The finest shades of blue are produced from the artificial colouring-matters; other recipes for these will be found under *Wool Printing*.

No. 12.—Green.

3 gallons Persian berry liquor, 12° Tw.,
6 lbs. Senegal gum.
Dissolve; and add
1½ lbs. indigo extract paste,
3 ozs. tartaric acid,
6 ozs. oxymuriate of tin, 80° Tw.

No. 13.—Green.

½ lb. solid green,
2 quarts acetic acid, 12° Tw.,
2 quarts water.
Dissolve; and thicken with
3 gallons dextrine thickening (10 lbs. per gallon).

No. 14.—Green.

1 lb. acid green B,
1 gallon water,
2¾ gallons dextrine thickening,
3 lbs. oxalic acid.

No. 15.—Yellow.

3 gallons Persian berry liquor, 10° Tw.,
1 lb. alum,
8 lbs. gum Senegal,
1½ lbs. tin salts (stannous chloride).

No. 16.—Yellow.

1½ lbs. naphthol yellow S,
3 gallons water,
12 lbs. British gum.
Boil; and add
2 quarts acetic acid, 12° Tw.

No. 17.—Pink.

2 gallons sapan wood liquor, 8° Tw.,
6¼ lbs. gum Senegal,
½ lb. oxymuriate of tin.

No. 18.—Cochineal Red.

5 quarts cochineal liquor, 8° Tw.,
4¾ lbs. gum,
½ lb. tin crystals,
¾ lb. oxalic acid.
When dissolved, add
¼ lb. perchloride of tin.

No. 19.—Red.

2 lbs. fast red N S (F. B. & Co.),
3 gallons water,
3 quarts acetic acid, 12° Tw.
Dissolve; and add to
6 gallons dextrine thickening.

No. 20.—Orange.

3 lbs. annatto,
3 quarts water,
1 lb. potash.
Boil; allow to cool; and add
½ lb. starch,
1 lb. gum.
Boil until thickened; then cool.

No. 21.—Orange.

2 lbs. orange 11 B,
2½ gallons water.
Dissolve; and add to
6½ gallons dextrine thickening (14 lbs. per gallon).
Then add
3 quarts acetic acid, 8° Tw.

No. 22.—Brown.

2 quarts peachwood liquor, 26° Tw.,
1¼ quarts logwood liquor, 30° Tw.,
1¼ quarts bark liquor, 30° Tw.,
3 quarts acetate of alumina, 18° Tw.
Mix; then add
2¼ lbs. verdigris,
1 lb. cream of tartar,
1 quart water.
Then add
14 quarts gum water (1 in 2½).

Recipes 18, 20, and 22 have been taken from *A Hand-book of Silk Dyeing and Printing*, by G. H. Hurst, F.C.S.

Reserve Style.—Reserves upon silk goods are very difficult to do well, the best reserve in general use being a wax reserve or resist, which resists the colour when the goods are dyed in a cold dyeing liquor. The following extract from a paper by Horace Koechlin * summarises the matter very tersely, and we cannot do better than reproduce his remarks :—

"**Mastic Reserve.**—This was not used, except in block printing, until, in 1880, a Lyons firm began to make a roller with very deep lines which allowed plenty of colour to be deposited on the tissue. It is prepared with :—

6,000 grammes American resin,
1,500 grammes tar,
1,200 grammes yellow wax,
800 grammes stearine,
6 to 10 litres paraffin.

"After printing, the goods are powdered to prevent marking off, then hung in a warm place. They are dyed to shade in a cold bath of

* A communication to the Mulhouse Society taken from *The Dyer and Calico Printer*, April 20, 1894.

an aniline colour, adding dyestuff as necessary. This operation takes from two to four hours, after which they are dried and passed through benzine to dissolve the reserve. To fix the colour better the cloth should be steamed after the benzine bath.

"For black, the goods are mordanted in a rust bath (nitro-sulphate of iron) and dyed in logwood in the same manner as for cotton. This is the time-honoured procedure at Lyons. The metallic oxides have a strong affinity for silk, and it is easy to mordant it after printing with the mastic reserve. It can be padded, either in acetate of alumina, acetate of chrome, or pyrolignite of iron, dried, passed through a chalk bath, washed, and dyed in a soap bath with alizarine blue at 80° C.

"A dark blue can be got as follows :—

"The tissue being printed with the mastic is padded in pyrolignite diluted with two or three vols. of water; dried, passed through the chalk bath, and dyed with 80° C. with—

15 grammes alizarine blue (Bayer),
2 grammes soda crystals,
10 grammes soap,
1 gramme bisulphite of soda,
1 gramme caustic soda,
2½ litres water (for every metre).

Wash and soap twice at from 50° to 60° C.

"**Tin and Zinc Reserves and Discharges.**—The printing is done with either acetate of tin or hydrosulphite of zinc. It is easy to colour these reserves with methylene blue, phosphine, safranine, &c. The cloth is padded with the tetrazo colouring-matters, steamed and washed. The same salts can be used as discharges on tissues dyed with the tetrazo colours. For instance, to get a white on a diamine blue ground print with—

1 litre thickening,
1 kilo. zinc,
¼ litre bisulphite of soda.

"**Tartar Emetic Reserve on Tannin Colours.**—Koechlin, for block printing, uses emetic reserves to which he adds the aniline colours.

White.

100 grammes tartar emetic,
1,000 grammes gum,
⅛ litre tin oxide in paste,
½ litre acetate of magnesia,
100 grammes sulphate of zinc,
¼ litre acetic acid.

Red.

1 litre as for white,
20 grammes rhodamine extra B,
10 grammes phosphine.

"Blue is done with night blue, olive with a mixture of blue and phosphine.

"The tannin colours are padded on with a one-colour machine with an impression not giving too much colour.

Blue.

1 litre thickening T,
10 grammes violet 145,
10 grammes malachite green.

Thickening T.

100 grammes tannin,
¾ litre gum,
⅛ litre acetine,
¼ litre acetic acid,
25 grammes tartaric acid.

"Black is got with the blue printing colour, with phosphine added. After padding, the goods are steamed and washed. To make the colours faster, an emetic bath may be given (as for cotton). It is absolutely necessary, in order to make the reserve act well, to add plenty of tannin to the colour padded on; 100 grammes a litre at least are necessary.

"The tannin colours are fixed very well on silk by steaming. They are not fixed well in dyeing. Silk mordanted with tannate of antimony dyes very badly. M. Auguste Romann takes advantage of these two facts to produce a red and blue style. He prints with methylene blue and tannin, passes through emetic after steaming, and dyes cold with ponceau 2R. The printed parts remain blue, the ground alone is dyed with the red. This property of tannined silk to take dye badly is used in dyeing two colours on mixed silk and cotton goods. It is a delicate operation."

The substantive colours can be used for printing silk in the steam style, and for this purpose the printing colours are prepared with the same assistants, &c., as for cotton (see p. 137), but an easily removable thickening, like dextrine, should be used. The thickening material should be of such a nature as to leave the fibre by simple washing alone, or, at least, by lightly soaping in cold or lukewarm soap solutions.

Silk pieces dyed with the substantive colours may be printed with either the tin or zinc-dust discharges mentioned on p. 210, and thus white patterns upon coloured grounds will be obtained; by using dyestuffs along with the discharging substances that will dye upon silk, and at the same time themselves resist the action of tin or zinc-dust respectively, coloured discharges are produced. The preparation of these colours will be found described on p. 212.

The alizarine and mordant colours generally are used for silk printing to a small extent. The printing colours prepared with this class of dyestuffs are thickened with dextrine, and they are employed along with either a tin, chrome, or alumina mordant; for tin mordant, a mixture of tin crystals or acetate of tin along with tartaric acid is used; for chrome, chrome alum and tartaric acid, or tartar, or bisulphate of soda; for alumina, alum and oxalic acid.

SECTION II.

THE PRINTING OF HALF-SILK TISSUES.

THE fabric known as "half-silk" is composed of silk and cotton; owing to the different properties of these two fibres, the methods by which it is possible to obtain even prints upon a fabric of this kind are few.

Practically, there is only one style that can be, or is on the large scale, used, and this is exactly the same in principle to that used for printing with the basic aniline colours upon cotton. The printing colours are made up in exactly the same way, with the exception that dextrine is employed for thickening the colours—because this thickening washes away readily and leaves the tissue soft to the touch—and the subsequent treatment of the printed cloth is precisely the same as for cotton.

Frequently the passage through the fixing solution of tartar emetic and chalk is omitted, as the colours are, as a general rule, fixed sufficiently by steaming alone.

Where it is found that washing does not completely remove the thickening from the cloth, and, consequently, the tissue, after drying, is too stiff on the parts printed, the cloth should be placed in a weak infusion of malt, at about 160° F., for some hours, and then well washed and dried.

Patterns Nos. 69 to 78 show some of the shades obtainable with basic colouring-matters upon half-silk; they are all printed from a printing colour containing tannic acid, the cloth, after printing and drying, being steamed and treated as described above. For fuller details with regard to the preparation of printing colours in *Basic Colouring-Matters* see p. 122.

PATTERN No. 69.

This colour has been printed with cotton blue 4B from a printing colour prepared with about the following proportions of ingredients:—

Cotton Blue.

1 lb. cotton blue 4B (A. L. & Co.),
½ gallon acetic acid, 8° Tw.,
3½ gallons water.
Dissolve; and add
5 gallons thickening.
Boil; and add
5 lbs. tannic acid,
½ gallon acetic acid, 8° Tw.

PATTERN No. 70.

Printing Colour.

7½ parts brilliant green crystals (F. B. & Co.),
7½ parts auramine II. (F. B. & Co.),
195 parts water,
100 parts acetic acid, 9° Tw.
Dissolve; and add
600 parts dextrine thickening (10 lbs. per gallon);
Then add
45 parts tannic acid,
45 parts acetic acid, 9° Tw.

The pieces, after printing, were steamed for an hour without pressure, fixed in tartar emetic, washed, and dried.

PATTERN No. 71.

Red.

4 lbs. red A 498 (A. L. & Co.),
½ gallon acetic acid, 8° Tw.,
3 gallons water.
Dissolve; and add
5 gallons thickening.
Boil; and add
8 lbs. tannic acid,
1 gallon acetic acid 6° Tw.

PATTERN No. 72.

Pyronine.

1½ lbs. pyronine G,
½ gallon acetic acid, 8° Tw.,
3½ gallons water.
Dissolve; and add
5 gallons thickening.
Boil; and add
7 lbs. tannic acid,
½ gallon acetic acid, 8° Tw.

PATTERN No. 73.

Yellow.

2 lbs. auramine II. (A. L. & Co.),
2½ gallons acetic acid, 8° Tw.,
1½ gallons water.
Dissolve; and add
5 gallons thickening.
Boil; and add
8 lbs. tannic acid,
½ gallon acetic acid, 8° Tw.

PATTERN No. 74.

Orange.

½ lb. acridine orange extra,
1 pint acetic acid, 8° Tw.,
7 pints water,
1¼ gallons thickening,
2¼ lbs. tannic acid,
1 pint acetic acid, 8° Tw.

PATTERN No. 75.

Brown.

This colour was prepared like that used for pattern No. 74, using Bismarck brown crystals (A. L. & Co.) instead of acridine orange extra.

PATTERN No. 76.

Bordeaux.

This has been printed from a colour containing 2 per cent. of Bordeaux (A. L. & Co.).

PATTERN No. 77.

Black.

Printed with 8 per cent. neutral black (A. L. & Co.) in the printing colour.

PATTERN No. 78.

Green.

¾ lb. brilliant green crystals (A. L. & Co.),
1 quart acetic acid, 8° Tw.,
1¾ gallons water.
Dissolve; and add
2¼ gallons thickening.
Boil; and add
2¼ lbs. tannic acid,
1 quart acetic acid, 8° Tw.

Half-silk goods are usually steamed in the cottage steamer, some of the iron plates at the top being removed, and the holes so formed covered over with two layers of blanket.

Half-silk pieces which have been dyed with the substantive dyestuffs can be discharged with the tin and zinc-dust discharges, as used for cotton piece goods, both for white and coloured discharges.

PART VI.

PRACTICAL RECIPES USED IN PRINTING.

Some of the following recipes are illustrated with patterns. Where this is the case the number of the pattern is given in each case for reference.

In the following recipes the quantities of each ingredient has been calculated for the volume of the finished colour given, but in the daily practice of a colour shop it is usual to prepare certain stock or standard printing colours, which are used, not only as self-colours, but also to prepare the many shades required by mixing these standard colours in various proportions; hence, although many of the colours in the following recipes appear of a very complicated nature, their preparation in the works is of a much simpler character than would appear at first sight. This method of giving recipes has been adopted to make each recipe complete in itself, and to avoid the necessity of repeated reference.

SECTION I.

COTTON.

Recipes for the Pigment Style.

Bright Blue.

½ pint chrome green paste,
2½ lbs. china blue,
2 gallons gum tragacanth thickening (4 ozs. per gallon),
¾ gallon blood albumen thickening.

Dark Blue.

17 lbs. ultramarine blue,
1 gallon water,
1 pint Gallipoli or cotton-seed oil,
3 quarts indigo paste, 25 per cent.,
13 gallons blood albumen thickening.

Blue.

¼ oz. lampblack,
1 noggin glycerine,
2 lbs. china blue,
3 noggins glycerine,
1½ gallons gum dragon thickening,
½ gallon blood albumen thickening.

Rose.

In this case the colour is not obtained from an insoluble pigment, but from erythrosine, one of the resorcine series of dyes. These colours have an affinity for albumen, and when mixed with albumen thickening, printed and steamed, they attach themselves to the coagulated albumen and thus become bound to the cloth. All the resorcine series of dyes can be printed in this way, but they are very fugitive to light :—

4 ozs. erythrosine,
1 quart water,
3 quarts albumen thickening.

Dissolve the erythrosine in the water, and then add the thickening.

Purple.

¾ lb. ultramarine red,
2 lbs. ultramarine violet,
1½ gallons gum tragacanth thickening,
½ gallon blood albumen thickening.

Claret.

1 gallon pigment green, 30 per cent. paste,
2 gallons pigment orange, 60 per cent. paste,
1 quart methyl violet solution (6 ozs. per gallon),
1 gallon albumen thickening,
1 gallon tragacanth thickening.

Stone.

1 lb. lampblack,
2 lbs. dark ultramarine blue,
2 lbs. light ultramarine blue,
8 gallons blood albumen thickening.

Steam Style.

The following colours are printed upon oleine-prepared cloth, steamed for an hour, and passed through the open soaper :—

Black.

3 gallons logwood liquor,
1½ gallons bark liquor,
7 gallons acetic acid, 4° Tw.,
1 lb. chlorate of potash,
9 lbs. starch.
Boil ; and add
1 gallon acetate of chrome, 28° Tw.

Brown.

1 gallon berry liquor, 3° Tw.,
½ gallon peachwood liquor, 8° Tw.,
1 noggin logwood liquor, 8° Tw.,
1½ lbs. nitrate of copper,
1½ lbs. alum.
1½ lbs. starch.

Brown.

5 gallons water,
2 gallons acetic acid, 8° Tw.,
1½ gallons orange alizarine, 15 per cent.,
3 gallons bark liquor, 13° Tw.,
1 gallon tragacanth thickening,
18 lbs. starch.
Boil; cool; and add
1 gallon acetate of lime, 20° Tw.,
1½ gallons acetate of chrome, 20° Tw.

Chocolate.

3 gallons logwood liquor, 12° Tw.,
2 gallons sapan wood liquor, 12° Tw.,
1 gallon nitrate of alumina liquor,
½ gallon bark liquor, 12° Tw.,
4 gallons water,
17 lbs. starch.
Boil; and add
½ lb. chlorate of potash,
2½ lbs. red prussiate of potash.

Chocolate.

2 gallons bark liquor, 16° Tw.,
3 gallons water,
1 gallon tragacanth thickening,
1½ gallons acetic acid, 12° Tw.,
3¼ gallons alizarine (blue shade),
14 lbs. starch.
Boil; cool; and add
3 gallons acetate of chrome,
1½ gallons acetate of lime,
2 lbs. red prussiate of potash.

Claret.

1 gallon water,
3 lbs. starch,
3 pints acetic acid, 12° Tw.,
3 lbs. bark liquor, 30° Tw.,
1½ pints colour oil,
2½ pints tragacanth thickening.
Boil; and add
1¼ gallons alizarine, 20 per cent.
Cool; and add
1 gallon acetate of chrome, 28° Tw.

Drab.

2 gallons logwood liquor, 14° Tw.,
1 gallon acetic acid, 8° Tw.,
1 gallon common red liquor, 14° Tw.,
1 gallon bark liquor, 16° Tw.,
1 gallon acetate chrome, 20° Tw.

Green.

4½ lbs. tannic acid,
¾ gallon acetic acid, 8° Tw.,
¾ gallon water.
Dissolve; and add
6¾ gallons water,
7 pints Persian berry extract, 32° Tw.,
7 pints common red liquor,
10½ lbs. starch.
Boil; and add
9¼ ozs. brilliant green crystals.

Print on oleine-prepared cloth, steam, fix, and soap, or soap only, according to the treatment required for the other colours on the cloth.

Green.

5 gills water,
2 gills berry extract, 35° Tw.,
1 gill acetic acid, 8° Tw.,
½ oz. brilliant green,
¾ lb. starch,
4 ozs. tannic acid.
Boil; cool; and add
4 ozs. citric acid,
1 gill acetate of chrome, 23° Tw.

Olive.

1½ gallons water,
1⅙ lbs. starch,
1 quart Persian berry extract, 48° Tw.,
1 pint logwood extract, 46° Tw.,
1 noggin colour oil.
Boil; cool; and add
1 quart acetate of chrome, 28° Tw.

Scarlet.

5 gallons gum Arabic thickening,
1¾ gallons orange alizarine, 15 per cent.,
1½ gallons alizarine, 20 per cent., blue shade,
1 gallon sulphocyanide alumina,
½ gallon acetate of lime, 30° Tw.,
½ gallon acetate of tin.

Slate.

4⅛ gallons Senegal thickening,
1½ gallons wood acid (pyroligneous),
4 gallons gall liquor, 16° Tw.,
Mix; and add
1 gallon iron muriate, 60° Tw.,
8 gallons water.

Yellow.

5 pints Persian berry extract, 56° Tw.,
3 pints water,
2 pints acetic acid, 8° Tw.,
2 ozs. tin crystals,
1 lb. starch.
Boil; cool; and add
½ noggin acetate of chrome, 20° Tw.,
½ noggin sulphocyanide of alumina, 20° Tw.

All the following recipes contain basic colouring-matters, and, after the pieces have been printed and steamed, they must be fixed with tartar emetic.

Blue.

5 pints acetic acid, 6° Tw.,
1¼ lbs. starch,
2 ozs. naphthylene blue G,
1 oz. methylene blue.
Boil; and add
1 lb. tannic acid,
1 oz. tartaric acid dissolved in
½ pint acetic acid, 8° Tw.

Blue.

1 gallon acetic acid, 12° Tw.,
5 ozs. methyl violet (blue shade),
4 ozs. brilliant green,
1½ lbs. starch.
Boil; and add
2 lbs. tannic acid,
1 quart acetic acid, 12° Tw.
Then add
1¼ gallons gum tragacanth thickening.

Medium Blue.

4 lbs. 6½ ozs. new blue extra F (Cassella),
3 lbs. new methylene blue GB,
4 gallons water,
½ gallon acetic acid, 9° Tw.,
8 gallons thickening.
Boil; cool; and add
10 lbs. tannic acid dissolved in
¾ gallon acetic acid, 9° Tw.,
½ gallon glycerine.

Blue.

32 lbs. starch,
10 gallons water,
6 gallons acetic acid, 8° Tw.,
3 lbs. brilliant green,
3 lbs. methyl violet (blue shade).
Boil; and add
32 lbs. tannic acid,
6 gallons acetic acid, 8° Tw.

Blue.

1 lb. brilliant green,
¾ lb. marine blue B,
1½ gallons acetic acid, 8° Tw.
Dissolve; and add
6 gallons water,
10 lbs. starch.
Boil; and add
4 lbs. tannic acid,
½ gallon acetic acid, 8° Tw.

Blue.

4 ozs. marine blue B,
4 ozs. marine blue R,
1 oz. methyl violet B,
5 ozs. brilliant green,
3 gallons water,
5 lbs. starch,
7 pints acetic acid, 8° Tw.
Boil; cool; and add
3½ lbs. tannic acid,
1 quart acetic acid, 8° Tw.,
2 ozs. tartaric acid.

Yellowish-Brown.

1½ lbs. aniline yellow (Cassella),
½ gallon acetic acid, 8° Tw.,
2 gallons water.
Dissolve; and add
6 gallons starch thickening.
Boil; then add
5 lbs. tannic acid,
½ gallon acetic acid, 8° Tw.
Cool; and strain.

Green.

5 gallons water,
4 gallons sumach extract,
2 gallons acetic acid, 8° Tw.,
8 lbs. tannic acid,
14 lbs. starch.
Boil; and add
1½ lbs. auramine,
1 lb. brilliant green.

Dyed Style.

The following proportions of dyestuffs are merely relative, and the exact quantity used must be regulated by the area of the cloth covered with mordants, the strength of the latter, and the weight of the cloth used. In all cases, the usual proportions of glue size, and chalk must also be added :—

Dye for Chocolate.

1½ lbs. alizarine,
¾ lb. peachwood,
½ lb. sumach.

Chocolate.

1 lb. chalk,
3 lbs. logwood,
12 lbs. prepared bark,
4 lbs. sumach,
1 lb. alizarine (yellow shade).

Chocolate.

5 lbs. alizarine,
15 lbs. sumach,
60 lbs. prepared bark.

The following numbers refer to the patterns in Part VII., the particulars of the production of which will not be found in the other parts of the book :—

No. 79.—Claret and Yellow on Cotton.

The blotch colour consisted of :—

Claret.—1⅓ lbs. cerise Ia (Cassella),
2¼ gallons acetic acid, 9° Tw.,
3 gallons water,
1 lb. glycerine.
Dissolve at the boil ; and add
4 gallons thickening.
Boil ; and, when cold, add
7 lbs. tannic acid,
¾ gallon acetic acid, 9° Tw.

Yellow.— 3 lbs. diamine fast yellow A,
1¼ gallons water,
10 gallons thickening.
Boil ; and, when cold, add
1 gallon acetate of chrome, 28° Tw.

The cloth should first be prepared with oleine, printed, steamed, fixed, and soaped.

No. 80.—Blue on Cotton.

The printing colour was composed of
4 lbs. 6½ ozs. new blue B (Cassella),
3 lbs. new methylene blue GB,
4 gallons water,
½ gallon acetic acid, 9° Tw.,
8 gallons thickening.
Boil ; cool ; and add
10 lbs. tannic acid.
Previously dissolved in
¾ gallon acetic acid, 9° Tw.,
½ gallon glycerine.

Print the colour upon oleine-prepared cloth, steam, fix, and soap.

No. 81.—Dark Blue and Bright Green on Cotton.

Blotch Colour.—3 lbs. 11 ozs. new blue R (Cassella),
⅛ lb. new methylene blue N,
¼ lb. methyl violet BB 720,
3 gallons water,
1 gallon acetic acid, 9° Tw.,
1 lb. glycerine,
½ lb. tartaric acid,
3 gallons thickening.
Boil; cool; and add
14 lbs. tannic acid,
2 gallons acetic acid, 9° Tw.

Bright Green.—This colour was made by mixing
1 gallon printing colour A,
2 gallons printing colour B,
as given below:—

Printing Colour A.
1 lb. brilliant green crystals extra,
2 gallons water,
2 gallons acetic acid, 9° Tw.,
¾ gallon glycerine,
5 gallons thickening.
Boil; cool; and add
4 lbs. tannic acid,
18½ noggins acetic acid, 9° Tw.

Printing Colour B.
3 lbs. thioflavine T,
1 gallon acetic acid, 9° Tw.
7¾ gallons thickening.
Boil; cool; and add
6 lbs. tannic acid,
18½ noggins acetic acid, 9° Tw.

Oleine-prepared cloth should be used, and the printed tissue treated in the usual way for tannic colours.

No. 82.

The cloth, in this case, has been printed with the two colours given below:—

Light Violet.
2 lbs. fast neutral violet B paste,
¾ gallon water,
½ gallon acetic acid, 9° Tw.,
6 gallons thickening,
½ lb. tartaric acid.
Boil; cool; and add
1½ lbs. tannic acid,
32 ozs. acetic acid, 9° Tw.

Dark Violet.
16 lbs. fast neutral violet B paste,
1½ gallons water,
1 gallon acetic acid, 9° Tw.,
1 lb. glycerine,
1 lb. tartaric acid,
3 gallons thickening.
Boil; cool; and add
14 lbs. tannic acid,
1 gallon 7 noggins acetic acid, 9° Tw.

No. 83.—Dark Blue and Orange on Cotton.

Dark Blue.—This is the same colour as used for pattern No. 8 .

Orange.—This is produced with tannin orange (Cassella), the following recipe being used:—

1 lb. 3½ ozs. tannin orange R paste,
2 gallons water,
24 ozs. acetic acid, 9° Tw.
Dissolve at the boil; and add
½ gallon thickening.
Boil; cool; and add
2 lbs. tannic acid,
32 ozs. acetic acid, 9° Tw.

Printed on oleine-prepared cloth, steamed, fixed, and soaped.

No. 84.—Bright Blue and Yellow on Cotton.

The two following colours were printed upon oleine-prepared cloth, and treated as usual for basic colours:—

Blue.

1 lb. new methylene blue GG,
1½ gallons water,
29 noggins acetic acid, 9° Tw.,
½ gallon glycerine.
Boil; and add
6 gallons British gum thickening.
Cool; and add
5 lbs. tannic acid,
½ gallon acetic acid, 9° Tw.

Yellow.

2½ lbs. anthracene yellow BN,
1½ gallons water,
3 gallons thickening.
Boil; cool; and add
5 pints acetate of chrome, 28° Tw.

No. 85.—This pattern has been mixed with gambine Y mixed with red prussiate of potash on oleine-prepared cloth, steamed, and soaped.

Printing Colour.

6½ gallons starch paste,
2½ lbs. gambine Y paste (R.H. & S.),
5 lbs. red prussiate in fine powder.

The yellow is converted into a myrtle shade by the formation of some Prussian blue by decomposition of some of the red prussiate.

No. 86.—Black upon Dyed Cloth.

The cloth was first dyed in a bath containing, for every 100 lbs. of cloth,

½ lb. diamine gold,
2 lbs. diamine black B O,
¾ lb. diamine red F.

After dyeing, the pieces were dried, and printed with a colour prepared from reduced black, steamed, and washed.

No. 87.—Russian Red.

The printing colour was composed of a mixture of Russian red B and cutch, prepared by mixing together (in the proportions given) the two standard colours named below. After printing, the pieces are steamed, fixed, and soaped; or they may be soaped or washed only.

Standard Colour A.

4 lbs. Russian red B (Cassella),
1¼ gallons acetic acid, 9° Tw.,
1¼ gallons water,
2½ gallons gum tragacanth thickening.

Printing Colour.

2 gallons standard colour A,
1 gallon standard colour B.

Standard Colour B.

25 lbs. cutch,
2½ gallons acetic acid, 9° Tw.,
6¼ gallons water.
Dissolve; and add
16 lbs. starch,
2 gallons water,
½ gallon oleine.
Boil well; cool to 104° F.; and add
2½ lbs. chlorate of soda,
1 gallon acetate of chrome, 28° Tw.

No. 88.—Bright Green on Cotton.

The shade is obtained by mixing together printing colours prepared from the two basic colouring-matters, new methylene blue G G and thioflavine T. The colour is printed upon oleine-prepared cloth, steamed, fixed, and soaped.

No. 89.—Dark Blue on Cotton.

Obtained, in this case, from the basic colouring-matter sold under the name of printing blue H paste, shaded with new methylene blue and methyl violet. The pieces, after printing, should be treated as is usual for tannic colours.

Printing Colour.

11 lbs. printing blue H paste,
1 lb. new methylene blue N,
½ lb. methyl violet, B B 720,
½ gallon water,
1 gallon acetic acid, 10° Tw.,
2½ lbs. glycerine.
Dissolve at the boil; and add
2 gallons starch thickening.
Boil; and add
4 ozs. tartaric acid, in powder.
Cool; and add
7 lbs. tannic acid,
7 lbs. acetic acid, 10° Tw.

Pattern No. 90.—The cloth, previously prepared with oleine, was printed with a colour prepared as below, steamed, fixed with tartar emetic, and finished in the ordinary way.

Indazine M.

500 grammes indazine M (Cassella),
2 litres water,
1 litre acetic acid, 9° Tw.,
1/10 litre glycerine.
Dissolve; then add
3½ litres thickening.
Boil; cool; and add
1,500 grammes tannic acid, dissolved in
1,500 c.cm. acetic acid.

No. 91.—This three-colour pattern has been printed from colours prepared from the following dyestuffs :—

Pale Blue.—From a mixture of diamine sky-blue and diamine green B, using sulphate of soda as the assistant.

Heliotrope.—Diamine violet N and diamine sky-blue, with the addition of phosphate of soda.

No. 92.—Three-Colour Pattern on Cotton.

This pattern illustrates the application of the new substantive colours to calico printing. The two shades of red have been obtained from diamine fast red F, for the dark shade; and diamine fast red F with diamine gold, for the pale red. The black is aniline black. All the diamine colours are made by Cassella & Co.

No. 93.—Seven-Colour Pattern on Calico.

Red—Alizarine red.
Yellow—Diamine gold.
Cream—Diamine gold and diamine bronze G.
Dark Olive—Diamine fast yellow A, diamine bronze G, and diamine sky-blue.
Light Olive—Diamine fast yellow A and diamine sky-blue.
Brown—Diamine fast yellow A, diamine bronze G, and diamine fast red F.
Light Blue—Diamine sky-blue.

This is a good example of the use of direct dyeing colours, all the shades (with the exception of the red) being done with them.

No. 94.—Seven-Colour Pattern on Cotton.

All the shades in this pattern are produced with substantive dyes, with the exception of the red, which is steam alizarine red.

No. 95.—Three-Colour Pattern on Cotton.

Dark Brown—Alizarine steam brown.
Light Brown—Obtained by using a mixture of substantive colours.
Red—Diamine fast red F.

No. 96.—Four-Colour Pattern on Cotton.

Red—Steam alizarine red.
Dark Blue—Steam alizarine Blue S, with chrome.
Medium Blue—Diamine sky-blue.
Pale Blue—Diamine sky-blue.

No. 97.—Black and Grey on Cotton.

Grey—Diamine black BH.
Black—Aniline black.

Nos. 98 and 99.—Eight- and Six-Colour Patterns on Cotton.

These patterns are printed, with the single exception of the dark brown shade, with the direct cotton colours. We are indebted to Messrs. L. Cassella & Co. for this and many of the other patterns illustrating the use of this class of dyes, patterns Nos. 100 to 109 showing their use along with some of the older colours. These patterns have been printed with the colours mentioned below :—

Pattern No. 100.—Three-colour effect produced with

Violet—Diamine violet N, diamine sky-blue.

Yellow—Diamine fast yellow, bronze G, and fast red.

Brown—Alizarine.

Pattern No. 101.—

Grey—Diamine black BH.

Blue—Diamine sky-blue.

Yellow—Diamine gold.

Brown—Diamine bronze G, gold, fast red F.

Prune—Alizarine.

Black—Steam black.

Pattern No. 102.—The cloth was first dyed with ½ per cent. of diamine yellow N, dried, and then printed with

Red—Alizarine red with acetate of tin.

Brown—Alizarine claret.

Pattern No. 103.—Dyed first with

2 per cent. thioflavine S.

¾ per cent. cotton brown N.

¼ per cent. diamine bronze G.

Then printed with

Yellow—Zinc dust discharge.

Green—Tin discharge with Persian berries and brilliant green crystals extra.

Brown—Alizarine Bordeaux.

Pattern No 104.—Dyed with

1 per cent. diamine sky-blue.

Printed with

White—Zinc-dust discharge.

Black—Reduced black.

Pattern No. 105.—The cloth was first dyed with ½ per cent. diamine violet N, and then printed as No. 104.

Pattern No. 106.—Dyed with

1 per cent. diamine green B.

Printed with

Buff—Tin discharge, Persian berries, alizarine red.

Brown—Alizarine Bordeaux.

Pattern No. 107.—Dyed with

2 per cent. diamine bronze G.

Printed with

Pink—Tin discharge, rose Bengale N extra.

Black—Reduced black.

Pattern No. 108.

Dark Brown—Cotton brown N, diamine gold.

Light Brown—Same mixture reduced.

Black—Aniline black.

Pattern No. 109.—Dyed with

2 per cent. cotton brown N.

2 per cent. diamine bronze G.

Printed with

Tin discharge.

SECTION II.

WOOL.

Black.

3 lbs. diamond black F (F. B. & Co.),
3 lbs. diamond green,
¼ lb. chrysophenine,
30 lbs. British gum,
6¼ gallons water.

Print on chlored wool, steam an hour without pressure, and wash.

Blue.

1 lb. 4 ozs. azine blue (F. B. & Co.),
2¼ lbs. dextrine,
2¼ pints water,
5 ozs. acetate of soda,
3 ozs. tartaric acid.

Dark Navy Blue.

1 lb. chromotrop 6B,
6 ozs. patent blue,
2½ lbs. sulphate of alumina,
1 lb. oxalic acid,
5 gallons dextrine thickening.

Navy Blue.

1 lb. fast acid violet 10B (F. B. & Co.),
1 lb. fast acid magenta B,
1 lb. fast green,
6 gallons water,
3 quarts acetic acid, 8° Tw.,
30 lbs. British gum.

This colour should be printed on wool strongly prepared with chlorine and tin, and steamed, after well hanging in a damp place.

Claret.

¾ lb. acid violet N,
1¼ lbs. orange II,
1 lb. oxalic acid,
5 gallons dextrine thickening.

Olive Green.

3 ozs. fast acid violet 10B,
3 ozs. fast yellow,
1 pint acetic acid, 8° Tw.,
3½ pints water.
Dissolve; then mix with
¾ gallon thick dextrine thickening.

Maroon.

5 ozs. milling red R (Cassella),
2½ ozs. amaranth B (Cassella),
2 pints water,
1¼ lbs. dextrine,
10 ozs. acetic acid, 9° Tw.
Boil; cool; and add
1 pint British gum thickening.

Print on prepared wool, and steam, &c., as usual.

Magenta.

3 lbs. acid magenta,
3 quarts acetic acid, 8° Tw.,
1 lb. tartaric acid,
3 gallons water.
Dissolve; and add
35 lbs. dextrine,
3 gallons water.
Boil well; and cool.

Print on tin-chlorine prepared wool, steam an hour, and wash.

Orange.

3 lbs. croceine orange R,
1 gallon acetic acid, 6° Tw.
Dissolve; and add
6 gallons dextrine thickening.

Pink.

1 lb. eosine S extra blue (F. B. & Co.),
3 quarts acetic acid, 8° Tw.,
½ gallon water,
7 gallons tragacanth thickening.

Dissolve the eosine in the water and acetic acid, then add the thickening. This colour may be printed upon either prepared or unprepared wool, and is steamed and washed as usual. The shade is "fuller" on prepared wool.

Pink.

8 ozs. chromotrop 2R (M. L. & B.),
½ gallon acetic acid, 12° Tw.,
2 ozs. tartaric acid,
4 gallons tragacanth thickening.

Reddish-Violet.

3 lbs. azo acid violet R extra (F. B. & Co.),
3 quarts acetic acid, 9° Tw.,
33 lbs. British gum,
6½ gallons water.

Yellow.

4 gallons best berry liquor, 10° Tw.,
16 lbs. dextrine.
Boil; cool; and add
2 lbs. tin crystals.

Grey.

1 gallon logwood liquor, 6° Tw.,
1 gallon thick dextrine thickening,
10 ozs. nitrate of iron, 80° Tw.

SECTION III.

SILK.

Black.

6 ozs. Victoria black,
2½ lbs. dextrine,
1 noggin acetic acid, 9° Tw.,
3¾ pints water.
Boil; and add
1¼ ozs. tartar,
7 ozs. water.

Blue.

6 ozs. alkali blue,
1 quart water.
Dissolve; and mix with
3 quarts dextrine thickening.

Dark Blue.

3 ozs. gallic indigo S,
1 gallon gum Senegal thickening.

Brown.

4 ozs. Bismarck brown,
½ gallon water,
¾ lb. phosphate of soda,
1 noggin acetic acid, 12° Tw.,
½ gallon thick dextrine thickening.

Pink.

2 gallons dextrine thickening,
2 ozs. rhodamine B,
1½ pints acetic acid, 8° Tw.

Bright Blue.

2 ozs. new Victoria blue B,
3 noggins acetic acid, 12° Tw.,
3 quarts water,
4 lbs. dextrine.

APPENDIX.

USEFUL TABLES.

THERMOMETRIC TABLES,

SHOWING THE ASSIMILATION OF THE THERMOMETERS IN USE THROUGHOUT THE WORLD.

Celsius.	Réaumur.	Fahrenheit.	Celsius.	Réaumur.	Fahrenheit.
100	80·0	212·0	49	39·2	120·2
99	79·2	210·0	48	38·4	118·4
98	78·4	208·4	47	37·6	116·6
97	77·6	206·6	46	36·8	114·8
96	76·8	204·8	45	36·0	113·0
95	76·0	203·0	44	35·2	111·2
94	75·2	201·2	43	34·4	109·4
93	74·4	199·4	42	33·6	107·6
92	73·6	197·6	41	32·8	105·8
91	72·8	195·8	40	32·0	104·0
90	72·0	194·0	39	31·2	102·2
89	71·2	192·2	38	30·4	100·4
88	70·4	190·4	37	29·6	98·6
87	69·6	188·6	36	28·8	96·8
86	68·8	186·8	35	28·0	95·0
85	68·0	185·0	34	27·2	93·2
84	67·2	183·2	33	26·4	91·4
83	66·4	181·4	32	25·6	89·6
82	65·6	179·6	31	24·8	87·8
81	64·8	177·8	30	24·0	86·0
80	64·0	176·0	29	23·2	84·2
79	63·2	174·2	28	22·4	82·4
78	62·4	172·4	27	21·6	80·6
77	61·6	170·6	26	20·8	78·8
76	60·8	168·8	25	20·0	77·0
75	60·0	167·0	24	19·2	75·2
74	59·2	165·2	23	18·4	73·4
73	58·4	163·4	22	17·6	71·6
72	57·6	161·6	21	16·8	69·8
71	56·8	159·8	20	16·0	68·0
70	56·0	158·0	19	15·2	66·2
69	55·2	156·2	18	14·4	64·4
68	54·4	154·4	17	13·6	62·6
67	53·6	152·6	16	12·8	60·8
66	52·8	150·8	15	12·0	59·0
65	52·0	149·0	14	11·2	57·2
64	51·2	147·2	13	10·4	55·4
63	50·4	145·4	12	9·6	53·6
62	49·6	143·6	11	8·8	51·8
61	48·8	141·8	10	8·0	50·0
60	48·0	140·0	9	7·2	48·2
59	47·2	138·2	8	6·4	46·4
58	46·4	136·4	7	5·6	44·6
57	45·6	134·6	6	4·8	42·8
56	44·8	132·8	5	4·0	41·0
55	44·0	131·0	4	3·2	39·2
54	43·2	129·2	3	2·4	37·4
53	42·4	127·4	2	1·6	36·6
52	41·6	125·6	1	0·8	33·8
51	40·8	123·8	0	0·0	32·0
50	40·0	122·0			

METRIC SYSTEM OF WEIGHTS AND MEASURES.

WEIGHTS.

Denominations and Values.			Equivalents in Use.
Names.	Number of Grammes.	Volume of the Weight of Water at its Maximum Density.	Avoirdupois Weight.
Millier or Tonneau,	1,000,000	1 cubic metre.	2204·6 pounds.
Quintal, . .	100,000	1 hectolitre.	220·46 pounds.
Myriagramme, .	10,000	10 litres.	22·046 pounds.
Kilogramme or Kilo,	1,000	1 litre.	2·2046 pounds.
Hectogramme, .	100	1 decilitre.	3·5274 ounces.
Decagramme, .	10	10 cubic centimetres.	·3527 ounce.
Gramme, . .	1	1 cubic centimetre.	15·432 grains.
Decigramme, . .	1-10	1-10th of a cubic centimetre.	1·5432 grains.
Centigramme, .	1-100	10 cubic millimetres.	·1543 grain.
Milligramme, .	1-1000	1 cubic millimetre.	·0154 grain.

THE CONVERSION OF FRENCH (METRIC) INTO ENGLISH MEASURES.

1 cubic centimetre	=	17	minims.						
2 cubic centimetres	=	34	,,						
3 ,,	=	51	,,						
4 ,,	=	68	,,	or 1 drachm		8 minims.			
5 ,,	=	85	,,	,, 1	,,	25	,,		
6 ,,	=	102	,,	,, 1	,,	42	,,		
7 ,,	=	119	,,	,, 1	,,	59	,,		
8 ,,	=	136	,,	,, 2 drachms		16	,,		
9 ,,	=	153	,,	,, 2	,,	33	,,		
10 ,,	=	170	,,	,, 2	,,	50	,,		
20 ,,	=	340	,,	,, 5	,,	40	,,		
30 ,,	=	510	,,	,, 1 ounce		0 drachm		30 minims.	
40 ,,	=	680	,,	,, 1	,,	3 drachms		20	,,
50 ,,	=	850	,,	,, 1	,,	6	,,	10	,,
60 ,,	=	1020	,,	,, 2 ounces		1	,,	0	,,
70 ,,	=	1190	,,	,, 2	,,	3	,,	50	,,
80 ,,	=	1360	,,	,, 2	,,	6	,,	40	,,
90 ,,	=	1530	,,	,, 3	,,	1	,,	30	,,
100 ,,	=	1700	,,	,, 3	,,	4	,,	20	,,

1000 ,, = 1 litre = 34 fluid ounces nearly, or 1¾ pints.

COMPARISON OF HYDROMETER SCALES AND SPECIFIC GRAVITY.

°Tw.	°Be.		Sp. Gr.	°Tw.	°Be.		Sp. Gr.
0	0	=	1·000	69	39	=	1·345
4	3	=	1·020	74	42	=	1·382
8	6	=	1·041	84	45	=	1·421
12	9	=	1·063	92	48	=	1·462
17	12	=	1·086	101	51	=	1·505
22	15	=	1·109	110	54	=	1·551
27	18	=	1·134	120	57	=	1·600
32	21	=	1·160	130	60	=	1·652
37½	24	=	1·188	141	63	=	1·708
43	27	=	1·216	153	66	=	1·767
49	30	=	1·246	166	69	=	1·831
55	33	=	1·277	180	72	=	1·900
62	36	=	1·310				

The Twaddle degrees are only approximately correct.

To Convert Specific Gravity into Degrees Twaddle.

Rule.—Subtract 1·000, and divide the remainder by 5. Thus a liquid has a specific gravity of 1·310, and will mark on the Twaddle scale—

1·310 sp. gr.
1·000
5) ·310
62° Tw.

To Convert Degrees on the Twaddle Scale into Specific Gravity.

Rule.—Multiply by 5, and add 1·000. Thus 62° Tw. =

62° Tw.
5
·310
1·000
1·310 specific gravity.

Strength of Bleaching Powder Solutions.

(*Lunge.*)

Specific Gravity.	Degrees Twaddle.	Available Chlorine.	
		Grammes per Litre.	Grains per Gallon.
1·1155	23·1	71·79	5025·3
1·1150	23	71·50	5005·0
1·1105	22·1	68·66	4806·2
1·1100	22	68·00	4760·0
1·1060	21·2	65·33	4573·1
1·1050	21·0	64·50	4515·0
1·1000	20	61·17	4281·9
1·0950	19	58·33	4083·1
1·0900	18	55·18	3862·6
1·0850	17	52·27	3658·9
1·0800	16	48·96	3427·2
1·0750	15	45·70	3199·0
1·0700	14	42·31	2961·7
1·0650	13	38·71	2709·7
1·0600	12	35·81	2506·7
1·0550	11	32·68	2287·6
1·0500	10	29·41	2058·7
1·0450	9	26·62	1863·4
1·0400	8	23·75	1662·5
1·0350	7	20·44	1430·8
1·0300	6	17·36	1215·2
1·0250	5	14·47	1012·9
1·0200	4	11·44	798·7
1·0150	3	8·48	593·6
1·0100	2	5·58	390·6
1·0050	1	2·71	189·7
1·0025	½	1·40	98·0

The last column is not given by Lunge, but has been calculated from the figures in the third column, which also represent the number of lbs. of available chlorine in 100 gallons of the solution.

ELSDEN'S TABLE OF POISONS AND ANTIDOTES.

	Poisons.	Remarks.	Characteristic Symptoms.	Antidotes.
Vegetable Acids,	Oxalic Acid, including Potassium Oxalate,	1 drachm is the smallest fatal dose known.	Hot burning sensation in throat and stomach; vomiting, cramp, and numbness.	Chalk, whiting or magnesia suspended in water. Plaster or mortar can be used in emergency.
Caustic Alkalies,	Ammonium ,, Potassium ,, Sodium ,,	Vapour of ammonia may cause inflammation of the lungs.	Swelling of tongue, mouth, and fauces; often followed by stricture of the œsophagus.	Vinegar and water.
Metallic Salts,	Mercuric Chloride,	3 grains the smallest known fatal dose.	Acid, metallic taste, constriction and burning in throat and stomach, followed by nausea and vomiting.	White and yolk of raw eggs with milk. In emergency, flour paste may be used.
	Acetate of Lead,	The sub-acetate is still more poisonous.	Constriction in the throat and at pit of stomach; crampy pains and stiffness of abdomen; blue line round the gums.	Sulphates of soda or magnesia. Emetic of sulphate of zinc.
	Cyanide of Potassium,	*a* Taken internally, 3 grains fatal.	Insensibility, slow gasping respiration, dilated pupils and spasmodic closure of the jaws.	No certain remedy; cold affusion over the head and neck most efficacious.
		b Applied to wounds and abrasures of the skin.	Smarting sensation.	Sulphate of iron should be applied immediately.
	Bichromate of Potassium	*a* Taken internally.	Irritant pain in stomach and vomiting.	Emetics and magnesia or chalk.
		b Applied to slight abrasions of the skin.	Produces troublesome sores and ulcers.	
	Nitrate of Silver,	... ...	Powerful irritant.	Common salt to be given immediately, followed by emetics.
Concentrated Mineral Acids,	Nitric Acid,	2 drachms have been fatal. Inhalation of the fumes has also been fatal.	Corrosion of windpipe, and violent inflammation.	Bicarbonate of soda, or carbonate of magnesia or chalk; plaster of the apartment beaten up in water.
	Hydrochloric Acid,	½ ounce has caused death		
	Sulphuric Acid,	1 drachm has been fatal.		
Acetic Acid, concentrated, has as powerful an effect as the mineral acids.				
	Iodine,	Variable in its action; 3 grains have been fatal.	Acrid taste, tightness about the throat, vomiting.	Vomiting should be encouraged, and gruel, arrow-root and starch given freely.
	Ether,	When inhaled.	Effects similar to chloroform.	Cold affusion and artificial respiration
	Pyrogallol,	2 grains sufficient to kill a dog.	Resemble phosphorus poisoning.	No certain remedy. Speedy emetic desirable.

INDEX.

BELL & BAIN, LIMITED, PRINTERS, GLASGOW.

PATTERNS.

SECTION I.—PATTERNS PRINTED ON COTTON.

No. 1.

Anthracene Yellow B N (Cassella).

(See p. 117).

No. 2.

Sterosine Grey (R. H. & S.).

(See p. 121).

No. 3.

Alizarine Cyanine Black G (F. B. & Co.).

(See p. 115).

No. 4.

Chrome Orange (F. B. & Co.).

(See p. 118).

No. 5.

New Methylene Blue G B (Cassella).

(See p. 127).

No. 6.

New Methylene Blue 3 R (Cassella).

(See p. 127).

PATTERNS PRINTED ON COTTON.

No. 7.

Capri Blue G O N (A. L. & Co.).
(See p. 128).

No. 8.

Turquoise Blue G (F. B. & Co.).
(See p. 128).

No. 9.

Neutral Blue (Cassella).
(See p. 128).

No. 10.

Indazine M (Cassella).
(See p. 129).

No. 11.

Solid Blue J B P.
(See p. 130).

No. 12.

Solid Blue R R S.
(See p. 130).

PATTERNS PRINTED ON COTTON.

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Brilliant Green (A. L. & Co.).
(See p. 130).

No. 14.

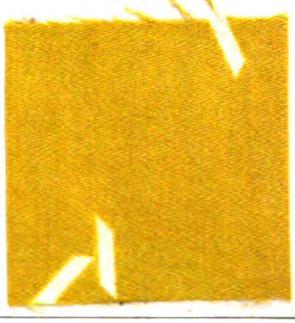
Solid Green Crystals O (Cassella).
(See p. 131).

No. 15.

Auramine O (A. L. & Co.).
(See p. 131).

No. 16.

Thioflavine T (Cassella).
(See p. 132).



No. 17.

Magenta Diamond Large Crystals B (Cassella).
(See p. 133).

No. 18.

Neutral Red Extra (Cassella).
(See p. 133).

PATTERNS PRINTED ON COTTON.

No. 19.

Pyronine G (A. L. & Co.).

(See p. 134).

No. 20.

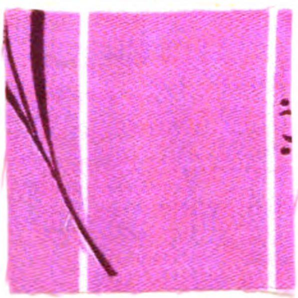
Acridine Scarlet 3 R (A. L. & Co.).

(See p. 134).

No. 21.

Safranine S, No. 150 (Cassella).

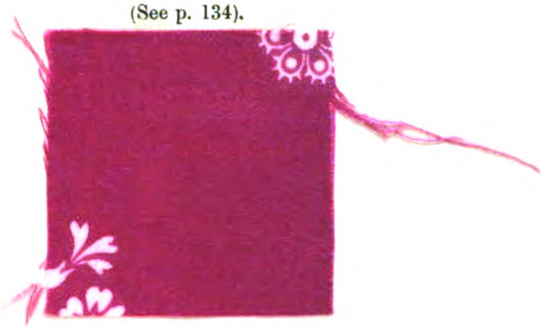
(See p. 134).



No. 22.

Safranine G G S (Cassella).

(See p. 134).



No. 23.

Methyl Violet 6 B O (Cassella).

(See p. 135).

No. 24.

Methyl Violet 3 R S (Cassella).

(See p. 135).

PATTERNS PRINTED ON COTTON.

No. 25.

Aniline Yellow (Cassella).
(See p. 136).

No. 26.

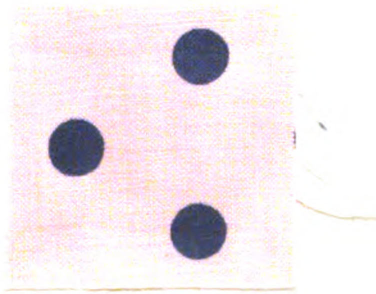
Phosphine 11 A (Cassella).
(See p. 136).

No. 27.

Acridine Orange N O (A. L. & Co.).
(See p. 136).

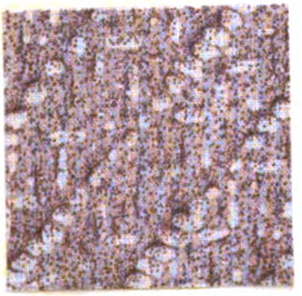
No. 28.

New Fast Grey (F. B. & Co.).
(See p. 136).



No. 29.

Diamine Violet N (Cassella).
(See p. 138).



No. 30.

Erythrosine B (Cassella).
(See p. 139).

PATTERNS PRINTED ON COTTON.

No. 31.

Brilliant Croceine M O O (Cassella).
(See p. 140).

No. 32.

Indigo Salt T (Kalle & Co.).
(See p. 149).

No. 33.

Vacanceine Maroon (R. H. & S.).
(See p. 152).

No. 34.

Vacanceine Red (β-Naphthylamine)
(R. H. & S.).
(See p. 154).

No. 35.

Vacanceine Red (Para-Nitraniline)
(R. H. & S.).
(See p. 154).

No. 36.

Black on Para-Nitraniline C Red Cloth.
(Cassella).
(See p. 154).

PATTERNS PRINTED ON COTTON.

No. 37.

Gambine on Chrome Mordant (R. H. & S.).
(See p. 208).

No. 38.

Printed Aniline Black—Padded Chloramine Yellow (F. B. & Co.).
(See p. 193).

No. 39.

Printed β-Naphthol and α-Naphthylamine Bordeaux—Padded Benzo-Sky-Blue (F. B. & Co.).
(See p. 194).

No. 40.

Printed Indigo Salt T—Padded Direct Scarlet B (Kalle).
(See p. 194).

No. 41.

Padded with Direct Yellow G (Kalle).
(See p. 194).

No. 42.

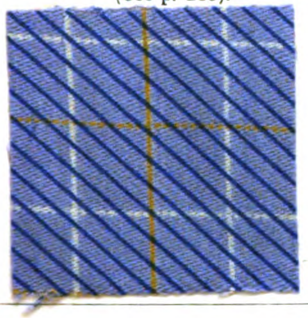
Printed Aniline Black—Padded with Brilliant Geranine B (F. B. & Co.).
(See p. 194).

PATTERNS PRINTED ON COTTON.

No. 43.

Yellow and White Discharge on Diamine Colours.

(See p. 213).



No. 44.

Blue Discharge on Diamine Colours.

(See p. 213).

No. 45.

Yellow Discharge on Benzoazurine G (F. B. & Co.).

(See p. 211).

No. 46.

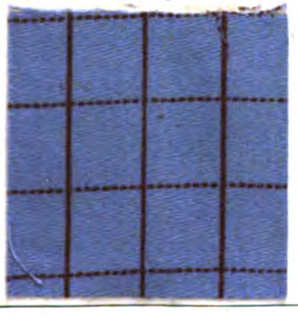
White Discharge on Titan Blue 3 R (R. H. & S.).

(See p. 213).

No. 47.

Brown Discharge on Silver Grey (Cassella).

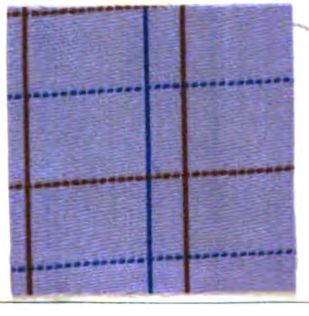
(See p. 213).



No. 48.

Blue Discharge on Diamine Colours (Cassella).

(See p. 213).

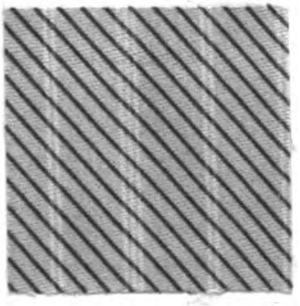


PATTERNS PRINTED ON COTTON.

No. 49.

White Discharge on Diamine Colours.

(See p. 213).



No. 50.

White and Yellow Discharges upon Direct Dyeing Colours.

(See p. 213).

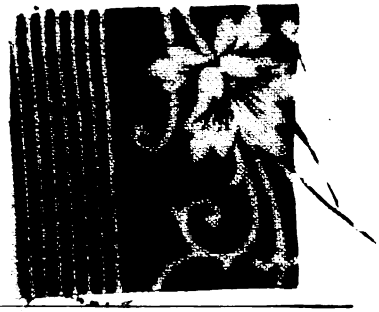
SECTION II.—PATTERNS PRINTED ON WOOL.

No. 51.

Wool Printing Black W (A. L. & Co.).
(See p. 251).

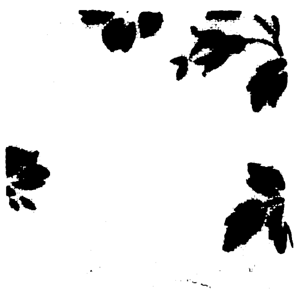
No. 52.

Induline L (A. L. & Co.).
(See p. 255).



No. 53.

Cotton Blue 4 B (A. L. & Co.).
(See p. 257).



No. 54.

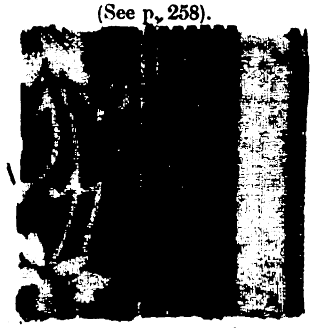
Water Blue R (A. L. & Co.).
(See p. 257).

No. 55.

Water Blue 7 B (A. L. & Co.).
(See p. 256).

No. 56.

Acid Violet 7 B (A. L. & Co.).
(See p. 258).



PATTERNS PRINTED ON WOOL.

No. 57.

Acid Green G G (F. B. & Co.).
(See p. 259).

No. 58.

Orange 11 B (F. B. & Co.).
(See p. 259).

No. 59.

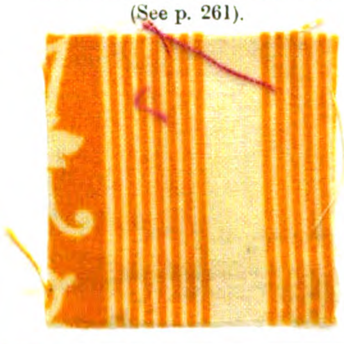
Acid Red C (A. L. & Co.).
(See p. 260).

No. 60.

Brilliant Ponceau 5 R (F. B. & Co.).
(See p. 260).

No. 61.

Brilliant Yellow (A. L. & Co.).
(See p. 261).



No. 62.

Eosine O O (A. L. & Co.).
(See p. 264).

PATTERNS PRINTED ON WOOL.

No. 63.

Rose Bengal B (A. L. & Co.).
(See p. 264).

No. 64.

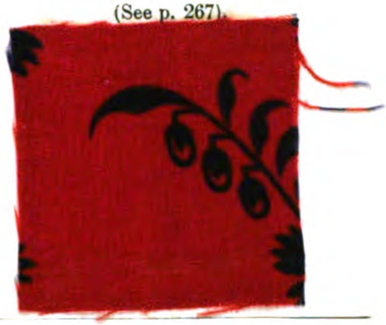
Yellow Discharge on Dyed Red
(A. L. & Co.).
(See p. 266).

No. 65.

Orange Discharge on Dyed Blue
(A. L. & Co.).
(See p. 266).

No. 66.

Blue Discharge on Dyed Red
(A. L. & Co.).
(See p. 267).



No. 67.

Red Discharge on Dyed Yellow
A. L. & Co.).
(See p. 267).

No. 68.

Green Discharge on Dyed Gold
(A. L. & Co.).
(See p. 267).

SECTION III.—PATTERNS PRINTED ON HALF SILK.

No. 69.

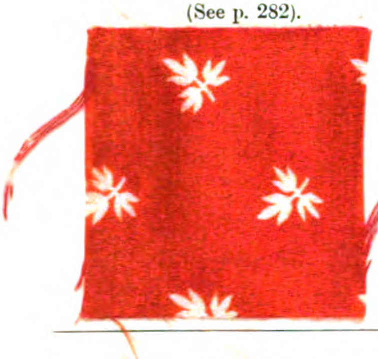
Cotton Blue on Half Silk (A. L. & Co.).
(See p. 281).

No. 70.

Green on Half Silk (F. B. & Co.).
(See p. 282).

No. 71.

Red on Half Silk (A. L. & Co.).
(See p. 282).

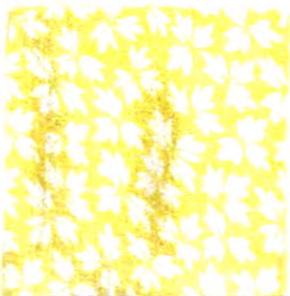


No. 72.

Pyronine G on Half Silk (A. L. & Co.).
(See p. 282).

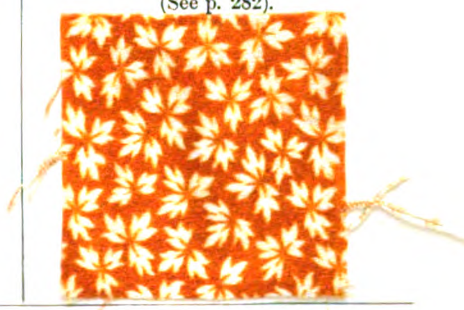
No. 73.

Auramine II. on Half Silk (A. L. & Co.).
(See p. 282).



No. 74.

Acridine Orange R on Half Silk (A. L. & Co.).
(See p. 282).



PATTERNS PRINTED ON HALF SILK.

No. 75.

Bismarck Brown on Half Silk (A. L. & Co.).

(See p. 283).

No. 76.

Claret on Half Silk (A. L. & Co.).

(See p. 283).

No. 77.

Neutral Black on Half Silk (A. L. & Co.).

(See p. 283).

No. 78.

Brilliant Green on Half Silk (A. L. & Co.).

(See p. 283).

SECTION IV.—MISCELLANEOUS PATTERNS ON COTTON.

No. 79.

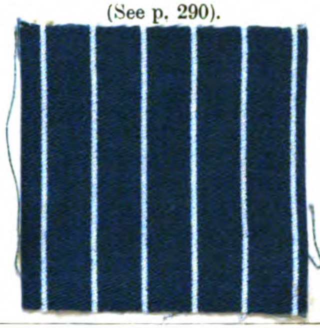
Claret and Yellow on Cotton.

(See p. 290).

No. 80.

Blue on Cotton.

(See p. 290).



No. 81.

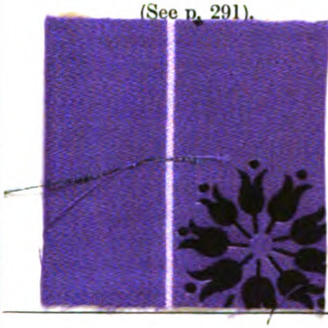
Dark Blue and Bright Green on Cotton.

(See p. 291).

No. 82.

Pale and Dark Violet on Cotton (Cassella).

(See p. 291).



No. 83.

Dark Blue and Orange on Cotton.

(See p. 291).

No. 84.

Bright Blue and Yellow on Cotton (Cassella).

(See p. 292).

MISCELLANEOUS PATTERNS ON COTTON.

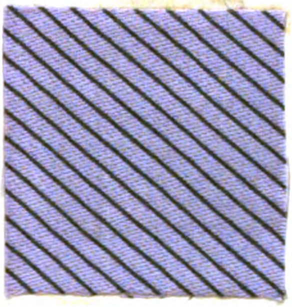
No. 85.

Myrtle on Cotton (R. H. & S.).
(See p. 292).

MISCELLANEOUS PATTERNS.

No. 86.

Black upon Dyed Cloth.
(See p. 292).



No. 87.

Russian Red.
(See p. 292).

No. 88.

Bright Green.
(See p. 293).

No. 89.

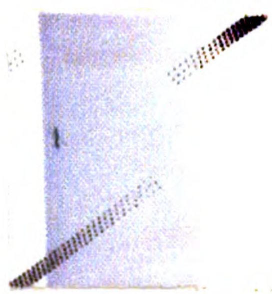
Dark Blue (Cassella).
(See p. 293).

No. 90.

Blue on Cotton.
(See p. 293).

No. 91.

Blue, Heliotrope and Brown on Cotton.
(See p. 294).

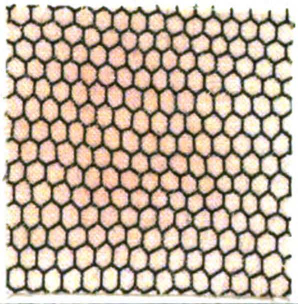


MISCELLANEOUS PATTERNS.

No. 92.

Pale Red, Red and Black on Cotton.

(See p. 294).



No. 93.

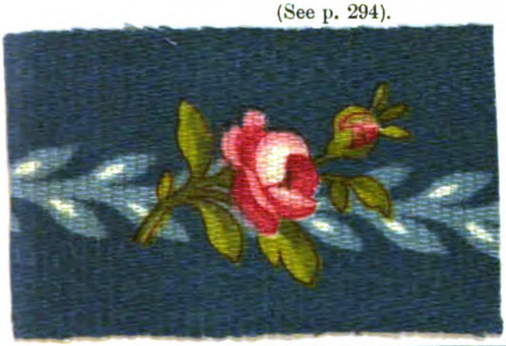
Seven-Colour Pattern on Cotton.

(See p. 294).

No. 94.

Seven-Colour Pattern on Cotton.

(See p. 294).



No. 95.

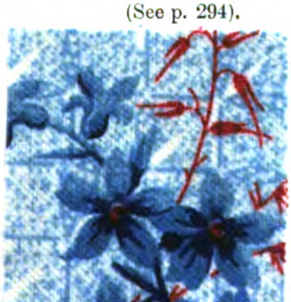
Red, Brown, and Dark Brown on Cotton.

(See p. 294).

No. 96.

Pale, Medium, and Dark Blue and Red on Cotton.

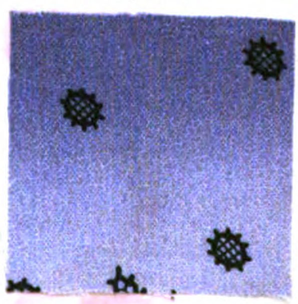
(See p. 294).



No. 97.

Aniline Black and Diamine Black B H.

(See p. 294).



MISCELLANEOUS PATTERNS.

No. 98.

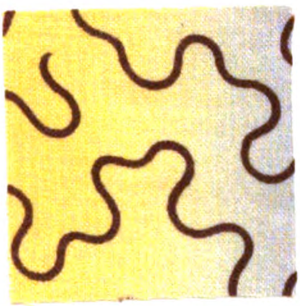
Eight-Colour Pattern on Cotton.
(See p. 294).

No. 99.

Six-Colour Pattern on Cotton.
(See p. 294).

No. 100.

Violet, Yellow, and Brown on Cotton.
(See p. 295).

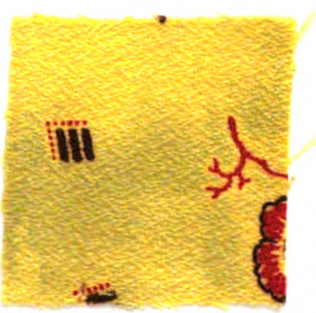


No. 101.

Six-Colour Pattern on Cotton.
(See p. 295).

No. 102.

Yellow, Red, and Brown on Cotton.
(See p. 295).



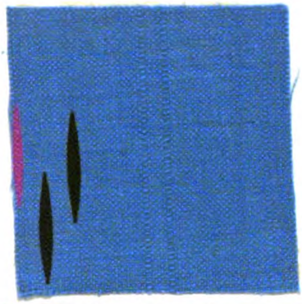
No. 103.

Four-Colour Pattern on Cotton.
(See p. 295).

MISCELLANEOUS PATTERNS.

No. 104.

Blue and Black on Cotton.
(See p. 295).

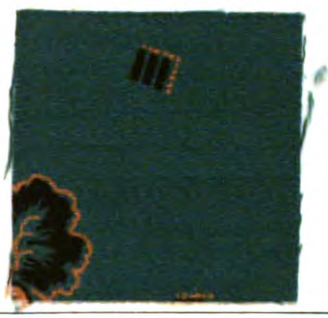


No. 105.

Violet and Black on Cotton.
(See p. 295).

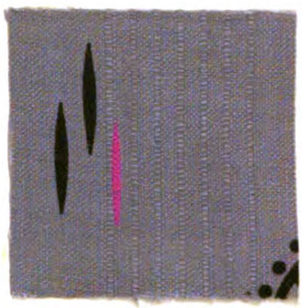
No. 106.

Diamine Colours on Cotton.
(See p. 295).



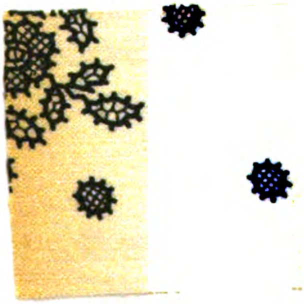
No. 107.

Diamine Colours on Cotton.
(See p. 295).



No. 108.

Diamine Colours on Cotton.
(See p. 295).



No. 109.

Diamine Colours on Cotton.
(See p. 295).