1768

*A New Survey of Universal Knowledge*

# ENCYCLOPÆDIA BRITANNICA

## Volume 22

TEXTILE *TO* VASCULAR SYSTEM

1768

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# ENCYCLOPÆDIA BRITANNICA

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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

FOUNDED A.D. 1768

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## Volume 22

## TEXTILE *TO* VASCULAR SYSTEM

**TEXTILE PRINTING,** the process by which a decorative pattern is applied to a woven or knitted fabric in at least one colour different from the body of the fabric itself. This mode of decoration differs from the formation of a pattern by weaving and knitting processes that employ threads that are already coloured or have different capacities for taking up dyes. The four main methods of textile printing are block printing, copperplate printing, roller printing and screen printing.

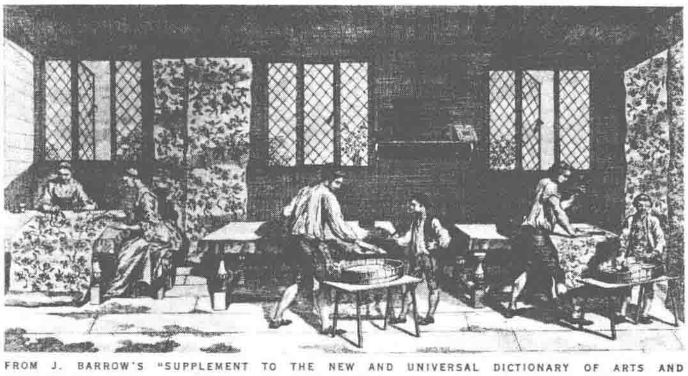
### EARLY METHODS

**Block Printing.**—The origin of block printing on textiles is somewhat obscure but it is clear that the printing of textiles by means of blocks was developed from free-hand painting with a brush. Wooden blocks believed to have been used for textile printing have been found in burying grounds at Akhmim, upper Egypt, and are said to date from the 4th century A.D. No textiles printed by means of these blocks have, however, been found. In Europe block printing of fabrics does not appear to have begun much before the end of the 12th century A.D.; the chief centre appears to have been the Rhineland of Germany.

In blocks used for printing, the spaces between the lines or devices forming the pattern were cut away, leaving the design standing in relief, as in letterpress printing. The colour was then applied to the surface of the block and the coloured block pressed down on the cloth. An interesting description of early block printing on textiles is given in *The Book of the Arts or Treatise on Painting* by Cennino Cennini, a document that dates from the end of the 14th century. According to Cennini, the thickened colour was applied to the block by means of a glove, probably made of leather. The pigments were mixed with starch, gum (tragacanth) or a mixture of these, or even with varnish, so that the colour was in a viscous state and did not run from the raised portions of the block. Cennini describes how the outlines of the patterns were printed by block and additional colours added by means of a brush. Later the colour was applied by a pad, either directly or by pressing the block down on a pad impregnated with colour. Wax resists were also printed by metal or wood blocks for indigo-resist dyeing. This method was used in Egypt in the 9th–10th century A.D. and in Germany in the 17th century. Apart from these indigo-resist dyed textiles, until the end of the 17th century all European block-printed textiles were printed with surface pigments or oil stains that were fugitive (not fast to washing). About 1676, however, more or less simultaneously in England, Holland and France, the European textile printers mastered the secrets of the complex problems of mordant dyeing with madder—the basis of the fast-dyed, hand-painted Indian chintzes that had begun to be imported into Europe during the early 17th century. Thereafter, most European block-printed textiles were produced in what was known as the "madder style."

One of the clearest expositions of block printing in the "madder style" is given in the supplement to John Barrow's *New and Universal Dictionary of Arts and Sciences* (1754). The cotton or linen was printed with chemical substances known as mordants, which on immersion in the vat reacted with the soluble dye to precipitate an insoluble colouring on the cloth fibres so that the colour remained permanently fixed in the mordant-printed areas while the dye taken up by the unmordanted parts could be easily removed by washing. In madder dyeing different mordants can produce various shades of reds, pinks, purples and browns from a single immersion in the dye. The different mordants were printed one by one; the printer moved along the whole length of the cloth printing the first mordant from one wood block, then the second mordant from another block, and so on, until the whole pattern was completed. The mordant-printed cloth was then immersed in the dye. The reds, browns and purples were produced by printing varying strengths of alum and iron mordants, followed by immersion in the madder dye. Yellows and drabs (light brownish colours) were produced by the printing of similar mordants followed by dyeing with weld, also known as dyer's weed. Blue was produced by "penciling-in" indigo with a brush. This operation was usually carried out by women or girls. All greens were produced by the penciling-in of indigo over yellow. To save expense, the yellows were often blocked or painted in to avoid an additional dyeing but with this method the yellow dye was fugitive and in many extant 18th-century textiles the yellow has almost entirely disappeared.

The standard method of printing madder mordants by wood block involved the use of a "tub" and a "sieve." In England the tub consisted of a sawed-off barrel but on the European continent



FROM J. BARROW'S "SUPPLEMENT TO THE NEW AND UNIVERSAL DICTIONARY OF ARTS AND SCIENCES," LONDON, 1754; PHOTOGRAPH BY COURTESY OF VICTORIA AND ALBERT MUSEUM

FIG. 1.—CALICO BLOCK PRINTING, 18TH CENTURY

a specially constructed square tub was more usual. The tub was filled with a viscous paste, called the "swimmings," made from discarded colour and gum; the paste provided a sort of elastic cushion on which rested the sieve, a wooden drum only fractionally smaller than the tub. The bottom of the sieve was a sheepskin, the upper surface a tightly stretched fine woolen cloth. An assistant, known as "tireur" or "tearer," kept the upper surface of the sieve constantly and evenly supplied with the thickened mordant, which was spread on with a large brush. When the printer pressed his block on the sieve, the swimmings in the tub provided just enough "give" to ensure a satisfactory colouring-up of the block. The cloth to be printed was supported on a stone, concrete or iron structure covered with a thick blanket; this arrangement provided a firm but resilient surface so that the raised surface of the block contacted the cloth with uniform pressure over the whole area. Between the blanket and the cloth was a layer of unbleached calico (the back gray) that absorbed the mordant forced through the cloth. When the block was placed on the cloth, the printer gave it one or two sharp blows with his mallet or maul to impress the mordant firmly into the cloth. Pins known as pitch pins were inserted into each corner of the block as a guide to the printer in matching the repeats. The blocks were generally made of layers of strong durable woods, such as pear wood, arranged so that the grain in each layer ran at right angles to that in the layers above and below; this arrangement prevented warping during the successive wetting and drying. For fine details, such as thin stems and the outlines of flowers or leaves, strips of metal or metal pins were inserted into the wood blocks. Elaborate "pin grounds," also called "picoté" or "sable" grounds, were achieved by inserting metal pins into the block.

A method of mechanical block printing was invented in 1834 by a French mechanic called M. Perrot. This machine, known as the perrotine after its inventor, employed ordinary wood blocks and was widely used in the 19th century, particularly in France, for printing up to four colours. Each block of the design is impressed simultaneously in the cloth at a distance of two repeats apart. The cloth is stepped through the machine, one repeat at a time, to emerge with the full numbers of colours printed upon it. Although the original machine needed five men to tend it, one machine could print as much cloth as 24 printers and 24 assistants using hand methods. By 1836 about 60 perrotines were in operation in Europe; and even in the early 1960s when, in spite of the expense of the process, block printing continued to be used for certain classes of goods, the perrotine was not quite obsolete.

**Copperplate Printing.**—Copperplate printing on textiles was invented by Francis Nixon at the Drumcondra printworks near Dublin in 1752. Although prior to 1752 maps and embroidery designs had been printed from engraved copperplates with ordinary printer's inks, it was not until Nixon's invention that it was possible to print textile designs in fast colours by printing the cloth with thickened mordants. The designs were printed from a single engraved copperplate, usually with a repeat of about three feet square, in red, purple or sepia, using the madder dye; or in blue, using indigo, by a method known in England and the United States as "china-blue" and on the continent of Europe as "bleu d'Angleterre." This method involved printing the indigo on the cloth in an undissolved state and arranging for its simultaneous reduction and solution on the cloth after printing. This was done by immersing the printed cloth in a bath of lime (to dissolve the indigo) and a bath of ferrous sulfate (to reduce it) as many times as was necessary to achieve the desired strength of blue.

Copperplate printing was eminently suited for the production of large pictorial designs and a fineness of detail and delicacy of drawing not possible with the comparatively coarse technique of wood-block cutting. It was also used for floral designs, both for furnishing and dress, and for the printing of handkerchiefs.

The textile printer's copperplate press was little different from the heavy, flat-bed, rolling press used for the printing of engravings on paper. The plate was first inked up with the thickened mordant and then was passed through the rollers in contact with the cloth being printed. Various improvements, however, were introduced by the textile printers to make the press more suitable for their purposes. An important innovation was the "D" roller, patented by Robert Kirkwood of Edinburgh in 1803, which overcame the difficulty of getting the plate through the rollers to its original position without winding the cloth back at the same time. Kirkwood's invention consisted of substituting for the lower roller a special roller shaved flat on one side (hence the name "D"). On the forward passage of the plate, the round part of the roller squeezed the plate up against the cloth for printing in the normal way; but on the reverse passage the roller rested with its flattened surface uppermost, thus allowing the plate to go through without touching the cloth.

With the introduction of roller printing copperplate printing began to die out, although it continued in use, particularly for the production of printed handkerchiefs, well into the 19th century.

**Roller Printing.**—The first commercially successful patent for a roller-printing machine was taken out in 1783 by Thomas Bell, a Scotsman. So fundamental was Bell's invention that the principle of his machine has been retained throughout the numerous improvements and refinements introduced since that date. Before 1783 several attempts had been made to replace hand printing by mechanical means but none of them had been commercially successful. As early as 1743 W. Keen and M. Platt had taken out a patent for a three-colour roller-printing machine but it does not appear to have been developed. In France a textile printer named J. A. Bonvallet introduced a primitive type of roller-printing machine at his factory in Amiens about 1775. It consisted of two rollers; the upper one was made of wood, the lower one of hollow iron covered with a copper mantle on which the pattern was engraved. The lower roller was filled with red-hot iron or burning coals and revolved in a dye bath. The cloth was passed over the upper, wooden roller and the lower roller pressed up against it by means of weights, levers and a cog wheel. The machine was operated by hand. Bell's original specification (patent no. 1378, 1783) describes his invention as "a new and peculiar art or method of printing with one colour or various colours at the same time, on linnens, lawns, and cambricks, cottons, callicoes, and muslin, woollen cloth, silks, silk and stuffs, and any other species or kind of linnen cloth or manufactured goods whatever."

A second patent taken out by Bell (no. 1443, 1783) contains a similar specification for printing "one, two, three, four or five, or more colours," and by the following year he was able to put the machine into practical operation with the firm of Livesey, Hargreaves and Co. near Preston, Lancashire. Strangely enough, however, the indiscriminate use of the new machines contributed to the collapse of the firm in 1788. Bell's machine for rotary printing from engraved metal rollers was fitted with a "doctor," or steel blade, designed to remove the surface colour from the printing rollers while allowing the recessed, engraved parts to retain enough colour to print a continuous length of fabric. The machine was said to be capable of doing the work of about 40 hand printers. Although the machine was theoretically capable of printing five or six colours at a time, mechanical and chemical difficulties that existed as late as 1840 made it difficult to print more than two or three colours simultaneously. At first the new roller-printing machines were used mainly for small-scale dress prints, and it was not until the early 19th century that large-scale furnishing patterns were produced by machine. Many of the furnishing fabrics of the 1820s were produced from a single, stipple-engraved metal roller, with additional colours being printed by wood blocks or surface rollers. With James Burton's and Adam Parkinson's union-machine (1805) it was possible to print simultaneously with engraved metal and wood surface rollers. (*See* also TEXTILES: *Printed Textiles.*) (B. J. Mo.)

### MODERN INDUSTRIAL PROCESSES

**General.**—Textile printing on an industrial scale consists of two fundamental operations: (1) the impression, *i.e.,* the mechanical and physical stages in which the colouring matters are distributed on the cloth; and (2) the coloration, *i.e.,* the choice of the appropriate colouring matters (dyes, dye-generating chemicals, pigments and the necessary auxiliary chemicals), the conditions for their application, their preparation in suitable forms for presentation to the cloth and their fixation against removal during use and wear.

Textile printing in some of its aspects differs greatly from the corresponding methods for printing on paper and other materials, although the mechanical methods for bringing the colour to the surface may be similar. Inks and paints used for printing on paper usually contain colouring matter in the form of pigments (*i.e.*; finely divided solid powders insoluble in the medium by which they are applied); such pigments are attached by adhesive media to the surface to be coloured; they cannot penetrate between the molecules of the fibres. In much textile printing, however, the various coloured areas that make up the print are, in fact, dyed. The dye is dissolved, usually in water alone or in aqueous solutions containing other reagents, and the molecules thus separated can be induced to enter between the molecules of the fibre in a much more intimate association. In general, a textile print in which the coloured areas are dyed in this way may be found to be faster to washing and similar treatments than a print resulting from the use of pigment in an adhesive. The presence of adhesive may also tend to stiffen the fabric. Improvements in adhesives, though, have made it possible to obtain reasonable fastness and softness and to obtain prints of great brilliance.

Cloth, either woven or knitted, may first be singed to burn off surface fibres, desized to remove weaving sizes, scoured to take away natural impurities and the soils of manufacture, bleached to destroy residual colouring matters, impregnated with solutions of dyes or other necessary chemicals by padding, dried and, occasionally, given extra smoothness by passage through a calender. Drying may be brought about by passing the cloth over steam-heated cylinders or by running it through a stenter. The latter operation fixes the width, ensures that warp and weft are at the correct angle and renders the selvedges straight and parallel. The cloth is wound under even tension on wooden shells to give cylindrical batches.

The pattern is impressed by hand blocks, stencils, silk screens or engraved or relief rollers. Drying is done in a hot flue or by steam-heated plates or cylinders. The cloth is then passed through a chamber (steamer, ager or flash ager) filled with steam. During the passage a limited amount of water condenses on the print, the dye is redissolved without being spread and the fibre swells. The dye molecules are thus enabled to penetrate into the fibre substance so that they can become fixed there. The high temperature of the steam also initiates or speeds up reactions by which some dyes are turned into soluble forms, are actually produced *in situ* from intermediates or are fixed more firmly within the fibre. Steaming for short periods is called aging or, for very short periods, flash aging. Volatile acids can be introduced into the steam (acid steaming or acid aging) if this is required. Dyes that are themselves volatile can be fixed in man-made fibres—Terylene (Dacron), Orlon, etc.—by dry heat. The adhesive medium in some pigment printing is also set by dry heat. (*See* also COTTON MANUFACTURE: *Converting of Cotton Goods.*)

Before and after (and sometimes instead of) steaming, the printed cloth may be passed through certain solutions, *e.g.,* of chromates, to fix the dye. Unfixed colour may be removed by washing or soaping. This minimizes the tendency to bleed off on other cloth during wet treatments and to rub off when dry.

**Impression.**—This is the essential part of the printing operation. With several exceptions, dyes, dye-generating substances and auxiliary chemicals are dissolved or suspended in water. When applied to a fixed area of a microporous structure like cloth the solutions would spread by capillary attraction (flush) beyond the boundaries of the pattern and so give prints of unsatisfactory definition. The viscosity of the solutions is therefore increased by the addition of thickening agents. These are usually substances of high molecular weight that yield colloid dispersions in water. They include the natural starches, starches that have been altered by regulated depolymerization (for example, by the action of heat or acids to furnish dextrins), chemical derivatives of starch and cellulose, and natural vegetable gums such as gum tragacanth and gum arabic, locust-bean gum, etc. There are other vegetable mucilages, such as sodium alginate (sodium polymannuronate) from seaweed, as well as egg and blood albumin and various synthetic resin products. A more recently developed form of viscous medium is a stabilized emulsion between water and another non-miscible liquid (emulsion thickener). It is possible sometimes to use colloid aqueous dispersions of the mineral bentonite.

The thickening agent for a given printing paste is chosen for its specific thickening power, its compatibility with the dyes to be used, its freedom from interference by the other chemicals that have to be added, its stability and its general flow properties. The flow property of the entire paste is adjusted to the printing method, the shapes of the impressions to be made, the intensity of colour required, the weight and structure of the cloth, the fixation methods to be employed, and the severity of treatment that can be allowed in order to remove the exhausted paste from the print after the dyes on it have been fixed. Many dispersions of thickening agents are thixotropic; *i.e.,* they become more fluid when they are subjected to the stresses that they receive in the printing operation, and this property has an important bearing upon the quality of the impression.

*Block Printing.*—This, the oldest method of textile printing, is also discussed above under *Early Methods.* The blocks normally consist of wood with the design carved to stand above the block surface. Alternatively, or in conjunction with these projections (pegs), fine details such as different shaped dots are provided by short lengths of copper wire (pins) of various cross section partly driven into the wood. Lines are provided by shaped copper strip (fillet) driven edgewise into the wood. Large areas of uniform colour known as blotches are produced by filling in an enclosed area with wool felt, which thus gives an extended printing surface. Areas corresponding in size to those produced respectively by pins, pegs or blotches in block printing are given the same name in screen or roller printing. Where the form of the design is suitable, where prolonged use of the block is anticipated or where a number of block sets of the same design are required, the relief printing surface may be cast in type metal. In most cases every distinct colour must be applied as a separate paste from a separate block. Further, since blocks have to be handled during the printing operation, those that are too heavy to be lifted easily are inconvenient; if the repeat of the pattern is large, more than one block may be needed for a single colour, and to print big, detailed and florid patterns the number of separate blocks may exceed 100. Block prints are thus laborious and expensive to produce but they are prized for their full, deep colourings and for the deviation from the exact design, which shows them to be "handmade." Since printing costs per yard are high, expensive cloths (*e.g.,* heavy linens for upholstery and pure silks for dress goods) are generally chosen for block printing. Designs tend to be traditional and may be "kept on the table" for many years.

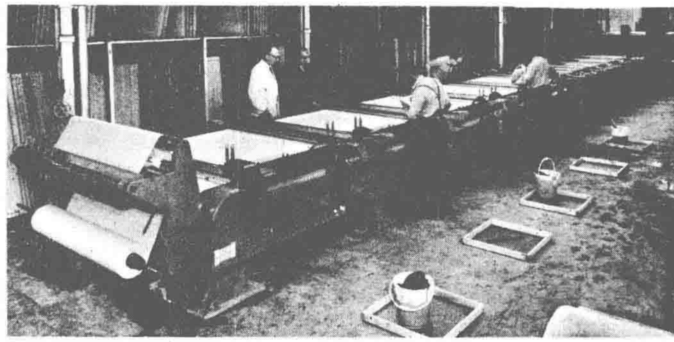
The perrotine is still used occasionally while in some firms the surface, or peg, printing machine, the forerunner of the roller printing machine (*see* below), is in continuous use. In this machine the circumference of one roller carries an exact number of the repeats of the pattern; a second roller guides the blanket, the back gray (back cloth) and the cloth itself and acts as the printing surface. The pegs of the patterned roller run in contact with the printing roller and are furnished by touching, at another part of the periphery, an endless band spread with paste. As with all cylinder machines, printing is continuous but the length of the repeat that can be printed is limited since the diameter of the printing cylinders cannot be increased indefinitely.

*Stencil and Screen Printing.*—The stencil printing method uses stencils made from paper impregnated with wax or from thin sheets of ductile metal. The method has been known for centuries but in modern times it has been employed only to a limited extent; some stencil printing is carried out with lacquers on nets and gauzes to give beadlike effects. The stencil may be cut from zinc foil and mounted on a frame that is laid over the fabric; the colour medium is applied through the stencil with air-spray, brush or squeegee.

Silk screen printing (*q.v.*) is the most commonly used form of what is essentially stencil printing. Fine, open-mesh gauges woven from yarns made of silk or nylon, or from fine bronze wires, are stretched with even tension upon rectangular frames of wood or light metal. The printing areas on the gauze are left open, the rest being blocked up with a lacquer. The design can be hand-painted on the screen directly with lacquer but this procedure is slow, especially for large areas, and a photographic method usually is used. The repeat is drawn in black and white on transparent film and this serves as a negative from which a number of positives are made by the ordinary procedures of exposure and development. The positives are pieced together to make up the printing area desired in the final screen, and from the composite a full negative is made on photographic film. The screen itself is coated with a solution of gelatin to which a soluble dichromate (bichromate) has been added and is dried in the dark. It is then exposed to light behind the composite negative, and the part of the gelatin that is exposed to light becomes insoluble in water. When the negative is removed the gelatin on the unexposed areas is washed away with warm water and the deposits are reinforced by coating them with a layer of lacquer. When the lacquer is dry, the screen is ready for use. As in the other printing methods, one screen is prepared for each colour in the pattern.

Screen printing by hand is carried out on tables wide and long enough to accommodate the cloth to be treated. The tables are covered with a resilient blanket on top of which is a smooth impervious fabric. A length of the cloth is rolled off to occupy the full length of the table and is fixed to the impervious cover with starch paste or other adhesive. The screen to be printed is laid on the cloth at one end of the table, gauze side downward, with the frame therefore forming the sides of a shallow trough. Printing paste is poured into the trough and driven through the open areas with a squeegee, which is a stout strip of wood with a firm lip of rubber along the lower edge. The longest side of the screen is usually placed across the cloth (weftwise), and the line in which the squeegee is moved is parallel with the shorter side. Two operatives do the printing, one at either side of the table, passing the squeegee from one to the other in the middle of the stroke. When one impression has been made with the screen, it is lifted and laid down on the next repeat and so on until all the cloth on the table has been printed with one colour. Then the operation is repeated, using another screen and another colour, until the full design is printed. Correct positioning of screens along the length and width of the cloth is obtained by projections on the screen frame that are made to engage with stops correctly adjusted on a metal bar (pitch rail) on one of the long sides of the table. After one table-length of cloth has been fully printed it is pulled from the table and succeeding lengths of the roll are printed by the same procedure.

Screen printing is never as swift as roller printing but the preparation of screens is easier, speedier and cheaper than the engraving of a set of copper rollers. The skill required is not nearly so great as that needed to operate a roller printing machine. While a roller printing machine can best interpret designs in which sharp definition is needed, the screen method may give superior results more easily when full colouring and a full gradation of shading is needed. There are distinctions connected with the nature of the design; *e.g.*, it is easier to get plain longitudinal stripes by roller printing and



BY COURTESY OF THE COTTON BOARD

FIG. 2.—TWELVE-COLOUR AUTOMATIC SCREEN-PRINTING MACHINE

lateral stripes by the screen method. The screen method is better adapted for the classes of commercial printing in which short runs and quick changes of design are called for.

Many machines have been introduced to mechanize the screen printing operation. Some imitate mechanically the operations of hand printing. In others, continuous working may be achieved by supporting the screens on rollers whose faces are perforated so that the screens can be furnished from inside; such machines approach the action of the roller printing machine.

*Roller Printing.*—This is the method by which the greatest percentage of cloth is printed. In general it is faster than other methods and produces a more accurate impression. The printing area is engraved in recess (intaglio) on a smooth copper roller. This is coated with the colour paste and then the unengraved surface is scraped clean with a steel blade (doctor), leaving the engraving filled. The roller then comes into contact with the cloth carried on a supporting roller and transfers the paste in the engraving to it. The number of engraved rollers employed depends upon the number of colours required in the design and may be from one to fourteen. With the exception of a few of continental origin, modern roller printing machines do not differ fundamentally from the one invented by Thomas Bell in 1783 (*see* fig. 3 and 4).

The engraved copper rollers, or shells, each rotate on a steel mandrel to which they are keyed by a tongue and groove arrangement. The drive is transmitted from one large crown wheel, driven by an electric motor, to a box wheel at the end of each mandrel. Different prints need to be printed at different speeds according to the quality of the engraving and the paste used, and the structure and composition of the cloth itself. The printing machine should be able to run at very slow speeds (inching) at the beginning of a printing in order that final adjustments in the fit of the different coloured impressions can be made before a substantial yardage of cloth has been printed.

The shells themselves are usually made of high-quality copper, but where a long life is called for, and especially where the paste contains hard, solid particles (*e.g.*, pigments and crystals), the surface may be chromium plated. The appropriate part of the total pattern is engraved on each shell by direct manual engraving, by milling or by acid etching, including various adaptations of the photogravure process (*see* GRAVURE). When another pattern is desired, a new series of shells is fitted on the mandrels.

The central cylinder, or printing roller, is made of cast iron; the larger the number of colours printed, the greater the diameter of the cylinder. It is wrapped with several layers of springy cloth (lapping) to impart resilience. The back gray and the cloth to be printed are carried through the rollers at a steady tension on an endless printer's blanket, which may be made of felt with a smooth resilient surface or made of cloth coated with rubber or a plastic substance. If it is rubberized it will be washed after the impression with water sprays or rotary cylindrical brushes to remove adhering paste, and dried by being passed through hot air or over steam-heated cylinders or by being dusted with talc before being passed forward again to support more cloth. Modern blankets, which are covered with compositions designed to resist wear and chemical attack and are embossed with fine lines, can be used without the back gray for some designs; the depressions hold the small amounts of paste pushed through the cloth and in addition increase the grip between cloth and blanket; such blankets exhibit better springiness than do the older forms.

The cleaning doctor consists of a straight strip of steel fixed in a pivoted clamp or shears, with an edge pressing at an angle against the surface of the shell. It removes the paste from the unengraved portions of the shell surface. The pressure of contact is obtained by weights that act on the shears through a lever. The adjustment of the doctor is one of the most exacting tasks of the printer since the variety of blade and the angle and pressure of contact have to be adjusted to meet the particular quality of the engraving and other conditions of printing. The edge is sharpened so that it is accurately linear, and, although it may receive an initial mechanical grinding, it always has to be finished by hand. Special adjustments (springing) of the steel strip in the shears are required to overcome bowing when wide cloths are printed.

As the shell rotates it is supplied with printing paste by a lapped or coated roller (the furnisher) that rotates in contact with the shell and also runs partly immersed in paste contained in a colour box. As the shell moves round it is cleaned by the doctor and then makes contact with the cloth. Before it completes a revolution, it passes under the edge of a second, or lint, doctor that is similar to the cleaning doctor but is made of a softer metal. Here the smooth portion of the copper is freed from lint and from printing paste of other colours transferred by the cloth from an earlier shell. This operation prevents paste of one colour from passing into the boxes of subsequent colours and falsifying the shade and removes solid impurities that might otherwise wedge between the edge of the cleaning doctor and the copper surface, letting through unwanted colour and giving rise to lines and smears in the print. Furnishing is sometimes effected with a stiff cylindrical brush instead of a roller. The brush is often rotated at a different surface speed from that of the shell; the brushing action prevents permanent clogging of the engraving.

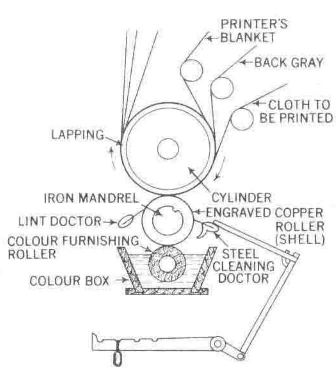



FIG. 3.—WORKING PARTS OF A ONE-COLOUR TEXTILE PRINTING MACHINE

In multicolour printing, the units, each consisting of a shell printing a single colour with its own doctors and furnishing arrangement, are fixed at intervals round the lower part of the periphery of the central cylinder, which is horizontally disposed. As the cloth passes around the cylinder, it is impressed in succession with the different colour components. Careful fitting is needed as each impression must fall accurately upon the appropriate area within the complete pattern; inconspicuous pitch marks are engraved as a guide at the appropriate place on each shell of the set. Adjustments are made after the first few feet of cloth have been inched through the machine: to correct the fit across the width of the cloth the bearings of the mandrel are displaced sideways; adjustments at the box wheel can turn the mandrel slightly relative to the wheel itself and make the impression from one shell fall a little earlier or a little later within the repeat, so ensuring longitudinal fit. Some adjustment of this kind may also be needed while the pattern is being printed, since the cloth may stretch a little unevenly under tension. The diameters of all the shells are the same and all are driven at the same rotational speed, so that the surface printing speed of each shell is therefore also the same. An integral number of repeats of the pattern is engraved around the circumference of each shell so that these repeats are printed without change of spacing regardless of the length of the cloth. With the older box-wheel mechanisms, adjustments in the fit were made manually and the slowing up necessary to effect them sometimes led to changes in the stretch of the cloth. However, more elaborate mechanical and electrical types of box wheels have become available; these allow the shift for fitting to be accomplished while printing at full speed.

Not all the rollers on a machine may be engaged in impression. Sometimes perfectly smooth, unpatterned rollers furnished with a paste containing no dye may be interposed in the sequence of engraved rollers when impressions of greater colour area, or with more intense colours, are printed on the cloth in front of impressions of smaller area or paler colours. This counteracts the danger of contaminating the pastes in the colour boxes toward the end of a series when the action of the lint doctor may not be adequate. The starch roller receives any loose colour from the cloth on its smooth surface, goes around to be coated with plain paste and then has its surface scraped clean by the doctor. When a multicolour machine is used to print a design with fewer colours than its maximum capacity, the engraved rollers may be too few to pull the cloth, blanket and heavy cylinder by frictional contact in the usual way and in this case additional plain rollers are run on the machine for driving purposes.

Three important modifications of the roller printing machine are made to meet special requirements of pattern or quality of impression:

1. Surface printing machines have already been mentioned; they are used to give prints of blocklike quality. Since the printing is from rollers in relief, modifications of the furnishing arrangements are needed.

2. Duplex printing machines are in effect two separate single-sided machines incorporated in the same structure and printing simultaneously on both sides of the cloth with the pattern on the one side in perfect fit with that on the other. Less perfect double-sided effects can be produced with single-sided printing in a push-through operation where the structure of the cloth, the pressure of the roller and the consistency of the paste allow the colour to go right through the cloth and give a reasonable impression on the underside.

3. Jumping machines are used for large repeats that are surrounded by an unprinted border. The machine is provided with gearing that checks the printing operation at the necessary intervals while the cloth moves forward by a distance equal to twice the width of the crosswise border. This obviates shells of inconveniently large diameter.

**Transfer of the Repeat to the Shell.**—*Milling.*—Patterns with small simple motifs and uncomplicated repeats such as spots, stars, rings, stripes, etc., are engraved by mounting the polished shell in a lathe and rotating it against a hard-steel, wheel-shaped die with a number of the design units in relief; these units indent the copper surface.

*Hand Engraving.*—To a limited extent, rollers are hand engraved by conventional methods. More frequently, hand engraving is employed to perfect rollers engraved by other methods and to correct defects caused by wear. (*See* also ENGRAVING, LINE.)

*Etching.*—This is the method used most frequently for engraving rollers. The original cartoon from the designer is projected optically onto a zinc plate and the repeat is incised on the plate, each detail being then coloured up to match the cartoon. An operator then follows the lines corresponding to one of the component colours on this plate with a stylus that forms part of a machine called a pantograph (or, less correctly, a pentagraph). Mounted in the pantograph is a smooth copper shell, covered with a layer of protective varnish; the movements of the stylus rotate the roller and also actuate a series of diamond points spaced along the length of the roller. As a result, the desired number of repeats are scratched at intervals along and around the shell. The roller is then rotated in a bath of suitable acids that penetrate the scratches and etch the repeats into the copper. If the engraving is a deep one it is not desirable to etch it in one stage, so the roller is revarnished and the scratching and acid treatment are repeated. When one roller of the set has been made, another is inserted in the pantograph, the lines on the zinc corresponding to a different colour are followed, and so on until the whole set has been completed.

*Photogravure Methods.*—A number of acid etching methods have been developed that follow the methods used to produce photogravure rollers for magazine printing. They reduce the time required for engraving and are specially suited for certain pictorial subjects.

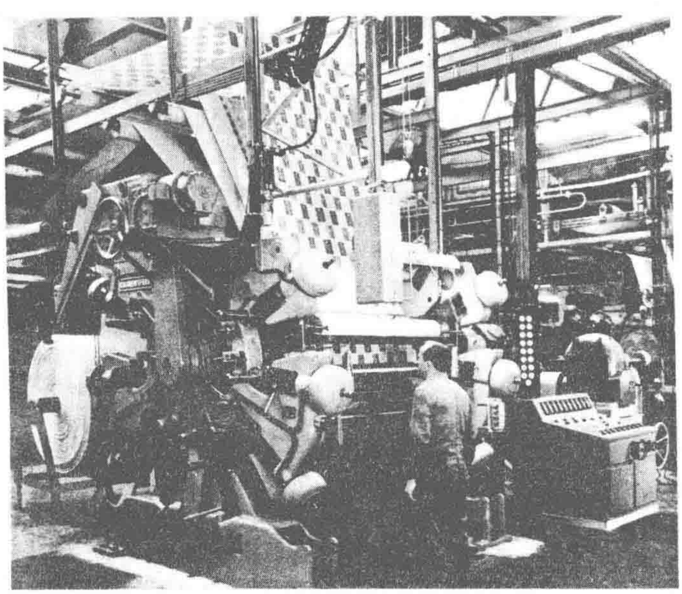
*Scale.*—For all shapes of appreciable area, simple engraving of a depression in the roller will not give satisfactory impressions since the paste that it contains after furnishing is not under adequate control and the printed area consequently will not be uniformly coloured. Such areas are therefore engraved as a series of parallel diagonal grooves. In printing, each line spreads laterally into the impression of its neighbour. The width and depth of the lines must be properly related to each other; these measurements are jointly specified in a number called the scale. In some engravings made by photogravure methods the impression is broken into dots by photographing the original image through a screen (rectangular disposition of lines), and the effect of the screen is the same as that used in photomechanical methods for printing pictures on paper.

**Colourings.**—A set of engraved rollers, blocks or screens can be used to produce a series of different and distinct decorative effects by (1) changing the combination of colours; (2) using only part of the set; (3) using the set in conjunction with rollers having small "all over" patterns that do not need fitting with the rest of the pattern and modify the ground or the blotches; (4) printing in conjunction with dyeing. Each modification of the use of the set of rollers in this fashion is called a "way."

There are also several more unusual methods for continuous printing. In one group of related methods, the colours are thickened until the printing medium is of the consistency of stiff dough. This is rolled out into sheets and cut into shapes that are mounted in mosaic fashion around the surface of a roller. This roller prints onto cloth damped with water or other solvent; the cloth is supported on another roller with a very resilient surface. The water or other solvent dissolves a small amount of the thickened colour, which is thus transferred to the cloth. Only a limited yardage can be printed with one roller because the roller coating is slowly consumed. The process has been used to produce beautiful and unusual prints that cannot be obtained in any other way; there is no limit to the number of colours that can be printed from the one roller. The usual difficulties of fitting are not present, since these have been dealt with in preparation of the roller itself, but there are restrictions in the kinds of dye that can be used.

In another unusual continuous method the design is first printed on paper with appropriate dyes in special media. It is transferred to the fabric by running the cloth and the paper through a heated calender together. Once the transfer has been obtained, the dyes used are fixed in the normal way.

**Colouristic Features.**—The choice of dyes and their adaptation for use in a given print depend upon a large variety of conditions, some chemical and some economic: the fibre or fibres from which the cloth is made, the colour requirements of the design to be reproduced and its durability in the expected conditions of use, the relation between the printed effect and later processes of manufacture (*e.g.*, finishing), the cost of production and the length of time before delivery. Most commercial printing is a compromise between the ideal interpretation of the design and the need to produce it at an acceptable price. The choice of dyes for a print, and to some extent the chemical and processing procedures used in their application and fixation, are known as styles.



"CIBA REVIEW," CIBA LIMITED, BASLE, SWITZ.

FIG. 4.—MODERN ROLLER GARMENT-PRINTING MACHINE

The relations between the kind of fibre in the material to be printed and the dyes used are in general similar to those that are obtained in dyeing but the physical differences in printing and dyeing systems may greatly modify the conditions of application. Two important differences are: (1) the dye and chemical assistants used in printing have to be applied in a much smaller volume of medium and are therefore concentrated; (2) the stage of diffusion and fixation in printing must be made to occur after the impression and in the relatively short, well-defined period of steaming or chemical aftertreatment. For this reason the formulations of a dye bath and of a printing paste containing the same dye may be very different.

The following groups of dyes are used in printing:

I. Direct cotton dyes, mainly for cellulose fibres; acid dyes for viscose, wool, silk, and nylon and certain other synthetics; basic dyes for wool, silk, cellulose esters; and disperse dyes for all hydrophobic fibres (those that swell very little in water).

II. Vat dyes, predominantly for cellulosic fibres but also (with special procedures) for other natural and synthetic fibres; insoluble azo dyes, mostly for cellulosic fibres, and often in special chemical forms to meet the special conditions of printing; phthalocyanine dyes, again for cellulosic fibres but again applicable in some chemical forms to other fibres.

III. Mordant dyes, in which the sequence of application of the dye, the mordant and the reagents that control the interaction of the two are specially chosen for printing conditions.

IV. Reactive dyes, which are mostly applicable to cellulosic fibres.

V. Pigment colours applied to the surface of the fibres and fixed with synthetic resin preparations so designed that, when fixed, they are not easily removed in washing and do not stiffen the fabric. They are applicable to a wide range of fibres, are simple to use, give full colorations and are particularly useful in screen printing.

A distinctive feature of much textile printing as compared with dyeing is that it is often necessary to use dyes from different classes to provide the different coloured areas in the same print and, for this reason, great ingenuity is needed in exploiting the chemical properties of individual dyes so that one fixation treatment, *e.g.*, steaming, is appropriate for all of them and so that the reagents used with one colour do not interfere with the other colours.

Two widely used styles that have no exact counterpart in dyeing are: (1) Discharge printing, in which the cloth is first evenly dyed before printing and then is printed with a paste that contains either an oxidizing or a reducing agent. Steaming causes the agent to destroy the dye on which it falls or to convert it to a soluble form so that it can be removed by washing. This therefore gives a white print on a coloured ground. An extension of this method is the use of the illuminated discharge in which a dye indifferent to the discharging agent is incorporated in the paste so that it takes the place of the ground dye that has been destroyed and gives a coloured print on a ground of a different colour. (2) Resist or reserve styles, in which the cloth is printed with a preparation (*e.g.*, wax or a synthetic resin) that protects the fibre from a dye solution, or with a reagent that chemically inhibits the fixation of a particular dye (*e.g.*, an acid for a dye that requires alkali for its fixation). The entire cloth is then dyed and the resisted areas remain undyed. As with discharge styles, the resist may be plain (white on a coloured ground) or coloured. A traditional example is the batik of Java and its analogue in west African styles. (H. A. T.)

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**TEXTILES** are woven fabrics. The term also means all spinnable fibres or materials suitable for weaving, in addition to fabrics produced by knitting and felting, and all laces. The Latin *textilis* meant a woven fabric, but the word *textile* was also used as a transitive verb for plaited, braided, woven or constructed. This article deals largely with decorative textiles. Other articles related to the subject include SPINNING; YARN; WEAVING; and WEAVING, HAND for the making of textiles; DYES AND DYEING for one process in their finishing; TEXTILE PRINTING for a detailed discussion of commercial aspects of that subject. There are also numerous articles on individual fabrics—*e.g.*, CALICO; CHALLIS; CHIFFON; DAMASK; DIMITY; etc.—which describe these fabrics and deal with them as items of commerce. COTTON MANUFACTURE; SILK; and WOOLEN MANUFACTURE similarly are concerned with textiles as industrial products.

This article is outlined as follows:



## I. HISTORICAL OUTLINE

**1. Early History.**—Since textiles are easily torn, burned or eaten by insects, the oldest surviving specimens probably date from long after the time when weaving was first practised. Whorls or weights for spinning have been found on Neolithic sites, indicating that thread was spun and therefore that cloth was made. The weaving of textiles for clothing, as a substitute for the skins of wild animals, was a corollary of settled life and the breeding of domestic animals. The four natural fibres, wool, linen, cotton and silk, originated in different parts of the world. Woolen textiles have been found in early Bronze Age sites in Switzerland and Scandinavia. In Egypt plain linen textiles of about 5000 B.C. have been found. Cotton scraps have been discovered in India on sites of about 3000 B.C. and in Peru on sites datable to 2000 B.C. Silk may have been used in China in the 2nd millennium B.C. and was certainly woven by 1000 B.C. Cloaks, tunics and caps from Scandinavian sites show that a high level of skill had already been reached there, even though tools were few and primitive. The preparatory processes of carding and combing raw wool were known, for the threads are well and evenly spun. Felt caps and narrow braids were also made, and sprang, a technique between knitting and netting, was used.

Flax was grown in the Nile valley. The natural colour of flax fibres is brownish, and since whitish linens have been found in very early tombs, methods of bleaching must have been discovered. Spinning was done by hand, using a simple weighted spindle, and cloths were woven on three types of loom: a horizontal loom fixed to the ground, an upright loom with a beam at the top and bottom, and an upright loom with the warp threads bunched in groups and weighted at the foot. Variants of this last loom are seen on ancient Greek vase paintings, and this type was probably used to weave the textiles found in Scandinavia. Tablet weaving for making narrow braids, netting, sprang and other techniques were developed. Normally cloth was woven in tabby (plain weave). In Ptolemaic Egypt very fine counts of linen have been found in textiles probably woven for the courts of the Pharaohs. Strangely analogous to the garments found in the north are tunics woven to shape.

The Romans wore both linen and wool, but as the empire extended so did the variety of textiles they imported. Pliny described the Roman toga of wool or linen, and later writers deplored the fashionable clothes made of silk from China. From two sites in Mesopotamia, Doura-Europus (deserted A.D. 256) and Palmyra (sacked A.D. 272), there are textiles showing the weaving repertoire of the ancient world to have comprised chiefly plain wool or linen—though at Palmyra some linens were dyed in true purple and among the wrappings of the dead were some imported cottons. Several of the earliest patterned materials made outside China were also found. These are the tunics and fragments woven in plain linen with tapestry-woven insertions.

The designs of the fragments from Doura-Europus are comparatively simple; on the other hand, for several centuries after the 3rd century A.D. Coptic weavers of Egypt produced an extraordinary variety of decorative textiles, chiefly for clothing. The dry sands of the burying grounds of Akhmim and Antinoë have preserved a profusion of such textiles dating from the 4th to the 10th centuries. The patterns reflect the cultural life of the entire Mediterranean. The bands of decoration, which were narrow on the fronts and shoulders of the tunic fragments at Doura, were larger and more elaborate, with roundels containing mythological and biblical scenes. Naturalistic birds, animals, gods and mortals in fresh, bright colours influenced by Hellenistic art were gradually transformed in subject and in style. Long after the conquest by Islam in the 7th century the Coptic weavers continued to look back to Christian subjects for their inspiration. The influence of other countries and other media can be detected, and the patterns of woven silks were copied in wool. In time, however, whatever their origin, the motifs forming the designs were subordinated to a general decorative effect until they became almost unrecognizable.

Many animal-fibre (vicuña, llama, etc.), agave and cotton textiles have been found in the sands in the narrow coastal strip of South America between the Andes and the Pacific, relics of the pre-Columbian civilization of Peru. The earliest of such relics date from about A.D. 1000, though their chronology is uncertain. Without any further modification of the loom than the weaver's fingers could provide, the inhabitants wove complex patterned textiles in tapestry, double cloth, brocaded gauze and other techniques for belts, blankets, bags and clothing. Anthropomorphic subjects are common.

**2. Advances in Weaving.**—One of the most important developments in the history of textiles was the invention of a method of making free designs that could be repeated indefinitely once the loom was set up. It is certain that the Chinese had found a means of achieving this early in the Han dynasty (202 B.C.–A.D. 221). The Chinese loom probably had treadles and rotary cloth and warp beams before those in the west, both of which presuppose the weaving of large quantities of fairly complex materials. The invention of a drawloom implies a civilization so advanced that expensive textiles were produced for a wide commercial market—it would not be worthwhile otherwise to set up the pattern. Chinese silks have been found not only on the old silk road from China, at Loulan, Turkestan, and other sites by Sir Aurel Stein but also a group of silk damasks were among the textiles excavated at Palmyra.

On the drawloom it is possible to lift the warp threads required for the pattern irregularly across the textile in each line of the design. In China a drawboy sitting on top of the loom pulled a set of cords attached to all the warp threads necessary for that line of the pattern each time the weaver opened a new shed. The warp threads thus pushed to the back of the textile the weft not required on the surface. The setting up of such a loom was laborious and the work very slow and tiring for the boy or girl helping the weaver. Though several important modifications very much later made the drawloom a more efficient machine—by the 17th century, for instance, the introduction of lashes and simples permitted the boy to work at the side of the loom—fundamentally the drawloom remained unchanged until the late 18th century. In the early Chinese silks the pattern was made either by a form of damask in which a warp-faced weave contrasted with a weft face, or by different-coloured warp threads entered in sequence in the loom and brought to the surface as required by the design. The patterns of the early Han textiles were often similar to the geometric cartouches on the backs of bronze mirrors or were derived from a repertoire of exotic fauna, dragons and birds being especially common.

Farther west the first drawloom patterns appear in woolen textiles found in the Egyptian burying grounds and perhaps dating from the 4th–5th century A.D. A group of these show small birds within compartments, woven in compound tabby. The word compound indicates a two-warp system: the main warp, controlled by the drawboy, is hidden between the front and the back of the textile and the binding warp appears on the surface to bind the wefts in tabby. These textiles were probably woven in the near east but it is not known where.

**3. 4th–15th Centuries.**—*Middle East.*—After the fall of the Roman empire textiles continued to be woven in the traditional centres and exported abroad. Following the Muslim conquests of the 7th century new textile centres appeared in Syria and Arabia. At the western end of the silk route across central Asia from China, silks were woven in Sogdiana and in Sasanian Persia (3rd–7th centuries A.D.). Important patrons of silk weaving were the Seljuks who ruled Persia, Asia Minor and Syria in the 11th and 12th centuries. Apart from a group excavated at Rayy, few Persian textiles can be certainly attributed to an earlier date than this. A number of important silks can be attributed to Egypt in the time of the Mamelukes.

Most of these near-eastern textiles are known only from literary sources but from the 7th–8th century onward woven silks have survived in some quantity in the tombs and reliquaries of saints and other important figures, opened at later dates, and from the 12th century onward as the seal bags of treasuries and as vestments. Such silks often came from far-distant countries; thus silks from central Asia have been found in French and Flemish churches, and Chinese silks have even been found in Viking burial grounds. The designs of near-eastern silks owe little to China but much to the traditions of Sasanian art. In roundels fabulous monsters such as the *senmurv,* half-bird half-dog, are typical. The sculptures of the Sasanian monuments, especially at Taq-e Bostan, prove that such patterns, themselves based on Achaemenid art, originated in Persia. The roundel became the set form of decoration for several centuries, though the motifs it contained and the ornament from which it was composed varied considerably.

A magnificent series of woven silks can be attributed to Byzantium. Silk weaving may not have been very important in the city until the 6th century but very soon afterward imperial workshops were established which controlled the industry. The capture of Ctesiphon, the Sasanian capital of Khosrau II, in 624 and the booty taken by the Byzantine troops may have influenced the development of silks made in Byzantium. Early Byzantine silks were made in compound twill—that is, with the hidden main warp making the pattern and the binding in twill, allowing longer floats of weft than in tabby and thus exploiting the lustrous quality of the silk. Subjects owing much to the inherited tradition of Rome included the Quadriga silk showing a charioteer, and the lion strangler, perhaps Samson. Byzantine silks have been preserved in the tomb of Charlemagne at Aachen. This was opened in 1000 A.D. and new silks added—the elephant silk found there was probably made not long before the opening and is similar in style to lion silks elsewhere with 10th-century inscriptions. These were made in the golden age of Byzantine silk production. A group of silks were woven in the 11th century in which the pattern appeared as a penciled or engraved outline in a self-coloured material; the vestments of Pope Clement II (1046–47) at Bamberg, Ger., are remarkable examples.

While the richest silks fit for kings and emperors have survived, the ordinary wool and linen materials worn every day have perished. The history of textiles between the terminal dates of the Egyptian burying grounds and the 16th century tends to be divided into the history of vanished products based on documentary evidence on the one hand and the history of luxury silks on the other.

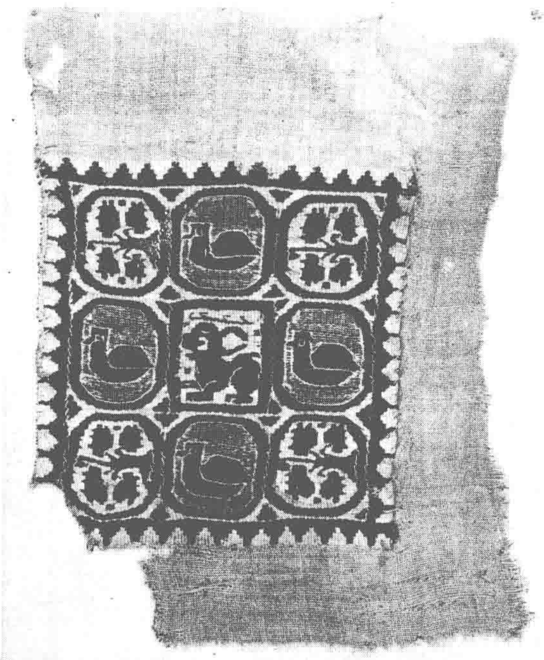
Among the rare textiles whose origin is known with certainty are those from the *tiraz* factories, which are inscribed with the names of the place and of the caliph in whose reign they were made. Some of these are tapestry-woven, most have embroidered inscriptions and date from the 8th–11th centuries.

*Western Europe.*—The Low Countries were the centre of a large and politically important cloth industry from the early middle ages. Already in the 8th century England was exporting wool to Flanders, but this trade did not become important till the 11th century. The Cistercians were important sheep farmers. Most districts in northern Europe made cloth of various qualities for local consumption, but by the 12th century the Low Countries were weaving cloth from imported Spanish and English wool and exporting it to other parts of Europe. In the later middle ages English royal policy sought with some success to prevent the export of wool in favour of that of unfinished cloth. Flax was similarly grown and linen woven in a number of European countries, but the only linen textiles to survive in any number are the towels with decorative ends said to have been made in Perugia, It., in the 15th century. Silks and linens were also made in Germany, especially in Cologne and perhaps in Regensburg.

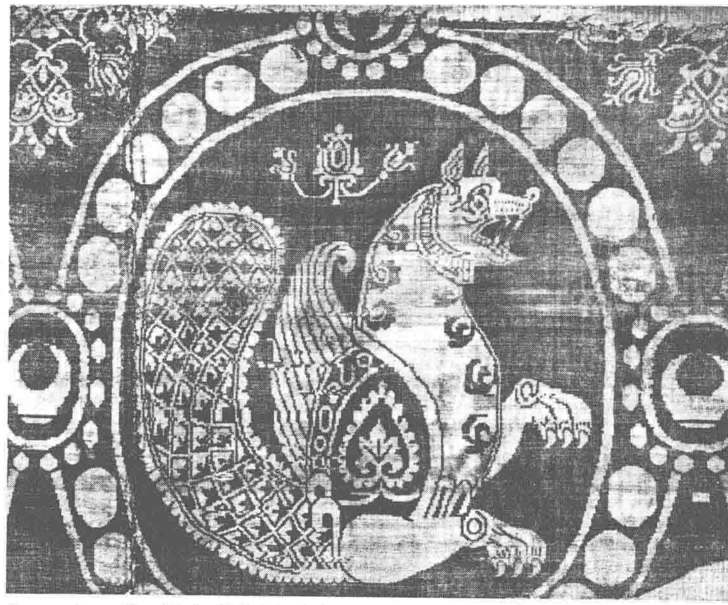
Silk was certainly being woven in Mediterranean countries by the 9th–10th centuries. Although at first raw silk was imported from the near east, the cultivation of the white mulberry tree essential to the silk worm soon followed. Some time after the establishment of the western caliphate in Spain (8th century) silk weaving was established in Córdoba; later it was carried to Almería, Zaragoza, Málaga and elsewhere. In Hispano-Moresque textiles ornament from the near east was combined with a wholly distinctive style of decoration originating in Spain. Emphasis on the purely decorative form of interlacing patterns reached its climax in the last Moorish factories of Andalusía. The Norman conquerors of Sicily established silk-weaving workshops, but it is difficult to distinguish silks from Egypt, Sicily or Asia Minor for all drew on the same cultural sources. The traders of Venice and Genoa imported silks into the mainland whence they were distributed throughout Europe. An accessible source of raw material together with the early growth of compact city-states favoured the establishment of silk weaving in Italy. A treaty between Lucca and Genoa in the mid-12th century gave Lucca access to the Levant and also to the fairs in northern Europe. Merchants of Lucca traveled to the Levant to buy silk and to northern Europe to buy woolen cloths and to sell woven silks. In the 14th century, however, political difficulties displaced the town from its preeminence. Guilds of silk weavers were established in Venice, Florence, Bologna and Genoa.

A comparatively large number of silks can be attributed to northern Italy in the period from the 12th to 15th centuries, though few are known to come from any particular city. Their designs reflect the general style of Gothic art, with animals, rinceaux and heraldic devices of unfailing invention. During the 14th century the route to China was reopened, and many silks woven after that time incorporate decorative details showing Chinese influence—dragons, exotic birds, palmettes and cloud bands. Some of these may be seen in contemporary paintings; *e.g.,* the robes worn by St. Edmund Martyr in the Wilton diptych (*c.* 1395) in the National gallery, London.

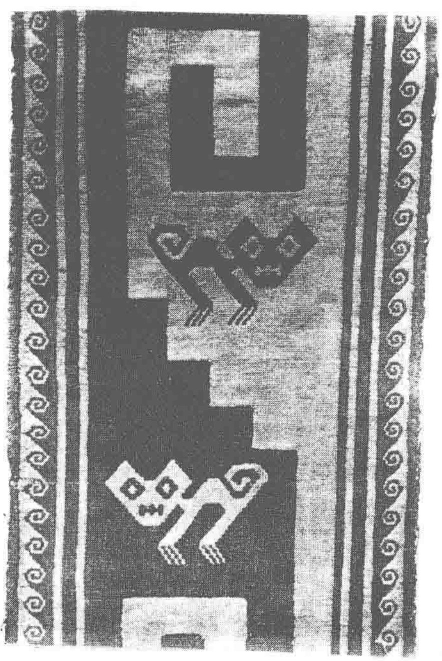
The technique with which these silks were woven was advanced; the main warp appeared on the surface of the textile and was combined with a second (or ground) weft to form a texture contrast-



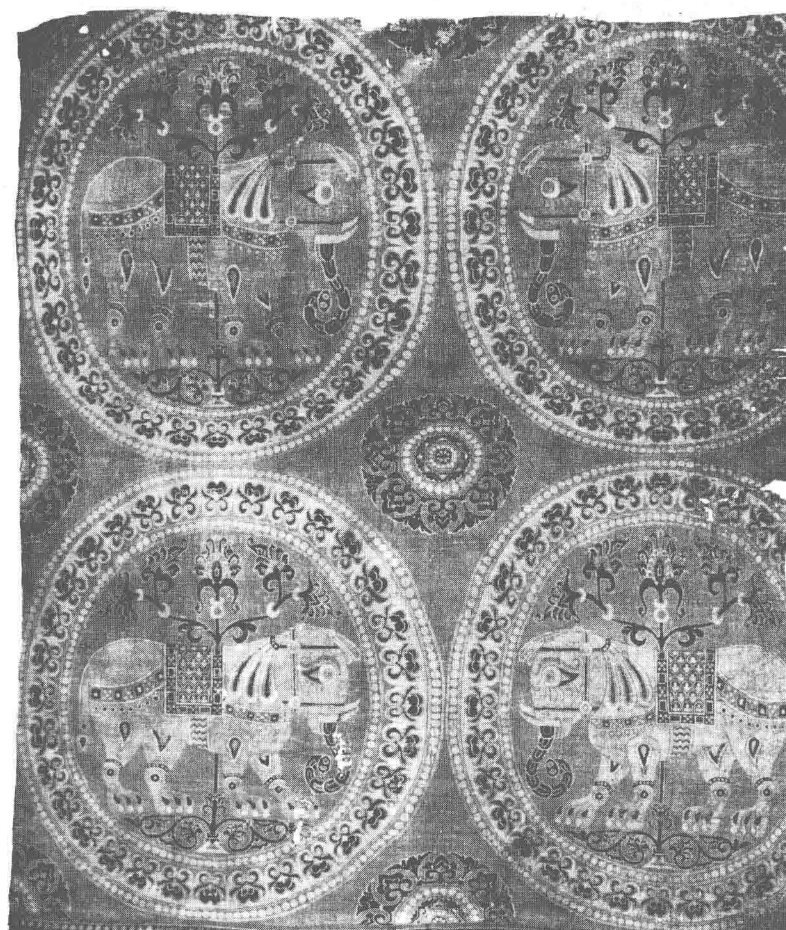
Panel tapestry woven of tan wool and purple linen; probably Egyptian or Mesopotamian, dating from the 5th or 6th century



Near eastern silk with half-bird, half-dog design, thought to have come from a reliquary in the church of St. Leu, Paris, about A.D. 700–900



Patterned cotton, woven in double cloth, with cat motif; relic of the pre-Columbian civilization of Peru



Byzantine elephant silk from the tomb of Charlemagne at Aachen, Germany; 10th century

## WOVEN TEXTILES: AMERICAN AND NEAR EASTERN

Northern Italian silk woven with gilt membrane. The design, composed of stags, hounds, lions and phoenixes, shows the influence of Chinese decoration which prevailed in Italy during the last half of the 14th century

Persian fabric woven with a cup-bearer motif in the tradition of Persian illuminated manuscript design; 16th century

WOVEN TEXTILES: 14TH- AND 16TH-CENTURY NORTHERN ITALIAN AND PERSIAN

## WOVEN TEXTILES: SILK DAMASK, SILK AND VELVET BROCADES

Chinese silk damask with floral design; early 18th century

Italian cut velvet brocaded with gold loops in a curving pomegranate design characteristic of late 15th- and early 16th-century textile fashion in Italy

Hispano-Moresque silk brocaded in gold. The design is a blending of near-eastern ornamentation and Spanish-style decoration

BY COURTESY OF MUSÉE HISTORIQUE DES TISSUS; PHOTOGRAPH BY RENÉ BASSET

**WOVEN TEXTILES: LATE 18TH-CENTURY FRENCH**

Woven silk textile hanging from the queen's chamber at Fontainebleau by Philippe de la Salle of Lyons, who designed a series of furnishings adorned with lifelike birds and flowers