Appendix I

STANDARD YARNS

(See Appendix II for terms used mainly in conjunction with man-made materials)

Angola yarn See Union yarns.

Angora yarn A very soft yarn spun from the long, fine hair of the Angora rabbit, and mostly used for knitted fabrics.

Artificial silk, or **rayon** (see Appendix II).

Asbestos Yarn Asbestos is a mineral fibre found as veins in serpentine rock, the chief supply being obtained in Canada. The fibre is fine and smooth, and the yarn may consist entirely of asbestos, or a small percentage of cotton may be added in order to make the material spin better, and to increase the strength. The yarn is used single and two, three, or more fold, and in some cases a brass or copper wire thread is twisted with asbestos thread, the latter being wound round and round the wire thread so as to cover it. (See Asbestos cloth.)

Balanced twist The twist is assumed to be balanced in a two-fold yarn when half as many turns per inch have been inserted in the doubling process as were previously inserted in the opposite direction in each single thread. Theoretically, each turn of reverse twist in the doubling takes a turn out of the single twist, and in twisting together two single threads which contain, say, twenty turns per inch, the twist will be balanced when ten turns of reverse twist have been made. It is usual, however, to exceed this condition so that the twist in folded yarns more nearly approaches that of the single threads as a result of which there is very little twist left in the single threads.

Bastard cop A size of cop made at one time between the ordinary sizes of warp and weft cops.

Bleached yarns Bleaching is employed for yarns which require to be white or which it is intended to dye in light shades.

Brass bobbin yarn The thread which is wound on the thin brass bobbin, and is used as weft in the manufacture of lace cloth, the counts ranging from about 20/2 tex to about 4/2 tex.

Bundle yarn Hank yarn which is made up for transport in the form of long bundles, which are unpressed, or in short bundles in which the hanks are compressed into smaller compass in a bundling press.

Cabled yarn Term applied to yarns, such as sewing cotton (q.v.), which are produced by twisting together two or more folded yarns. The method yields a stronger, smoother, and more regular yarn than when all the single threads are twisted together at one operation.

Camel-hair yarn See Worsted yarns and Hosiery yarns.

Carpet yarns Fulness and resiliency are the main qualities required in a carpet pile yarn. Traditionally, Scotch blackface and East Indian wools were used along with Welsh and lower qualities of cross-bred wools. These materials are still employed extensively and are spun mainly on the woollen system although in fine Wilton and Gripper Axminster carpets worsted spun yarns are also used.

Yarns composed of man-made fibres, however, are even more extensively used than wool and in the field of non-traditionally constructed carpets they occupy a predominant position. Chief materials are certain types of viscose rayon and acrylic staple yarns as well as bulked nylon (q.v.). Fibre blends are also commonly employed, e.g. viscose rayon staple/wool; or, viscose rayon staple/wool/nylon, and, although the constitution of these blends varies, the first type is frequently encountered composed of 60 per cent viscose staple and 40 per cent wool, whilst the second type quoted is often made in the proportion of 50/30/20.

Cashmere yarn See Worsted yarns and Hosiery yarns.

China grass or ramie yarn Composed of fibres derived from the stems of plants of the same species as the nettle. The thread is lustrous, white, and strong and is largely used in the manufacture of gas mantles.

Chlorinated yarns Wool in fibre, sliver, top, or yarn form is made non-shrinkable by treatment with chlorine, and at the same time is made more readily absorbent of dyes than untreated wool. (See Chlorinated cloth.)

Coir or coconut fibre yarn Thick, coarse yarn spun from the reddish-brown fibre of which the outer covering of the coconut is composed. Used for matting (q.v.) and cordage.

Cop-and-cop doubled yarn Two-fold yarn of which the single threads are from two different qualities or spinnings, a cop of each being twisted together in order to equalise the cost or quality of the two yarns.

Core yarn Made with a cheap yarn in the centre round which a special kind of thread is wound in such a manner as to cover the central thread. (See Tinsel yarn.) Lastex yarn (q.v., Appendix II) has a rubber thread in the centre.

Cotton yarns The different classes of cotton vary in length of fibre from 12 mm to about 50 mm, but the limits to which they will spin range from about 30 tex to upwards of 2 tex. The fibres are arranged somewhat straight and parallel in the thread in a very similar manner to the fibres in a worsted yarn.

Mule-spun cotton yarn Very little cotton yarn except for the fine counts is now mule-spun. Drafting, spinning, and winding on are performed intermittently, and the twist is inserted over a long stretch of thread, so that short fibres project freely from the body of the yarn, which has a full appearance and makes a well covered cloth.

Ring-spun cotton yarn The thread is smoother and stronger than mule-spun yarn, as the fibres are better twisted in, but it is not so elastic. Drafting, spinning, and winding on are performed continuously, and the thread has to be wound on to a substantial basis in the form of ring bobbins or strong paper tubes. About 7 tex is the limit of fineness in combed Egyptian yarn and 12 tex in carded American.

Combed cotton yarn The short fibres, and along with them any impurities which have been left in the cotton, are separated from the long fibres by combing. The resultant yarn is, therefore, cleaner, smoother, stronger, and more lustrous than a carded (uncombed) cotton yarn, but it has less filling power, owing to the absence of the short fibres. A thread may be stated as half, ordinary, super, or double-combed, the waste taken out being respectively about 11, 15, 18, and 24 per cent. On account of the increased cost, combing is only employed to give the cotton the requisite spinning property for fine counts, and when a high-class yarn is required in medium counts.

Carded cotton yarn Contains the short fibres and is a more fibrous or oozy thread than a combed yarn, and cannot be spun to such fine counts. A carded yarn is less costly, however, and is particularly useful when a well-covered cloth is required. In super-carded yarn the material has been specially cleaned of the very short fibres and fine impurities, to enable a superior or finer thread to be spun.

Condenser cotton yarn A thick, soft, full handling yarn, liable to contain many impurities, which is composed of soft wastes from cotton carding, combing, and drawing, and hard thread wastes from cotton spinning and weaving. These are opened out and formed into a soft, fibrous condition, and then carded on the 'roller and clearer' system, and condensed and spun on the same principle as woollen yarn.

See, also, the following Cotton yarns: *Brass bobbin, Crotchet, Doubled, Flannelette, Heald, Lace, Lisle, Mercerised, Motor tyre, Polished, Prepared hank* and *Sewing.*

Crêpe yarn Very hard twisted, single or two-fold yarn, composed of cotton, wool, silk, or rayon (q.v.). In folded yarns the twist is usually in the same direction as that of the single threads, and the high twist causes the yarn, when slack, to snarl or kink up. To set the twist and make the yarn easier to work it is subjected to humid heat, usually by steaming the yarn on bobbins. In cotton crêpe yarns the tex twist multiplier ranges from 140 to 240, but the strength gradually decreases as the multiplier rises above 130.

Crossband yarn The twist runs from right to left looking up the yarn, as shown at B in *Figure 2.12.*

Crotchet yarn A softer thread than sewing cotton, and when made at two operations of doubling the twist in the first process is in the opposite direction to that of the single twist, and in the second process is in the opposite direction to that of the folded twist.

Curled yarn See Worsted yarns.

Doubled or folded yarn Consists of two or more threads twisted together with the primary object of obtaining greater strength and evenness than can be obtained in a single yarn of the same count. Special yarns are also obtained by twisting together threads which differ in thickness, length, colour, material, etc. (see Fancy yarns). The terms flyer, ring, and twiner or mule-doubled are applied to the yarn according to the method in which the twisting is effected. (Cap doubling is employed for a certain amount of worsted yarn and tends to make a rough thread, and in the *Climax* system of doubling, the threads, wound two or more together, are twisted while passing from the twisting spindles to cheeses or warpers' bobbins, which is the reverse direction to that of ordinary doubling, a process of winding being saved.) Flyer doubling is used for high qualities of fine yarns, and for very thick doubled yarns, as a rounder and smoother thread and more regular twist is produced than in ring doubling. The latter, however, is the cheaper and more productive method, and is the one chiefly employed. In ordinary doubled yarn the direction of the folded twist is opposite to that of the single threads. This produces a softer folded yarn than if both twisting operations are in the same direction (see Twist-on-twist), because each turn of reverse twist in the folding takes a turn of twist out of each single thread. For the same reason a folded thread is usually softer than the single threads of which it is composed, and in dyeing the yarns a given tone can generally be obtained on folded threads by means of a lighter dye than is required for single threads. (See Balanced twist.)

Doubling weft (D.W.) Term applied to single cotton yarn used for doubling purposes, the amount of twist in which is between the ordinary warp and weft twist, and the direction the same as warp twist.

Wet doubled cotton yarn The single threads pass together through a trough containing water to the twisting spindles, and a smoother and stronger folded yarn is produced, because the loose fibres are laid and thoroughly twisted in. In the *English* system of wet doubling the threads simply pass under a glass rod in the water trough, whereas in the *Scotch* system the lower delivery roller revolves in the water, and the threads pass under it and then between the two rollers, by which the yarn is made much wetter than in the English system. In wet doubling fine, hard-twisted yarns the moisture does not penetrate very readily, and a wetting out agent is sometimes added to the water to improve moisture penetration.

Dry doubled yarn Threads which have to be bleached, dyed, sized, etc. are dry-doubled, as they require to be in an open condition so that they will be absorbent; also soft, full yarns such as those used for hosiery.

(See, also, *Balanced twist, Cabled, Double-throw yarn, One-throw yarn,* and *Twist-on-twist.*)

Double-throw yarn Consists of a number of single threads, which are twisted together at two operations of doubling (see Cabled yarn).

Embroidery and **crewel yarns** Made from silk, rayon, linen and cotton, from two to six-fold and soft twisted. The cotton yarns are mostly made from a high quality of cotton, and are gassed and mercerised to imitate silk.

Fancy, novelty or **effect yarns** These are chiefly produced by blending different colours or materials in the fibre state; by printing or dyeing a pattern on the sliver or yarn; by introducing spots or neps of coloured fibres which are twisted in with the threads; by twisting together threads which are different in material, colour, softness, thickness, length, and amount and direction of twist; and by forming curls, snarls, lumps, knops, and thick and thin places at intervals in the yarn. The principal types of

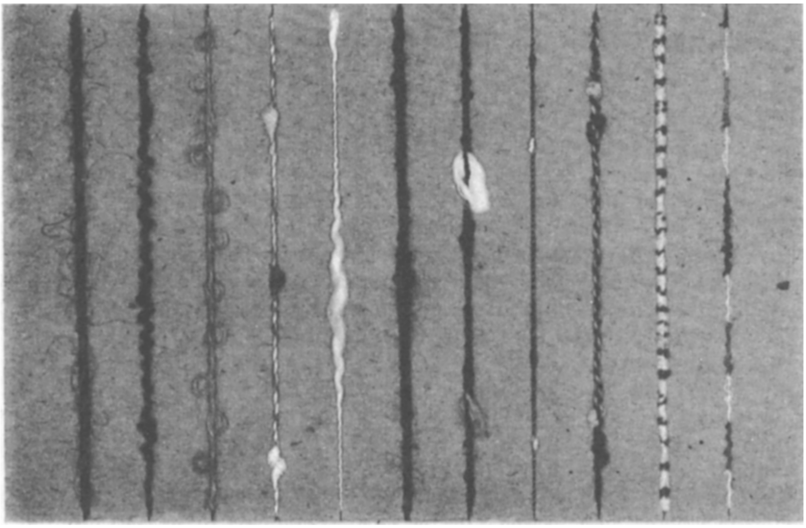

Figure A1.1

yarns are illustrated in *Figure A1.1*, and described in the following, but there is practically no limit to the diverse ways in which the different effects may be combined and utilised.

Grandrelle yarn Composed of two or more differently coloured threads twisted together, which are usually about equal in thickness. A in *Figure A1.1* illustrates a two-ply yarn. In order to produce a regular effect in a cloth which is largely composed of grandrelle warp threads, each warp float on the surface should contain approximately one complete twist of the yarn, and there should, therefore, be some relation between the number of turns per inch and the length of the warp float. Thus, in a cloth with 24 picks per cm, 2-and-2 twill gives a warp float of $\frac{1}{12}$ cm, 3-and-1 twill of $\frac{1}{8}$ cm, and 5 shaft satin of $\frac{1}{6}$ cm, and the number of turns per cm of the grandrelle warp should be approximately 12, 8, and 6 for the respective weaves.

Marl yarn Produced by spinning from two differently coloured rovings (or one white and the other coloured), a single-twist thread being made which looks similar to a two-fold grandrelle yarn, and the term mock-grandrelle is applied to it. The colours are not so distinct as in a grandrelle thread, however, and, in order to further break up the solidity of the colours, two marl threads are sometimes twisted together.

Spiral yarn The example illustrated at B in *Figure A1.1* is a cotton yarn, and consists of a two-fold (cross-band) thread twisted cross-band with a thick soft-twisted (open-band) thread, which is given in much more quickly than the two-fold thread. The folded thread is then twisted open-band with a fine single (open-band) thread, which is held tighter than the folded thread. A worsted spiral yarn is made by twisting a thick, soft twist thread slackly with a fine, hard twist thread. This type of yarn is sometimes used in producing curl effects by heavily shrinking the cloth in which it is woven, the soft-twisted thread being thus made so slack that it forms loops on the surface.

Gimp yarn Similar to spiral yarn, but is harder twisted than the latter, and usually is finer in counts.

Corkscrew yarn Usually consists of a rather hard-twisted fine thread and a soft-twisted thick thread, the former being held tighter than the latter in the doubling process, so that the thicker thread is woven spirally round the fine thread. The yarn is sometimes similar in appearance to a spiral yarn, but the effect is not so pronounced.

Diamond yarn The yarn illustrated at D in *Figure A1.1* shows a diamond effect between the knops.

Bead yarn Contains hard lumps, like beads, at intervals, while in some cases proper beads on one thread are fixed in position by twisting another thread with the first thread.

Curl or loop yarn The example illustrated at C in *Figure A1.1* is a worsted curl yarn in which the thread that forms the curls is made with open-band twist and is folded cross-band with a double thread that has been twisted cross-band. The curl thread is much thicker than the other thread, and is slackly twisted round the latter, and the two threads are then twisted open-band with a fine open-band twist thread. The reversal of the twist in the second folding process untwists the slack curl thread, so that it forms loops at intervals. The formation of the curl may also be due to the thick thread being given in slack at regular intervals.

Snarl yarn Similar to curl yarn, but the slack thread is hard twisted, so that, instead of forming loops, it twists up and produces snarls.

Knop yarn The example illustrated at D in *Figure A1.1* consists of a dark cotton thread twisted with a light worsted thread, which at regular intervals is delivered very rapidly, so that it is wound round and round the first thread in the form of a hard knop or lump. The two threads are then twisted in the reverse direction with a second cotton thread, which acts as a binder.

Cloud yarn Illustrated at E in *Figure A1.1*. The example consists of two fine threads twisted together, and at intervals a portion of a thick, soft roving is given in and twisted with them. The threads are given in rapidly along with the roving, so that there is much less twist in the thick parts of the yarn than in the thin parts. The term cloud is also applied to a type of yarn which is mainly composed of two differently coloured threads, each of which, in turn, is wrapped round the other thread, so that the yarn shows first in one colour for a space and then in the other colour.

Slub yarn Thick slubs or lumps, as shown at F in *Figure A1.1*, are formed at intervals in the yarn. A fine thread is twisted with a thick roving, which is given in with a variable draft, so that it is made alternately fine and thick, with most of the twist running into the fine parts. A fine binding thread is then twisted with the two-fold thread in the opposite direction. The yarn is similar to a cloud yarn, except that the roving is not continuous in the latter. The thick lumps are sometimes produced by giving the roving in rapidly and winding it round and round the fine yarn (as in making a knop yarn), the roving in this case being the same thickness throughout.

Knickerbocker yarn See example G in *Figure A1.1*. Spots of colour appear in the yarn, which is usually produced on the woollen principle. Coarse and medium wools of the cheviot and cross-bred types are used for the thread, while the coloured spots are generally composed of fine wool which is introduced in small tufts during the later stage of carding, so that it remains unopened and shows as solid spots of colour.

Nub yarn An irregular thread that contains small spots or nubs, as illustrated by the yarn shown at H in *Figure A1.1*, which has been produced on the same principle as a knop yarn. The thread may also be made in the same method as a knickerbocker yarn.

Spot yarn See example I in *Figure A1.1*. Small lumps or spots, in a different colour from the ground thread, occur at regular or irregular intervals. The term spot is also applied to knop, knickerbocker, and nub yarns, which show spots of colour.

Flake yarn Rather large patches or flakes of white or coloured material are twisted in with a differently coloured ground thread. The term flake is also applied to cloud yarns.

Chenille yarn See example J in *Figure A1.1*. For use as a novelty yarn, chenille has a central core of threads, from which fibres project more or less all round. The yarn is formed in a weaving process in which warp threads are placed in groups at a suitable distance apart (according to the required length of the projecting fibres), and are interwoven on the gauze principle with the weft, which may be variously coloured (see *Watson's Advanced Textile Design*). The floats of weft between the groups of gauze threads are afterwards cut, and a number of chenille threads are simultaneously produced, each of which is as long as the texture which is woven in the loom. Chenille is used as a novelty yarn in both warp and weft, but it is chiefly employed as weft in chenille fabrics, and in the production of figure textures the threads are coloured to coincide with the form of the required design.

Printed yarn In the ordinary process of printing threads one or more colours are impressed on hank or warp yarns in the form of bars, as shown at K in *Figure A1.1*, and all the threads, which are printed at the same time, are coloured alike. For chiné fabrics (q.v.) varied and elaborate colourings are printed on the warp threads.

Fast-dyed yarn Has been so dyed that the colour will withstand without deterioration the action of such agencies as light, washing, scouring, bleaching, rubbing, etc.

Flannelette yarn A cotton weft used for cloths which are finished with a raised surface. The thread is usually soft spun and thick, and is made from a rather short-fibred cotton of fair quality, such as Indian or similar cotton, mixed with a good class of waste fibre. Should the yarn contain too much short fibre excessive waste is made in the raising process, and if it is very soft-twisted the cloth does not wear well (see Flannelette fabric).

French or **dry-spun worsted yarn** See Worsted yarns.

Gassed yarn The yarn is passed through the flame of a gas burner by which the loose surface fibre is burned off. The threads appear browner after gassing, but they are made smoother and more lustrous, and the process is employed for voile and lace yarns, sewing threads, and yarns for mercerising. The usual loss in weight is about 5 per cent but threads which require to be very clear and are gassed twice may lose upwards of 8 per cent in weight. The term *genappe* is applied to gassed worsted yarn.

Hard-twist yarn Contains more than the normal number of turns per cm, and is used for special fabrics, such as voiles, crêpes, crepons, etc.

Hemp yarn Is naturally dark coloured, and is chiefly used for twine, cordage, and ropes, but is also employed for the backs of carpets and as a substitute for flax yarn in coarse canvas cloths.

Heald yarn Genappe worsted heald yarn, made from long wool, is used to some extent, but Egyptian cotton yarn, ranging from 9 to 16 or more fold is more generally employed. A smooth yarn which is capable of absorbing varnish is required, and the thickness is varied according to the counts of the warp and number of ends per cm in the cloth to be woven.

Hosiery yarns Chiefly made from wool and wool hairs, cotton, rayon, and synthetic fibres, and, as a rule, the thread should be soft-twisted, open in structure, and possess the properties of fulness and softness in a high degree. In wool a wide range of qualities is used, but a fibre which has little tendency to shrink or felt during washing is particularly serviceable. English Downs wool, which is of medium quality and length and very full handling, and fine cross-bred, are among the best knitting wools. Botany wool, which felts readily, provides a good foundation for the formation of a raised surface, but when this class of finish is not required, the material is occasionally mixed with cotton in order to reduce the shrinking property of the yarn (see Union Merino yarn). Pure Shetland wool and the fine hairs (goat, camel) possess excellent properties for hosiery yarns, and they also have a natural colour which renders them useful for many purposes without dyeing. Cotton tends to produce rather a hard thread, but when loosely twisted it can be raised so as to give a soft feel. Most frequently hosiery yarns are two or more fold in structure, and sometimes a silk or rayon thread is twisted with a wool or cotton thread.

A wide range of synthetic materials is also used in making the yarns which may be in the staple form, or in the form of continuous filament yarns either bulked or flat.

Wheeling yarn The single thread is spun on the woollen principle (see Woollen yarn), and usually two, three, or four of the threads are folded together, a somewhat heavy and coarse knitting yarn being produced.

Lambs' wool yarn Term applied to woollen-spun knitting threads made from the shorter and finer qualities of wool (not necessarily lambs' wool).

Worsted hosiery yarns (see Worsted yarn) Vary very much in quality, the longer and coarser fibres being open-drawn and flyer-spun, whereas cone-drawing along with flyer or cap spinning is employed for shorter and finer wools. Sometimes a large proportion of the short fibre is left in the yarn, and occasionally combing is entirely omitted. For under-wear yarns the best and fullest threads are obtained from fine wools by dry-combing, French drawing, and worsted mule spinning.

Fingering yarn Usually consists of two or more worsted-spun threads folded together (as distinct from a wheeling yarn, in which each thread is woollen-spun).

Cashmere hosiery yarn Made from fine Cashmere goat hair on the worsted principle.

Shetland yarn Made from soft handling natural-coloured wool (not necessarily Shetland wool), or from a mixture of white and natural-coloured wool (such as alpaca), in imitation of Shetland wool. 'Natural' wool has the advantage that it does not soil readily.

Alpaca and camel-hair knitting yarns Very soft natural-coloured yarns, spun respectively from alpaca and camel-hair fibres on the worsted principle.

Berlin wool A brightly coloured knitting yarn used chiefly for embroidery and fancy knitting by hand.

Jute yarn Is naturally yellowish-brown, and is used in coarse counts for sacks and packing sheets, but the largest proportion of the output is utilised by the carpet industry, either as ground yarns in conventional woven carpets (particularly for the weft and the stuffer warp), or in backing cloths for tufted and other unconventional types of carpetings. Jute tow yarns are made from the waste of jute.

Lace yarn High-class cotton yarn, ranging up to 5/2 tex and finer, used in the manufacture of lace (see Brass bobbin yarn). The term lace, however, is also applied to a good quality of two-fold cotton yarn in any thickness which is used for weaving purposes.

Linen or **flax yarns** Made from the fibre obtained from the stems of the flax plant by the processes of retting, scutching, hackling, drawing and spinning.

Dry-spun flax yarn The dry method of spinning is employed for thick yarns, the sizes of which are traditionally indicated by the weight in pounds per spyndle of 14 400 yards. The fibres retain their original length, and the yarn is very strong.

Demi-sec or *half-dry-spun flax yarn* The drafted rovings, after leaving the front rollers, are passed in contact with a damp roller, so that the twist is inserted in the thread while in a wet condition, the fibres being better laid and a smoother yarn produced than in dry-spinning.

Wet-spun linen yarn In wet-spinning the rovings, previous to passing between the drafting rollers, go through a trough of hot water (85°C), by which the gum is softened that joins the ultimate fibres together, so that these are separated in the drawing process. The fine, short fibres that result are capable of being spun to very fine counts.

Boiled linen yarn Has been boiled once or twice in soda lye, which causes a loss in weight of from 5 to 10 per cent.

Creamed linen yarn Has been boiled and partly bleached, the loss in weight being about 10 or 12 per cent.

Half-bleached, three-quarter-bleached, and *full-bleached* Terms applied to linen yarn according to the length of time that the material has been subjected to the bleaching processes, and the number of times that the processes have been repeated. The yarn loses from 10 to 20 per cent in weight.

Lisle yarn Originally a linen thread (made in Lisle or Lille) used in the manufacture of lace, gloves, and hosiery, and now made of long-stapled cotton. It is a combed, rather hard-twisted, smooth, and wiry thread, with all the surface fibre removed by gassing.

Llama yarn See Union yarns.

Mercerised cotton yarn The yarn is passed through a cold, strong solution of caustic soda (50° to 60° Tw.), which causes it to contract considerably (about 20 per cent), and then the impregnated material is stretched to about its original length, during which the threads take on a permanent silky lustre. The caustic soda causes the flat, twisted-ribbon like fibres to swell up and become round, straight, and transparent, while the tension on the yarn (which is continued while the alkali is washed off) develops the lustre. The yarn is passed through a dilute solution of sulphuric acid to neutralise the caustic soda, and is again washed off and then dried. The most lustrous results are obtained by using a combed and gassed two-fold yarn, which contains rather less twist than ordinary two-fold, and has been spun from a high quality of cotton. Formerly no lower quality than Egyptian cotton yarn was used for mercerising, but now successful results are obtained in yarns spun from some of the better qualities of American cotton (see Mercerised cloth).

Motor tyre yarn Heavy yarn used in the manufacture of the walls of rubber tyres. At one time constructed from high quality cotton but this though still used has been largely replaced by high tenacity rayons and by nylon. (See Appendix II.)

Mule-spun yarns See Cotton yarns, French or dry-spun worsted yarn, and Woollen yarns.

One-throw yarn Consists of a number of single threads, which are twisted together at one operation of doubling (see Sewing cotton).

Open-band yarn The twist runs from left to right looking up the yarn, as shown at A in *Figure 2.12*.

Open-end spun yarns Yarns spun by a continuous process in which the roving or sliver is separated into individual fibres which are then combined together into a yarn in a twist insertion element. Yarns of this type are loftier and have better filling capacity than ring spun yarns.

Overspun yarn Has been spun too fine for the quality of the raw material of which it is composed, with the result that the thread is uneven in thickness, and contains weak places, or is 'twitty'.

Pack dyed yarn Yarn dyed in a package form by forced circulation of the dye liquor through the pack. Yarn for this method of dyeing is wound on to open mesh or perforated core containers (cops, cheeses, cones, beams) and clamped upon perforated hollow spindles through which the dye liquor is circulated.

Paper yarn A broad sheet of dried paper pulp is wound in the form of a large roll, and is then run off and mechanically cut into longitudinal flat strips, ranging upward from one-quarter of an inch in width. After a process of damping each strip has its edges turned and is passed to a twisting spindle, which twists it into the form of a round thread. It is largely employed in its natural shade, but when required coloured it is dyed in the pulp form. Its use is chiefly as weft in such fabrics as packing sheets, mats, rugs and carpets. The paper strips may be twisted round a core of fibres in order to increase their strength (see Textilose).

Pin cop Cotton weft yarn in cop form.

Polished or **glacé yarn** Cotton threads are passed through a special size mixture either in the hank or warp form, and then are operated upon by flat brushes carried in a large revolving cylinder, which lay the fibres. The yarn is made very hard, smooth, lustrous, and stiff, and is increased in weight from 7 to about 15 per cent. In polishing warp yarns, as many as 360 threads are treated at the same time in the form of a flat sheet, and are wound from bobbin to bobbin in the process.

Prepared hank yarn Bobbin yarn for lace (see Brass bobbin yarn) is prepared in the hank form by a process of calendering in which the hanks are passed between heavily weighted revolving rollers. The thread is made smoother and more pliable, and during the process the hanks are continually turned, so that the treatment is uniform. To increase the flexibility of the yarn, sometimes it is lubricated by the addition of from 2 to 3 per cent of its weight of grease.

Print grandrelle A two-fold yarn which is composed of a solid coloured thread twisted with a printed thread, the latter consisting of alternate narrow bars of white and the same colour as the solid thread. The yarn is used as warp for waterproofed overcoatings, in which the specks of white show less prominently than when the ordinary grandrelle warp is used (see Grandrelle cover fabric).

Ramie yarn See China grass yarn.

Raw material dyed yarn Spun from material which has been cleaned and then dyed in the loose fibre condition. A solid coloured thread results from using one colour of fibre, and a mixture yarn by blending two or more different colours in the fibre state. The method is extensively employed in woollen manufacture, and to a smaller extent in the cotton trade.

Reeled yarn Wound into hanks or skeins of definite length for convenience in bleaching, dyeing, etc., and for transport in bundle form.

Straight or *lea-reeled yarn* The thread is parallel wound, and each hank is divided into leas—usually seven—which are separated by a lease band, to which the ends of the thread are tied.

Cross-reeled yarn The thread, as it is wound, is traversed rapidly across the width of about 8 cm, so that it is crossed with itself. The thread unwinds better and with less waste, and as there is less liability of entanglement from two to four hanks may be reeled in one length.

Grant or *diamond-reeled yarn* A cross-reeled hank which shows diamond-shaped openings during the reeling process. It is wound with a wider traverse and is more open than the ordinary cross-reeled hank, and a greater number of hanks can be reeled in one continuous length.

Ring-tie reeled yarn A straight reeled cotton yarn, with 210 yards (192 m) as the length of the lea, and made one or two leas in length. It is intended to be polished in the hank, and the tie band is so arranged that it will move freely with the friction of the brushes, at the same time that the ends of the thread are indicated.

Relative twist of yarns The same relative twist is produced when the angle of twist on the surface of two different thicknesses of thread is the same. Yarns which contain the same relative twist may be used when similar effects are required in different weights of the same quality of cloth, so long as the difference in the thickness of the yarns is not extreme.

Resist-dyed yarn Has been treated in such a manner that the threads will resist the subsequent action of dyestuffs, which are applied when the yarn has been woven into cloth.

Selvedge or **selvage yarn** These are usually two-fold threads, and as long as they are sufficiently strong and of suitable thickness in relation to the warp threads of the cloth, the quality of the yarn, and regularity of twist are not important. Thus, in the manufacture of such fabrics as cotton voiles and warp satins the selvedge yarns may be inferior to the other warp threads.

Sewing cotton Usually consists of from 6 to 12 threads, which are generally folded together at two operations of doubling. Thus, for a cable-laid 6-ply yarn, two-, or three-fold preparings are first made by twisting a corresponding number of single threads together in the same direction as the twist of the singles; then three or two preparings are twisted together in the reverse direction (see Cabled yarn). In a one-throw yarn all the single threads are twisted together at the same time in the opposite direction to the twist of the singles. Sewing thread has all the surface fibre removed by gassing, and is then polished or glazed (see Polished cotton).

Silk yarns Consist of the pale-yellow or white filaments which the silk worm spins round about itself in the form of a cocoon. The silk issues in the form of a fluid from two glands, and two other glands secrete gum, which flows through the same exit as the two fibres and cements the latter together, and the whole coagulates on contact with the air. After the filaments have been made into yarn, the gum is removed and the natural brilliance of the silk is developed, and a strong, relatively elastic, and lustrous thread is produced which dyes very readily.

Raw silk (French term—grêge) An untwisted silk thread in skein or hank form, which is produced by reeling together the filaments from several cocoons. Each filament (termed bave) consists of two fibres (termed brins), which are joined together by a coating of natural gum or sericin, and the length of the double fibre from a cocoon varies from about 500 (460 m) to 1200 yards (1100 m). Usually from three to eight cocoons are reeled from, and the sizes of raw silk range from 1 tex to about 2.5 tex. The most popular size is 1.5 to 1.7 tex, which is reeled from five cocoons, and is composed of ten continuous fibres lying side by side and gummed together. The reeled silk thread forms the raw material of the nett silk industry.

Nett or *neat silk* A general term applied to thrown silk threads to distinguish them from spun silk threads, which are made from waste silk.

Spun silk yarns Made from waste silk, which includes every kind of raw silk that cannot be thrown, such as defective and pierced cocoons, and the waste made in the processes of reeling, re-reeling, sorting, winding, cleaning, and throwing. The long raw fibres are cut so that the maximum length of fibre is about 25 cm, and the material by a series of processes of combing (termed dressing) is divided up into six or seven drafts, according to length. The longest drafts are then prepared, drawn, and spun in a somewhat similar manner to long lustrous wool, whereas the method employed for the shortest drafts more nearly resembles the processes used in cotton spinning. In the manufacture of British spun silk yarns the waste silk is first fully discharged or degummed (see Boiled-off silk yarn).

Douppion silk Raw silk reeled from double cocoons, which are united owing to two worms having spun their cocoons close together. The cocoons are reeled from alternately, and where the two filaments overlap they come forward together, so that the thread is uneven.

Bright silk Raw silk which has not been soaked with a soapy solution previous to the winding, cleaning, and throwing processes.

Washed or *steeped silk* Raw silk which has been soaked in a solution of warm water and pure soap, in order to soften the natural gum and loosen the threads in the skeins from one another, so that the winding will be more easily performed. Sometimes advantage is taken of the steeping process to add weight to the silk, with the result that there is a greater loss in weight in the subsequent degumming operation.

Thrown silk Raw silk which has passed through the operations of winding, cleaning, and twisting or throwing. The throwing process consists of inserting twist in the raw silk thread, and of producing a nett silk thread of the required size (two or more threads may be twisted together), which is suitable for the purpose for which it is intended.

Singles silk Raw silk which has been wound and cleaned, and is without twist, or very slightly twisted, if required for making tram (weft), and hard-twisted if required for making organzine (warp). Certain silk fabrics are composed of singles yarn which is thrown or twisted with about 6 or 7 turns per cm, and a commonly used size of thread ranges from 1.5 to 1.7 tex. In order that the threads will retain the maximum of elasticity and strength, they are woven in the gum condition, the material being afterwards degummed and dyed in the piece. Crêpe singles, which is used for special fabrics, such as chiffon and silk crêpe, contains from 16 to 30 or more turns per cm. The term 'dumb' singles is applied to 'untwisted' singles which are used in making tram.

Tram silk Used for weft and consists of two or more untwisted or slightly twisted singles, which are run together, and, for ordinary purposes, are twisted with one or two turns per cm. The number of singles thrown together is varied according to the required size or count of the tram, and the term two-thread, or three-thread, etc., is applied according to the number of threads twisted together. The slack twist enables the natural lustre of the fibre to be retained, but sometimes hard-twisted tram is used, for example, as weft for crêpe de chine fabrics.

Organzine silk Used for warp, and is composed of two or more hard-twisted singles, which are wound together and hard-twisted. For example, a two-thread 3.5 tex organzine yarn may have each single thrown with 7 turns per cm, which are then twisted together in the reverse direction with 6 turns per cm. The best qualities of silk are used for organzine, but on account of the thread containing much more twist, it is not so lustrous as tram.

No-throw silk Very soft yarn, consisting of two or more untwisted singles, which are doubled together with no more twist than is necessary to bind the filaments together and prevent them from forming loops in the thread.

Hard or *gum silk* Thrown silk yarn which contains the natural gum or sericin. For textures which can be boiled off and dyed in the piece the use of silk in the hard state has the advantage that the gum makes the yarn stronger, and threads can be employed which otherwise would be too weak to bear the strain of weaving.

Boiled-off or *degummed silk yarn* Thrown silk which has had the natural gum removed by a process of boiling in hot water and soap. Before the degumming process the silk thread is harsh, stiff, and dull in appearance, and ranges from white to fawn or yellow in colour, but the boiling-off process makes the yarn soft, flexible, lustrous, and white or cream. The term 'soft' is sometimes applied to degummed silk. The 'scroop' of silk, or the characteristic rustling sound made by silk when subjected to friction, is produced by treating the degummed material with a dilute acid in the dyeing process. The extraction of the gum causes a loss in weight of from 20 to 25 per cent, frequently the loss in weight is recovered in the dyeing process by loading the thread with such substances as tannic acids or metallic salts, by means of which the weight may be increased 50 per cent or more without materially affecting the natural lustre. Along with the count of the silk, the weight to which the thread has been loaded may be stated.

Souple silk Dyed thrown silk with only a small portion of the gum removed, which makes the thread less lustrous, although stronger than when it is fully discharged.

Ecru silk Thrown silk in its natural colour and with only a small part of the gum removed.

Weighted or *loaded silk yarn* Nett silk which in the dyeing process has been weighted by means of tannic acid or metallic salts (see Boiled-off silk).

Sized silk yarns Yarns that have been tested for size or counts. The raw silk fibre varies so much in thickness that even when the singles silk contains the same number of filaments and the same number of singles are thrown together, there is considerable variation in the thickness of the resultant thread.

Lousy silk yarn A defective yarn in which some of the fibres have split and curled up, causing small specks to show on the surface.

Crêpe silk yarns Very hard twisted silk, and may be a singles thread of 1.7 tex with from 24 to 40 turns per cm, or from two to six or more singles, twisted slackly as for tram, are twisted together with from 20 to 32 turns per cm. Before twisting gum silk is softened by soaking in a soap solution.

Crêpe de chine yarn A hard-twisted silk tram yarn, largely made by twisting from two to eight Canton singles together, with from 16 to 28 turns per cm.

Grenadine silk yarn A hard-twisted organzine silk thread (see Crêpe silk yarn) used for the warp in grenadine silk fabrics.

Marabout silk A stiff silk yarn composed of two or three untwisted singles, which are dyed in the gum condition and very hard-twisted, and used for crêpe.

Sewing or *twist silk* A small or large number of cocoon filaments may be reeled together and slightly twisted in forming the singles, two to six or more of which, according to the required size of thread, are then firmly twisted together in the reverse direction.

Embroidery silk Similar to sewing silk, but softer twisted, and made in various sizes and a great variety of colours.

Etching silk A harder twisted thread than sewing silk; used for outlining embroidered effects.

Cordonnet silk A thick, soft thread, used for crotchet work, braiding, knitting, etc., and consists of a number of singles loosely twisted together in one direction, two or more of which are then twisted together in the reverse direction.

Floss silk yarn A very thick, soft-twisted silk thread, used for embroidery purposes. A similar rayon yarn is made.

Tussah silk yarn (also termed Tussur and Tussore) Made from the cocoons spun by wild or uncultivated silk worms, which produce a thicker and less lustrous fibre than the cultivated worm. It is brown in colour, and is largely used in the natural shade in the manufacture of such fabrics as shantungs, pongees, etc. Only a small quantity of 'thrown' tussah yarn is produced, as a large proportion of the cocoons cannot be reeled, and the material is chiefly used in the making of spun silk.

Schappe silk yarn Spun silk yarn in which the natural gum is only partially removed by a process of fermentation in warm water followed by washing off in hot water, or hot water and soap. The amount of gum retained varies from 2 to 10 per cent of the weight of the yarn. Schapping is the Continental method of treating waste silk.

Bourrette silk yarn Spun silk yarn made from the shortest drafts of waste silk, which are carded, combed, and spun in a similar manner to cotton.

Silk noil yarn Made from the very short fibres (termed noil) combed out of the short drafts of waste silk, the processes of carding and spinning being similar to those employed in woollen yarn manufacture.

Sized yarn Size is added to yarns prior to weaving mainly to reduce the friction in the healds, in the reed and in the yarns themselves, to strengthen the yarn and to lubricate it. Occasionally the intention may be to increase the weight and substance of the woven cloth. Weft is only sized for special purposes, and cotton warp yarns are usually classed as light or pure, medium, and heavily sized. In light or pure sizing from 5 to 10 per cent of size (by weight) is added to the warp, solely to make it weave better, and is employed for cloths which have to be bleached or dyed or otherwise wet-finished. In medium sizing from 10 to 40 per cent is added to the weight of cotton warp yarn, in order to make the cloth heavier, while in heavy sizing the weight of the warp is increased by from 40 to upwards of 100 per cent. Sizing is also practised in weaving most of the man-made materials in staple and continuous filament form. The purpose may be to increase the strength of the yarn, to protect the yarn from the chafing action of the moving machine parts or to reduce the tendency to form static electricity effects.

The main ingredients of sizes consist of starches (natural or modified), gelatin and synthetic resins with additions of tallows, oils and waxes for the purpose of lubrication.

Slubbing-dyed yarn Worsted yarn which has been drawn and spun from wool that has been dyed in the 'top' or sliver form. For solid shades the method ensures greater cleanness and solidity of colour, while by mixing together differently dyed tops at the first stage of drawing worsted fibre mixture yarns are produced.

Soft twist yarn Contains less than the normal number of turns per cm, and, according to the amount of twist, the threads are designated as soft, X soft, XX soft, XXX soft. The yarns are used for hosiery and embroidery purposes.

Textilose A composite yarn, used as a substitute for jute, and consists of a paper thread with which short waste fibres are twisted.

Tinsel or **metallic yarn** Consists of a flat thread of silver, copper, aluminium, or other metal which is used by itself or is twisted round a central thread of cotton or other fibre. It is used for church vestments, officers' uniforms, theatrical textures, banners, fringes, embroideries, lace, veils, etc. An imitation tinsel yarn is made by coating a cotton thread with metallic powder.

Tinted yarn When different threads for the same cloth are so nearly alike that they are practically indistinguishable in the grey state—as, for example, when a warp consists of both right and left twist threads arranged in a prescribed order—one of the yarns, usually that which is the reverse of the ordinary spinning, is tinted with a pale fugitive dye. This enables both series of threads to be kept in proper order during the manufacturing processes, and, as the colour readily washes out in the subsequent wet finishing operations, the appearance of the bleached and dyed cloth is not affected.

Twist Cotton warp yarn is termed twist, and unless otherwise stated it is understood that the direction of the twine is warp way (termed twist way), as shown at A in *Figure 2.12*.

Twist-on-twist Folded yarn in which the direction of the twist is the same in the doubling process as in the single threads, whereby the number of turns per cm in the latter is increased so that a harder folded yarn results than when the two twisting operations are in opposite directions. The single threads are made more solid, and if the turns per cm are not excessive, the folded thread has increased strength and elasticity, but the insertion of too much twist causes the thread to be snarly. Twist-on-twist is employed for voile yarns, and in the first doubling process of sewing cotton (q.v.).

Twist-way (T.W.) and **weft-way (W.W.) spun** Terms applied to cotton yarns to indicate the direction of the twist or twine, the former corresponding to right-hand twist and the latter to left-hand twist, looking up the thread, as shown at A and B respectively in *Figure 2.12*. While twist-way and weft-way coincide respectively with the normal direction of cotton warp and weft twist, if required warp yarn may be twisted weft-way and weft yarn twist-way, the former then being termed W.W. twist, and the latter T.W. weft. Warp, however, is much more rarely spun in the reverse direction than weft.

Twitty yarn Is irregular in size, and contains weak, brittle places, where the thread is liable to break sharply.

Union yarns Composed of two or more different classes of fibres, which may be mixed together in the fibre state, or as a 'union twist', in which a separate thread of each material is twisted together. The purpose of producing blends of fibres may be to cheapen an expensive material by adding a proportion of less expensive material, or, to obtain a superior product from the end-use point of view by combining two or more compatible materials of which each contributes a specific quality, e.g. one may be introduced for the sake of pleasant handle and appearance, and the other to improve the wearing properties. Many blended or union yarns of different types are in existence but the most common mixtures are those of wool with cotton and cotton with polyester fibre (shirtings), wool with viscose rayon staple (lightweight trouserings), and wool with acrylic or polyester fibres (suitings and overcoatings). A special reason for twisting a cotton with a wool thread is described in reference to extracted cloth (q.v.). Fibre mixtures may be produced on the woollen, cotton, and worsted systems of yarn manufacture (see Union shirtings).

Angola and *llama yarns* Composed of a mixture of wool and cotton fibres, and spun on the woollen principle. Very frequently the mixture consists of a low quality of shoddy or waste wool and waste cotton, with a small quantity of good length cotton introduced to give the necessary spinning property to the material. Sometimes, however, fairly good grades of both wool and cotton are used in producing a superior thread of this class, and for white yarns the cotton may be bleached in the fibre state. The percentages vary from about 15 of wool and 85 of cotton to 85 of wool and 15 of cotton. The yarn is used as both warp and weft in shirtings, and as weft in worsted and cotton warp cloths.

Merino yarn Produced by blending wool and cotton slivers together and drawing and spinning the material on the French worsted system. Fine, short wool is first 'dry-combed' and prepared in the form of 'tops', and these are combined, in a process termed 'melanging', with similar cotton slivers, the necessary proportions of the two being run together in the 'melangeur', according to the desired percentage of wool and cotton. In the subsequent processes of drawing and worsted mule spinning the two materials are intimately blended, and a good class of yarn is produced, as both the wool and cotton are of good quality. A common mixture is 50 per cent of each fibre, but the proportion of wool ranges from 85 per cent or more to as low as 5 per cent. Merino yarn is used in the manufacture of shirtings, and for hosiery purposes.

Alaska yarn Another term applied to a mixture of combed wool and cotton.

Vigogne Continental term for thick, soft yarn spun from waste cotton on the woollen principle, or from waste cotton with which a small quantity of waste wool has been mixed. The material is frequently dyed in the raw fibre state.

Voile yarns Made in both worsted and cotton from a high quality of material, and are combed, firmly twisted, and genapped or gassed in order to produce a round, hard thread free from projecting fibres. The yarns are mostly two-fold, with the folded twist inserted in the same direction as in the single threads (see Twist-on-twist), but single cotton voile yarns have been used with, however, less satisfactory results.

Woollen yarns Vary chiefly according to the kind of wool that is used, which may range from the finest qualities of short merino, through cross-bred and medium wools, to shoddies and wastes which are so short and low in quality that a small quantity of a longer fibre, e.g. cotton, has to be introduced to enable the material to spin. A typical woollen yarn consists of short, fine wool, and contains all the varying lengths of the fibres, which are indiscriminately mixed together so that they lie across each other in all directions. A fibrous, dull, compact, but rather uneven thread is produced, which has excellent felting properties, and when dyed takes on a soft, deep, and rich colour.

Saxony woollen yarn A typical thread, made from fine merino wool, and used for the finest and best woollen textures.

Cheviot woollen yarn Made from sound and strong cross-bred and medium wools, and used for cheviot and tweed cloths which require little felting.

Lustre woollen yarn Similar to cheviot yarn, but is made from lustrous medium wool, and is used for rugs and similar pile fabrics.

Shoddy yarn Made from re-manufactured wool and wastes, and frequently contains a proportion of cotton. The cheaper classes of woollen yarn mostly contain more or less shoddy material mixed with good wool.

Angola and *llama yarns* Spun on the woollen principle (see Union yarns).

Ring-spun woollen yarns Spun on the continuous system from condenser bobbins, with a special arrangement of the drafting rollers to ensure uniform drafting of the long and short fibres, and an attachment for giving a vibratory movement to the threads to impart fulness to the yarn. A satisfactory thread is produced, which, however, is somewhat inferior in softness, fulness, and felting property to a mule-spun woollen yarn.

Worsted yarns (see also Hosiery yarns) Vary in structure and appearance according to the kind of wool used and the processes employed. A typical worsted yarn is made from long lustrous wool from which the short fibres are removed by combing, and all the processes tend to straighten the fibres. Such a yarn, therefore, is composed of fibres which do not vary extremely in length and are laid as straight and parallel as possible. The thread is smooth and lustrous, open in structure, and even in thickness, but it has little felting property, and when dyed takes on a bright colour. A typical worsted yarn is practically opposite in structure and properties to a typical woollen yarn, but this is not due to the difference in the raw material so much as to the difference in the processes through which the fibres pass. From the same class of wool two entirely different yarn structures are produced by the two different methods of construction, but certain classes of worsted yarns somewhat resemble the appearance of a woollen thread.

Flyer-spun worsted yarn In flyer spinning the fibres are better controlled than in any other system, so that a smoother thread is produced, and the method is the most suitable for promoting the brightness of lustrous wools and wool hairs, and for obtaining a smooth yarn from coarse cross-bred wools.

Cap-spun worsted yarn Cap spinning is much more productive than flyer spinning, and is very suitable for botany and fine cross-bred wools. The system tends to produce a thread with a large amount of fibre projecting from the surface, and is, therefore, not suitable for either lustrous or strong cross-bred wools.

Ring-spun worsted yarn Ring spinning is employed only to a limited extent for worsted yarn, but it is a very suitable system for the finest botany threads. The fibres are under better control than in cap spinning, so that the yarn is not so wild and hairy.

Mule-spun worsted yarn See French or dry-spun.

Lustre worsted yarn A typical thread made from long, lustrous English wools and mohair and alpaca, by gilling, Lister-combing, open drawing, and flyer spinning, by which the brightness and smoothness of the yarn are best developed. Mohair and alpaca yarns are sometimes double-combed.

Demi-lustre worsted yarns Made from long English and cross-bred wool, which is not so bright as lustre wool, by similar processes to those used for lustre yarns, except that Noble-combing may be employed.

Camlet yarn A strong, rather hard-twisted worsted yarn made from demi-lustre wool (see Camlet fabric).

Serge worsted yarn Made of medium and cross-bred wool, which is sharp and crisp to the touch, by gilling or carding (according to the length of fibre), Noble-combing, open drawing, and cap spinning. The best qualities are full handling, but have a somewhat rough and fibrous surface.

Cross-bred yarns Range from fine to low cross-bred, the former being spun from Australian and New Zealand wools (46s to 58s quality) and used for coatings, dress fabrics, and fine hosieries. Medium cross-bred yarns are spun from wool of about 40s to 46s quality, and are used for serge and other cloths which require a firm, crisp feel, while low cross-bred yarns are spun from wools below 40s quality, and are fairly lustrous. The finer cross-bred wools are cap spun, but the lower qualities may be flyer spun, in order that the fibres will be sufficiently controlled.

Botany worsted yarn Made of fine merino wool (60s quality or finer is termed Botany), and is a fuller, softer, and denser thread than typical worsted yarn. For fine counts the processes are carding, Holden-combing, cone drawing, and cap or ring spinning, and for coarse counts, Noble-combing, open drawing, and cap spinning. Used for the best qualities of costumes, dress fabrics, suitings, linings, shirtings, etc.

French or *dry-spun worsted yarn* Made from short, fine wool by carding, dry-combing, French drawing, and worsted mule spinning. The system is suitable for treating the inferior classes of fine wool, as it enables shorter fibres to be left in the top, and a full, soft handling, fibrous thread is produced, which is particularly useful for soft dress and knitted fabrics. As the yarn, also, is free from oil, it is readily cleaned and dyed, and brighter, more delicate, and more even colours can be obtained than is possible in similar oil-spun yarn.

Alpaca yarn Generally composed of a mixture of white, black, and different shades of grey and brown alpaca fibres, which is too dark to be dyed into bright colours, and the yarn is, therefore, mostly used in the natural state or is dyed black. Its chief use is as weft in dress and lining fabrics (see Bradford lustre fabrics).

Camel-hair yarn A very soft worsted yarn made from the fine natural-coloured fibres of the camel and dromedary.

Cashmere yarn Cashmere yarn is made from the short, fine, undercoat fibres of the Tibetan goat. It is very soft, is sometimes naturally grey or brown in colour, and is chiefly used as weft or in knitting.

Melange yarn (French term—Vigoreaux) A coloured mixture worsted yarn, usually made of long, lustrous wool, the colours in which are printed on the 'top' or combed sliver in the form of bars of colour. The subsequent processes of drawing and spinning cause the different colours to be thoroughly intermingled, but as each fibre may be variously coloured throughout its length, a 'melange' mixture differs in appearance from an ordinary fibre mixture in which each fibre is all one colour.

Genappe yarn A smooth, flyer-spun worsted thread, sometimes hard-twisted, which has had all the loose fibre removed from the surface by gassing (see Gassed yarn). Used for the straight threads in rib cloths, and for braid and heald yarns.

Curled yarn Used for astrakhans, rugs, etc., and is produced by winding together and twisting very tightly a number of worsted threads, reeling them into hanks, and setting by boiling. After untwisting and winding separately each thread is permanently curled, so that a portion that is left slack immediately curls up.

Yarn dyed Yarn which has been dyed after the processes of spinning, doubling, etc., have been completed. The threads are reeled into hank form, or made into ball warps in readiness for dyeing, or wound into packages and dyed in that form. (See Pack dyed yarn.)

II—Standard woven fabrics

The particulars of fabrics that are given are those of actual cloths, but it will be understood that in almost every type of structure a wide range of qualities is made. Unless otherwise stated, the particulars indicate the original counts of the yarns, the ends per cm in the reed, and the picks per cm in the cloth. Most of the fabrics mentioned fall within the scope of the constructions dealt with in this work. The very wide field of compound fabrics is covered in ***Watson's Advanced Textile Design,*** *a companion volume to this.*

Alpaca cloth True alpaca cloth is a Bradford lustre fabric (q.v.) in which alpaca weft is used. Normally the cloth is woven with a black cotton warp and subsequently piece dyed. Used chiefly for linings and dress goods and produced either in weft faced twill weave or in plain weave.

Amazon A fine dress fabric, generally woven in 5-thread warp satin with worsted warp and woollen weft. The weave and the twist of the warp are so arranged that the twill lines of the satin are emphasised. The cloth is lightly milled and raised, and a full, soft handling texture with a fibrous surface is formed which, however, is not so dense as to entirely conceal the fine twill effect. 24 to 22 tex worsted warp, 72 to 48 tex woollen weft, 28 to 36 ends, and 14 to 18 picks per cm.

Appliqué A figured texture in which the ornament is obtained by sewing or embroidering a rather opaque fabric to the surface of a thin fabric. The upper fabric is then cut away round the stitched portions so that an opaque figure is left on a light, transparent ground.

Armure A dress fabric usually made in modified or broken warp rib weaves (see Nos. 42 and 43, *Figure A1.4*), which cause waved lines to be formed in a horizontal direction. Sometimes the warp is all alike, but the weave effect is improved by employing two kinds of warp arranged end and end, as for example—ordinary and reverse twist, mohair and botany, or wool and cotton. A botany worsted warp cloth in ordinary and reverse twists—30/2 tex warp, 28 tex worsted weft, 38 ends, and from 23 to 28 picks per cm. If large patterns, with long warp floats on the surface, are formed, the ends are interwoven plain on the back in order to give firmness.

Asbestos cloth A fireproof structure (see Asbestos yarn) used for such purposes as brake linings, firemen's garments, theatre curtains, etc.

Astrakhan A cloth with a peculiar curly surface, in which the effect is largely due to the use of a thick, curled, lustrous, worsted yarn (see Curled yarn). The texture may be produced in four ways: (a) By cloth shrinkage, a non-shrinking curled yarn being floated somewhat loosely on the surface of a firmly woven ground texture which is made to contract (see Curl effects). (b) As a weft pile structure (see *Watson's Advanced Textile Design*). (c) As a warp pile fabric (see *Watson's Advanced Textile Design*). (d) As a knitted texture.

Atlas A rich, lustrous silk fabric made in 8-thread warp satin weave, used for dress fabrics, and also for linings when woven with cotton weft.

Bag cloths Used for flour, salt, grain, etc., cotton, plain or 2-and-2 twill, rather light and open in structure, and heavily sized in order to close up the interstices and prevent the contents from coming through (see Seamless bags). A plain cloth—about 30 tex warp, 28 tex weft, 22 ends, and 19 picks per cm in the grey cloth.

Bagging and **sacking**—The term D. W. Bagging is applied to a coarse plain woven jute fabric made with double ends in the warp and very thick weft. Jute sacking is largely woven in 2-and-1 twill, with double ends in the warp and finer set than D. W. Bagging. These structures are now also produced in polypropylene tape yarns.

Baize A plain woven, heavily felted, woollen cloth with raised pile surface; piece dyed in bright colours, usually red or green.

Bannockburn tweed A Scotch Cheviot woollen cloth woven with a thread of solid colour alternating with a grandrelle twist thread in warp and weft.

Barathea A fine dress fabric with spun silk warp and botany weft, and similar in structure to 'Henrietta' (q.v.), except that the broken weft rib weave No. 16, *Figure A1.3* is used in place of 1-and-2 twill. The cloth is also made in the same weave with cotton warp similar to a cotton warp cashmere. The term 'Barathea' is also applied to a heavy worsted suiting usually made in a twilled hopsack weave similar to No. 5, *Figure A1.2*, which is an example of the weave as applied to heavy wool fabrics. In addition, a class of cotton shirting, made in a broken warp rib weave (see No. 4, *Figure A1.2*), is termed Barathea.

Batiste The term refers chiefly to the finish of very fine, thin, plain cotton cloths, like muslin and cambric, used for dresses and linings.

Beaver cloth A heavily milled and raised woollen overcoating fabric which is finished with a dress face (q.v.), and is made in a variety of weights, and in single, backed, and double weaves.

Beaverteen A very strong cotton fabric, with a fibrous surface on the underside, similar to but lighter than moleskin (q.v.), and is made in the same weave as the latter; or the weave given at No. 59, *Figure A1.5*, which has a weft float of four on the surface, may be employed. Used for heavy trouserings and suitings, and frequently piece-dyed. About 60/2 tex warp, 33 tex weft, 13 to 14 ends, 90 to 120 picks per cm.

Bedford cords Warp-face fabrics in worsted, linen, and cotton yarns in which rounded cord effects are formed longitudinally. Very broad cord effects can be made firmer by interweaving the picks on the underside with the wadding ends in plain order (see No. 52, *Figure A1.5*). A worsted dress fabric—28/2 tex botany warp, 32 tex botany weft, 36 ends and 32 picks per cm. Cotton Bedford cords are frequently sold under the name of 'piqué'.

The term 'London cord' is applied to twill-face cotton Bedford cords—42 tex warp, 30 tex weft, 34 ends and 31 picks per cm, wadding ends extra.

Military Bedford cords Used for riding breeches and made with two picks floating behind the cords to one on the surface (see No. 51, *Figure A1.5*). The cloth is composed of woollen yarns (except that cotton is used for the plain ends), and is very heavily milled and clear finished (see Clear woollen finish)—100 tex woollen warp, and 50/2 tex cotton warp for the plain ends, 100 tex woollen weft, 26 ends and 27 picks per cm in the loom. Contraction from 17 to 20 per cent in length and from 25 to 30 per cent in width.

Belting One class of cotton belting, woven plain, twill, or sateen, is used for the tops of skirts (see Petersham). A second class is an elastic texture, composed of cotton, wool, or silk, which is frequently richly ornamented with figures. A third class, used for power transmission, is a heavy and very strong texture, which may consist of several thicknesses of cotton duck (q.v.) cemented together, or of a solid structure in which from three to six strong, cotton fabrics are woven one above the other and firmly stitched together by special binding threads. The solid-woven beltings are specially treated and seasoned before use.

Bengaline A heavy warp rib cloth composed of silk warp and worsted or cotton weft, similar in appearance to poplin except that the rib effect is more pronounced. A 3-and-3 rib fabric—4 tex (2-thread) organzine warp, 30 tex worsted weft, 144 ends, and 36 picks per cm.

Bengaline de soie consists of silk in both warp and weft. Other names of ribbed silk fabrics are Cotelé, Eolienne, Epingle, Faille, Gros-de-Tours, Grosgrain, Ottoman, Poplin, etc.

Beige Originally a fine soft dress fabric made in worsted warp and weft in 2-and-2 twill weave. More recently imitated in cotton yarns. The cloth generally has a mixed colour appearance, due to the use of printed, melange, or coloured twist yarns—24 to 22 tex worsted yarns, 30 ends and 28 picks per cm.

Billiard cloth A plain woven, heavily milled woollen cloth with a fibrous finish, made from very fine merino wool and shrunk about 33 per cent in width and 25 per cent in length from the loom dimensions. About 84 to 72 tex warp and weft, 12 to 13 ends per cm, and 14 to 16 picks per cm in the loom.

Blanket range A length of cloth made as a pattern range which is woven in sections, both warp and weft way, so as to exhibit a number of designs, each of which, frequently, is only a few inches square. Satisfactory designs are selected, and a short full width length of cloth is then generally woven of each, to be again submitted for the buyer's approval or rejection.

Blankets Thick, heavily milled fabrics woven with woollen spun yarns composed entirely of wool or of wool with an admixture of cotton. The weft is soft spun, and the quality of the wool used ranges from strong and coarse fibres to fine cross-bred and merino. They are made unbordered, with coloured borders all round, or bordered only at the ends. The most important makes are known as Irish, English or Yorkshire, Witney, Ayrshire, and Cheviot or Bath blankets. Irish blankets are similar to Yorkshire except that they are made broader and shorter. Thus, a blanket might be 2540 mm × 2030 mm in a Yorkshire size compared with 2130 mm × 2410 mm in an Irish size. Typical Yorkshire blankets are woven plain and finished with a dense fibrous pile on both sides, which conceals the weave structure. The term 'Witney' can only be applied to blankets actually manufactured in Witney, but they are finished with a dense pile, and are like the Yorkshire blankets. Ayrshire blankets (not necessarily made in Ayrshire) are woven in 2-and-2 twill, which shows more or less clearly through the surface pile of fibres, and when bordered have a dark indigo-blue border all round. Cheviot or Bath blankets also are 2-and-2 twill weave, but they are raised rather more than the Ayrshire cloths, and are woven with light blue borders.

The dimensions vary extremely and range from about 1270 mm wide and 1760 mm long to 2500 mm wide and 2900 mm long, while the weights vary from about 1 kg to 3 kg. for a single blanket. A 2-and-2 twill blanket 2100 × 2150 mm—about 200 tex warp and weft, 8 ends and 10 picks per cm in the loom, 20 per cent shrinkage in width and 15 per cent shrinkage in length. A plain woven Yorkshire blanket 2000 mm × 2500 mm, about 250 tex yarns, 6 ends and 10 picks per cm in the loom; contraction about 12 per cent in length and 20 to 25 per cent in width.

Horse blankets are coarse, heavily felted woollen textures, and rug blankets (q.v.) are used in some parts of the world as articles of clothing. Cotton blankets are made with a flannelette finish, as a single cloth or as a weft backed reversible texture (see *Watson's Advanced Textile Design*).

Blankets are also made in a cellular leno construction (see *Watson's Advanced Textile Design*) using woollen, cotton or various synthetic staple yarns. Acrylic staple and polypropylene are used in the making of light-weight blankets in plain or in 2-and-2 twill constructions.

Blazer cloth A wool flannel somewhat heavily milled and raised and finished with a fibrous surface. Used for sports jackets and caps—80 tex warp and weft, 16 ends and picks per cm.

Book muslin The term 'book' is applied to a fine, soft, plain woven cotton muslin, and also to a very stiffly finished cotton cloth that is used for stiffening and lining clothing and millinery. The latter fabric is made of fine yarns, and is very open and flimsy as it leaves the loom, but it is heavily sized and given a board-like glossy finish. From 12 to 10 tex yarns, 13 ends and 11 picks per cm. If made with thicker yarns, like cheese cloth (q.v.), it is termed stiff book muslin (see Tarlatan and Swiss mull).

Botany twill cloths Made in botany yarns in various weights for costumes and suitings. The 2-and-2, 3-and-3, and 4-and-4 twills are employed, and the cloths may be slightly milled to improve the feel, but they are clear finished in order that the twill effect will be clearly defined. Cloths in 2-and-2 twill range from 120/2 to 64/2 tex warp and weft, with from 13 to 20 ends and picks per cm (see Worsted Cloths).

Box cloth A stout heavily milled woollen cloth with a dress-face finish, and a dense felt-like appearance, mostly woven in broken 2-and-2 twill. About 170 tex, wool dyed warp and weft, 13 ends and picks per cm in the loom. Contraction, 35 per cent in width and 25 per cent in length from loom dimensions.

Bradford lustre fabrics Chiefly used for dress fabrics and linings, and are made with cotton warp and mohair, alpaca, or English lustre worsted weft, while demi-lustre is substituted for lustre weft in lower qualities of the cloths. The weft is much thicker than the warp, and in order that the brightness of the former will be developed in the highest degree, in the finishing process the cloth is drawn out in length and shrunk in width. Thus, from 63 m of warp, 127 cm wide in the reed, from 55 to 56 m of grey cloth, about 120 cm wide, is produced, and this yields about 60 m of finished cloth, 110 cm wide. In the finished fabric the ends lie almost straight with the picks bending round them, so that the structure approximates to that of a weft rib in which the warp is nearly concealed while the weft is brought prominently to the surface. In order to secure the maximum of lustre the cloths are either woven with one end per split, or if there are two ends per split in the finer setts, the loom is specially timed to obtain good cover. Very frequently the cotton warp is yarn dyed fast black or a fast colour, so that in the piece only the lustre weft requires to be dyed, but for white or light colours a bleached warp may be used.

Brilliantines, Sicilians, and *glacés* Different makes of lustre dress fabrics chiefly woven plain or with a weft figure on plain ground. The class of weft that is used is frequently coupled with the name in order to distinguish the quality, as, for instance, a mohair brilliantine is superior to an English lustre brilliantine, etc. The term brilliantine is applied to the finer makes that range from about 20 to 28 ends per cm in the loom, and in which the weft is finer than about 38 tex worsted. A Sicilian is woven with from 14 to 19 ends per cm, and the weft is thicker than 38 tex worsted, and may be as thick as 72 tex. A glacé may be similar in structure to either a brilliantine or a silician, and the term is used to distinguish cloths in which the weft is not dyed, although the warp may be either coloured or black. Brilliantine—14/2 to 10/2 tex cotton warp, 38 to 30 tex mohair weft, 22 to 26 ends and 22 to 28 picks per cm. Sicilian glacé—14/2 tex cotton warp, 72 to 64 tex mohair or English lustre weft, 16 ends and 18 picks per cm.

Melange lustre A fabric in which the weft has been spun from lustrous wool that has been printed in the combed sliver or top form (see Melange yarn).

Puritan A half-mourning lustre fabric made with both bleached white and fast black cotton threads in the warp, and lustre weft which is dyed black in the piece.

Pekin stripes Are shadow effects produced in plain lustre cloths by denting the ends irregularly, as, for example, 12 ends, two per split, 6 ends, one per split; or a section dented one per split may be arranged alternately with a section dented one per split, one split missed for a number of times.

Grenada, Florentine, and *Lorraine lustres* Woven in the weaves given respectively at Nos. 7, 13, 17, *Figures A1.2* and *A1.3*, each of which produces a weft surface, lustre

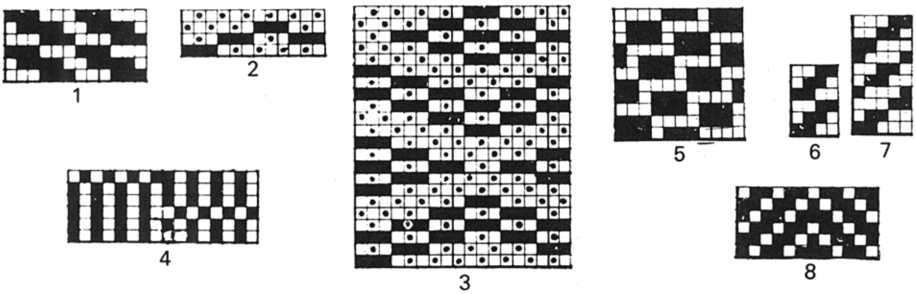

Figure A1.2

weft and cotton warp being used as in the plain lustres.

Lustre linings Made with various weft-face twill weaves, each of which is given a distinctive name. The lining cloths are generally made lower in quality of material than the dress fabrics, single twist cotton warps, ranging from 20 to 12 tex, with from 32 to 38 ends per cm, being largely used, while the weft varies from 38 to 24 tex, of alpaca, English-lustre, and demi-lustre wool with from 28 to 40 picks per cm, according to the thickness of the weft and the firmness of the weave (see Orleans).

Brilliantine See Bradford lustre fabrics.

Broadcloth and **plain super** One of the oldest types of woollen cloths, made from fine merino wool in plain weave, heavily milled and finished with a dress face (q.v.). For 140 cm finished woven about 225 cm in the loom (hence the origin of the term *broad*). About 74 tex warp and weft, 12 to 13 ends and 14 to 16 picks per cm in the loom.

Brocade Originally a heavy, rich, silk fabric ornamented with raised figures formed by extra threads or by embroidery, but now applied to any ordinary jacquard figured cloth which shows variety of effect.

Buckram A coarse cotton fabric, woven plain, piece-dyed, and stiffened with resin or size according to the purpose for which it is intended. Thus, if employed as an under-lining (see book muslin), it is not made so stiff as if used as a foundation for hats, while for use as hat shapes one class of buckram is composed of two stiffened fabrics cemented together, one of which is a rather fine muslin, and the other like cheese cloth.

Burl dyed cloth Piece dyed woollen or worsted cloth that contains particles of undyed vegetable matter which are too numerous to be picked out, and are subjected to *burl dyeing*.

Calendered cloth Has been subjected, in finishing, to heat while under pressure between rollers, which produces a smooth, glossy surface, and is applied to a great variety of cotton, linen, etc., fabrics.

Calico A general term applied to various qualities of plain woven cotton cloth which are coarser than muslin.

Cambric Originally the name of a fine linen cloth made at Cambrai in Belgium, and is now applied also to a fine bleached cotton texture which is usually given a rather stiff, bright finish and used for summer dresses. A class of cambric used for dress linings is finished soft, and is termed kid-finished cambric. 10 to 8 tex cotton warp, 8 to 6 tex cotton weft, 38 ends and about 32 to 58 picks per cm. Embroidery cambrics are made —10 to 9 tex cotton warp, 10 to 8 tex cotton weft, 32 to 40 ends and 34 to 56 picks per cm. Cotton cambrics, jaconets, lawns, mulls, nainsooks, and fine muslins are all made from a high quality of cotton yarn, and are similar cloths in the grey state, the difference between them being chiefly in the finish. Further, the finish of each class of cloth may be varied as regards softness or stiffness, and brightness or dullness, etc., according to its use, and a wide range of qualities, also, is made in each kind of cloth.

Camlet A stout plain cloth originally made with camel-hair yarns, for which strong worsted yarns of the demi-lustre type have been substituted. 64/2 to 56/2 tex worsted warp and weft (rather hard twisted), and about 13 to 14 ends and picks per cm.

Canton A plain cloth woven with botany warp and weft, or with cotton warp and botany weft. 12 tex combed cotton warp, 15 tex botany weft, 26 ends per cm, 30 to 36 picks per cm.

Canton flannel A strong medium, or heavy weight, cotton flannel, woven in 2-and-2 twill, and finished with a raised surface on one side. Used for pockets, and also for underwear and dresses.

Cantoon A strong, heavily wefted cotton fabric (see Fustian) woven in the twill weave given at No. 25, *Figure A1.3*, which repeats on six ends and twelve picks. Although the weave runs at a steep angle on design paper, in the cloth there is such a preponderance of picks over ends that a fine weft-face twill is formed running at a flat angle. The cloth is raised on the under-side, and is used for such purposes as riding breeches, jackets, etc.

Casement cloth A plain woven cotton fabric, soft and full handling, and usually finished white or cream, made in different ways, but generally with the weft predominating on the surface. The cloth should be woven with a good quality of warp and weft, and the ends evenly spaced; sometimes mercerised in the piece. 35 tex cotton warp and 20 tex cotton weft, 18 ends and 28 picks per cm. The cloth is also made with lustre worsted weft on the same principle as Bradford lustres (q.v.), and while this texture is used for casement curtains, it is also made into summer dresses.

Cashmere A fine botany weft face dress fabric woven in 1-and-2 twill with a larger number of picks than ends per cm. In the better qualities the warp also is botany, but for cheaper cloths cotton warp is used—20/2 to 14/2 tex cotton warp, 16 to 12 tex botany weft, with 22 to 26 ends per cm, and 52 to 64 picks per cm. Cobourgs, Henriettas, and Paramattas (q.v.) are similar in structure to cashmere, and in the finishing processes the cloths are drawn out in length and shrunk in width in order to show the weft as much as possible on the surface.

Chameleon taffeta A rich silk fabric woven in three contrasting colours, two in the weft, arranged pick and pick, and going into the same shed, and one in the warp; gives a 3-colour shot effect (see Taffeta).

Cheese cloth A loosely woven cotton plain cloth fabric, very light and soft, in which condition it is used for wrapping cheese and butter. This kind of cloth is also heavily sized and stiffened, and used as an underlining. About 16 tex warp and weft, 10 ends and 8 picks per cm.

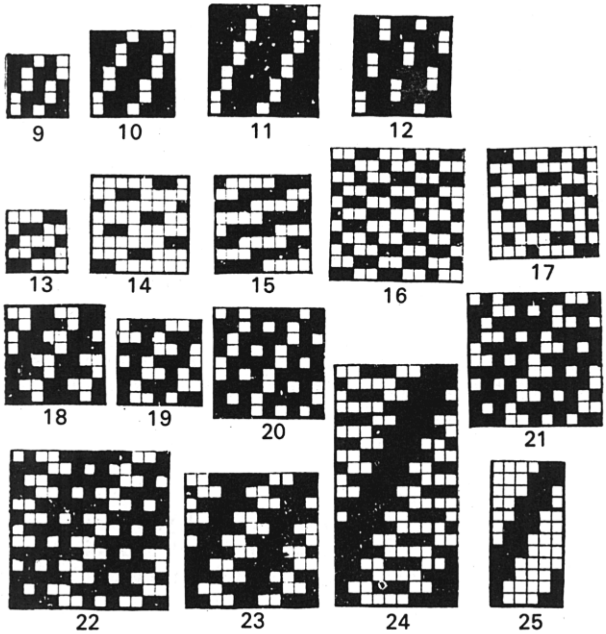

Figure A1.3

Cheviot cloth A woollen texture made from rather thick and rough yarns, which are spun from medium wools of the Cheviot and cross-bred type. The cloth is only lightly milled and raised, and after finishing it has a crisp feel and somewhat open structure. Generally a rough fibrous surface is formed, through which the weave is more or less clearly seen, while brightness of colour is a distinct feature. Used for costumes, suitings, and overcoatings, the weight being varied according to requirements—160 to 95 tex warp and weft, 10 to 14 ends and picks per cm.

Chiffon A very soft and filmy, plain woven silk texture, consisting of the finest singles, which are hard-twisted and woven in the gum condition, the cloth being afterwards degummed. 1.7 tex warp and weft, 40 ends and picks per cm. The term chiffon is also used in conjunction with certain silk fabrics which are finished with a soft pliable feel—e.g., 'chiffon taffeta', 'chiffon velour'.

Chiné or **chené** Term applied to fabrics in which a design or pattern, usually of a figured character, appears that has been printed upon the warp prior to the weaving of the cloth. The cloth is most frequently woven plain, but pleasing effects are got in weaves of a crêpe character. In the weaving process the warp threads do not retain the exact relative positions that they occupied during the printing operation, so that the colours tend to run into each other and cause the edges of the different parts of the figure to be somewhat indefinite; and as the weft is not printed a much softer effect is produced than in ordinary cloth printing. The fabrics include silk, worsted, cotton, and linen structures, and are used for a variety of purposes, certain styles of designs being employed in silk ribbons, and other styles for light dress and blouse fabrics, while very large and elaborate patterns are made in furnishing textures (see Shadow cretonne).

Chintz Cotton cloths printed with elaborately coloured designs, and used for similar purposes to cretonnes (q.v.). The cloth is usually highly glazed.

Chintzed fabric A cloth in which one colour of weft is replaced by another colour in succeeding horizontal sections of a design so that a figure is formed in more colours than there are series of weft threads employed (see *Watson's Advanced Textile Design*).

Chlorinated cloth The chlorination process is employed to make wool fabrics 'non-shrinkable' when they are washed. The process makes the wool brighter and harsher, and increases its affinity for dyes, but it is turned yellow and requires stoving, and the handle of the material is adversely affected.

Cleaning cloth A coarse plain or gauze fabric employed for cleaning machinery and consisting of thick yarns spun from cotton waste. The gauze structure is generally woven by means of a gauze reed mounting.

Clear woollen finish Applied to warp-face woollen cloths of the buckskin, venetian, and whip-cord types, and certain West of England cloths in single, backed, and double weaves in which the design and colour patterns are required to show clearly. The warp-face cloths are made with hard-twisted warp and soft-spun weft, and in twill patterns the direction of the twill and of the warp twist are arranged to show the weave distinctly. The felting of clear finished cloths is chiefly to give compactness of structure, and this is followed by dry raising or brushing, and cropping in order to remove the loose fibres from the surface.

Clip spot fabrics Light textures, ornamented with spots or figures formed by means of extra warp or weft threads, from which the loose material, floating between the spots, is cut away (see *Watson's Advanced Textile Design*).

Cobourg Similar to cotton warp cashmere as regards weave and yarns, but is a coarser and heavier fabric, and is used more as a lining cloth, for which purpose it is given a stiffer handle (see Cashmere).

Coco matting Very coarse cloth composed of thick yarn made of coir fibre obtained from coconut husks. The fabrics are largely woven with two colours of warp arranged end-and-end, and fancy diamond, etc., designs are made on the warp rib principle. A similar kind of cloth is made in jute and sisal yarns.

Cord effects The term 'cord' is applied to rib effects which run longitudinally in the cloth, and 'repp' to those which run transversely (see Repp).

Cable cord A plain woven weft rib structure in which the weft is worsted and the warp cotton—38/2 tex cotton warp, 16 tex botany weft, 17 ends and 52 picks per cm.

Hair cord Produced in plain cloth by introducing one thick end at a place on a ground formed of fine warp and weft, the latter being dented two ends per split and the former single. Also used to denote a 1-and-2 rib construction in which all the ends are of equal count (see D in *Figure 3.3*).

Persian cord A 2-and-2 weft rib cloth in cotton warp and botany worsted weft, woven two ends per split, with the ends that run in pairs separated by the reed wires. 24/2 tex cotton warp, 18 tex botany weft, 30 ends and 48 picks per cm.

Russel cord Similar in structure to Persian cord, but woven with mohair or lustre worsted weft.

Royal rib An all-cotton, weft cord fabric woven plain with two ends per mail, and with the weft predominating over the warp—23 tex warp, 16 tex weft, 28 ends and 56 picks per cm.

Gordon cord A botany weft and cotton warp structure made in the weave given at No. 1, *Figure A1.2.*

Metz cord Similar structure to Gordon cord, but woven in No. 6, *Figure A1.2.*

Corduroy Corded velveteen structures in which a weft pile forms longitudinal lines or cords, strong heavy cloths being used for trouserings, smoking jackets, and riding breeches, and lighter fabrics for dress materials. (See Fustian; also *Watson's Advanced Textile Design.*)

Corkscrew fabric Usually a fine worsted cloth in which a warp rib twill effect is formed running at a flat angle. The 13-thread corkscrew weave (see O in *Figure 6.4*) is largely used for very fine coatings and suitings. 28/2 tex botany warp, 30 tex botany weft, 48 ends and 36 picks per cm.

Corkscrew repp A plain woven, warp rib fabric made with fine warp and thick spiral weft, which gives an irregular, but interesting, appearance to the rib lines. 15 tex cotton warp, 120 tex cotton count spiral weft, 38 ends and 11 picks per cm.

Cotton cashmere The term 'cashmere' is applied to all-cotton cloths woven in 1-and-2 twill, and constructed in a similar manner to botany weft cashmere. 16 tex cotton warp, 14 tex cotton weft, 26 ends and 54 picks per cm.

Cotton Georgette A cotton crêpe fabric made in imitation of silk Georgette, with hard twisted warp and weft yarns. A good cloth is woven plain with right and left twist threads arranged in 2-and-2 order in warp and weft—17/2 tex yarns, 20 ends and 18 picks per cm in the loom; contraction, about 25 per cent in width and length. In cheaper cloths the yarn is twisted all alike, and weaves with small floats of warp or weft on a plain foundation are used (see Nos. 26 and 27, *Figure A1.4*)—11/2 tex warp and weft, 24 ends and 26 picks per cm in the loom.

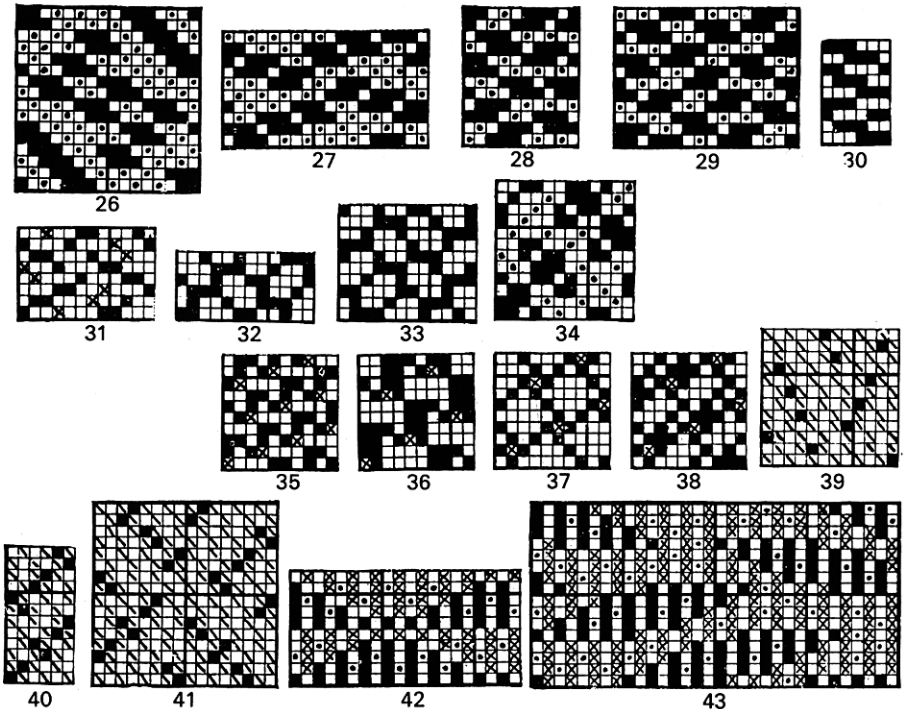

Figure A1.4

Cotton suitings and **trouserings** Made in imitation of worsted cloths as regards colouring and weave effects, very good fabrics being produced at a relatively low price, and although they lack the fulness and warmth of wool textures, they are suitable for tropical countries. The colours are mostly subdued with bright threads introduced in the form of grandrelle twists, while the weaves are simple twills, hopsacks, ribs, and the warp-face Venetian. The yarns should be spun from a good quality of cotton, and the warp doubled with less twist than ordinary, so that the threads in both directions will be full and soft. The underside of the cloth is frequently given a flannelette finish. A 2-and-2 twill fabric—38/2 tex warp, 60 to 38 tex weft, 26 ends and 19 to 26 cm picks per cm. 3-and-2 warp-face Venetian (No. 9, *Figure A1.3*)—38/2 tex warp, 38 to 30 tex weft, 30 to 36 ends and 20 to 29 picks per cm.

Cotton Venetian A cotton lining cloth made in 8-thread warp satin weave, and containing many more ends than picks per inch. It is given a finish which produces a lustrous surface similar to that of a cotton Italian, and it has the advantage over the latter that the cloth is more quickly woven as the predominating threads are in the warp. A combed and gassed Egyptian cotton warp is employed consisting usually of two-fold yarns, with the warp twist in the same direction as the twill of the satin. The weft is ordinary American or Egyptian, and the cloth is woven grey, piece-dyed, mercerised, and schreinered—20/2 to 14/2 tex warp, 24 to 16 tex weft, 58 to 66 ends and 32 to 42 picks per cm.

Coutil A strong cotton cloth, piece-dyed drab or French grey, and used for corsets (see also Nankeen). Woven in 3-thread warp-face twill, which is frequently in the form of a waved twill, 6 × 6 ends wide (see No. 8, *Figure A1.2*). A fine cloth—13/2 tex warp, 12/2 tex weft, 56 ends and 48 picks per cm.

Covert coating A light, warp-face, overcoating cloth which usually has two distinguishing features i.e., the union in the warp of coloured and white fibres and the formation of a fine, clear, steep twill effect. Olive, fawn, brown, and grey are chiefly combined with the white in the warp, and the weft is generally dyed to correspond with the warp colour. The 5-thread Venetian weave (No. 9, *Figure A1.3*) is most commonly used, but similar derivatives of satin on 7, 8, and 9 threads (see Nos. 10, 11, and 12, *Figure A1.3*), which will give a fine steep twill effect, are employed for heavier weights of cloths. The two-colour effect in the warp may be obtained in various ways, as, for example, (a) from a mixture of dyed and undyed fibres; (b) by twisting together a dyed and an undyed thread, or a dyed thread with a coloured and white marl thread; (c) from a mixture of wool and cotton fibres; (d) by twisting together a wool and a cotton thread. In (c) and (d) methods neither the wool nor the cotton is dyed before weaving, but wool weft is used and the grey cloth is piece-dyed for wool, which, by leaving the cotton in the warp unaffected, produces the two-colour effect required.

The warp yarn is most frequently worsted, or a union of worsted and cotton, and the weft worsted, but sometimes a woollen weft is used, and certain cloths are made with woollen yarn in both warp and weft. 35/2 to 30/2 tex botany or union twist warp, 45 to 38 tex botany weft, 34 to 38 ends and 22 to 26 picks per cm; or, 90 tex woollen mixture warp, 120 tex weft, 22 ends and 14 picks per cm. The worsted and cotton twist yarns usually consist of a thicker worsted than cotton thread; thus a 35/2 tex thread might be composed of 10 tex cotton and 25 tex worsted twisted together.

Covert cloths are usually shower proofed, and given a clear finish, although slight milling is generally practised in order to impart the required firmness of handle. Cloths containing woollen yarn are somewhat severely milled and raised so that the surface is covered with a short fibrous nap, which is allowed almost to conceal the weave, or, on the other hand, is cropped close enough for the weave to show clearly (see Venetian overcoating).

Crash A linen fabric with an irregular appearance due to the use of thick, uneven yarns, particularly in the weft, woven plain or in fancy crêpe weaves, largely used for towels. For the warp brown mercerised cotton is sometimes used in place of linen. Cotton crash towelling is made with waste cotton weft in weaves of an oatmeal crêpe character (see Oatmeal cloth).

Crease resist finish Applied to cotton, linen, and rayon fabrics, by which they are made strongly resistant to creasing by the incorporation of a synthetic resin within the fibres. The cloths are made heavier and stronger and they launder better.

Crêpe fabrics Have an irregular or broken surface appearance, and are produced in ordinary yarns by using such weaves as those given in *Figures 5.4* and *5.5*, and at Nos. 26 to 34, *Figure A1.4*. For weave P *Figure 5.5*—14 tex cotton warp, 32 tex lustre worsted weft, 24 ends and 22 picks per cm. For weaves Nos. 28 and 29, *Figure A1.4*—14 tex cotton warp, 18 tex filament rayon weft, 22 ends and 20 picks per cm.

In most crêpe fabrics, however, the weave is plain and the effect is due to the use of very hard twisted threads (see Crêpe yarns), either in the weft, or warp, or both weft and warp, which, when the cloth is subjected to a wet finishing process, cause the latter to shrink considerably—from 12 to 20 per cent—in the direction of the crêpe threads. As a rule the crêpe threads are introduced in equal proportions of right and left twist, and as the cloth shrinks the differently twisted threads tend to untwist in opposite directions, so that an irregular surface results. The textures are usually dyed in the piece, and, in order that the right and left twist yarns may be distinguished during the processes of manufacture, one of them is tinted in a fugitive colour, while weft yarns are wound (in opposite directions) on to differently coloured pirns. Crêpe fabrics are light and soft to the touch, and relatively fine yarns are used with only sufficient threads per inch in the loom as will contribute to the proper shrinking of the cloth. Sometimes a more pronounced crêpe effect is obtained by using such weaves as Nos. 26 and 27, *Figure A1.4*, which show small floats on a plain foundation.

Crêpe de chine A plain woven, lustrous and finely crinkled fabric in which a fine silk warp is woven in the gum with crêpe twisted silk weft arranged 2 × 2 of right and left twist (see Crêpe silk yarns). The cloth is degummed and dyed in the piece—6.4 tex warp, 9 tex weft, 60 ends, 34 picks per cm.

Serpentine crêpe A plain weave cotton fabric that has almost the appearance of a crepon. The crêpe twist is used only in the weft, and is all in the same direction—10 tex warp, 23 tex weft, 23 ends and 20 picks per cm; contraction about 25 per cent from the loom width.

Crêpe cotton yarns are used very extensively not only in all-cotton cloths (see Cotton Georgette), but in combination with worsted, silk, and rayon, while crêpe botany yarns provide the shrinking element in all wool crêpe cloths, and are also used in conjunction with real silk (see Estrella) and rayon yarns. (See also, Rayon crêpe yarns and crêpe fabrics, Appendix II.)

Crepoline A dress fabric composed of lustre or cross-bred worsted yarns, and woven in various modifications of 2-and-2 warp rib weave (see Nos. 39 to 41, *Figure A1.4*), which give a greater proportion of warp on the surface and produce an irregular effect of a crêpe character—50/2 to 38/2 tex worsted warp, 45 to 25 tex worsted weft, 26 to 30 ends and 18 to 24 picks per cm.

Crepons, crimps, and **blisters** In the finished state these fabrics contain threads in warp, weft, or both warp and weft, which differ in length so that certain parts of the texture are slacker than other parts, and tend to cockle or form blisters on the surface. The difference in length of the threads may be obtained in three ways, as follows:

(1) A portion of the warp is placed on a separate beam, and is allowed to come in more rapidly than the warp on the ground beam. By arranging the slacker woven ends in stripe form a crimped or cockled effect is formed longitudinally, as illustrated by the fabric represented at G in *Figure 2.3*. The term 'seersucker' is also applied to the structure. A cotton fabric—45/3 tex crimp warp, 25 per cent contraction, 34 tex tight warp, 4 per cent contraction, 12 tex weft, 26 ends and 24 picks per cm.

(2) Threads are combined which naturally have different shrinking properties, so that the finishing operations cause certain threads to become much shorter while the others are scarcely affected. For example, a relatively non-shrinking mohair or English lustre worsted yarn is used in combination with either a hard twisted botany worsted yarn or a good felting woollen yarn. Plain weave may be used in producing crimped or crepon stripe or check effects, as for example by combining, say, 20 threads of 52/2 tex mohair worsted and 60 threads of 30/2 tex hard twist or crepon botany worsted.

Figured crepons or blisters are produced by employing different weave structures in conjunction with the shrinking and non-shrinking yarns. In the ground the two yarns work together and make one cloth, but where the blister structure is formed a double weave (usually double plain) is used which produces a fabric in the non-shrinking yarn above a similar fabric in the shrinking yarn. The contraction of the cloth in the finishing processes causes the non-shrinking upper fabric to become slack and a waved blister effect results.

(3) Threads which naturally have similar shrinking properties are made to contract unequally in the cloth by chemical means. Cotton yarn is, therefore, substituted for hard twisted botany in the manufacture of crepons and blisters, and the cloth is subjected to a finish, which consists of mercerising without stretching the fabric so that the shrinking of the cotton yarn has full play and may amount to 20 per cent or more. From 30/2 to 20/2 tex Egyptian cotton warp, and 14 tex cotton weft may be used in conjunction with mohair warp.

Crimp stripes and cockled effects are also produced in plain cotton fabrics by printing a caustic soda solution on the ground portions of the cloth. The printed sections contract and form a flat, even surface, while the remaining parts become slack and give the crinkled effect.

Cretonne Used for hangings, bed valances, and upholstery purposes, and is usually ornamented by elaborate printed designs. For cloths printed in the piece plain, twill, oatmeal crêpe, and small fancy weaves are used, with thick, soft weft, which is frequently spun from waste cotton. The finish is usually dull.

Shadow cretonne is a 'chiné' or warp printed style (see Chiné), woven plain, with the warp usually predominating over the weft. The pattern has a blurred appearance, and is the same on both sides—46/2 tex cotton warp, 84 tex cotton weft, 26 ends and 13 picks per cm.

Curl effects Produced during cloth shrinkage by arranging two kinds of yarn one or two threads of each alternately, a non-shrinking yarn being floated somewhat loosely on the surface while a yarn that shrinks readily is interwoven firmly. The cloth is heavily shrunk, but, as the floating threads do not contract, they form curls or loops on the surface. (See *Watson's Advanced Textile Design*, and also Astrakhan.)

Damask Originally a silk fabric (made in Damascus) with a weft sateen figure on a warp satin, or twill, or plain ground. The cloth is now extensively used for household purposes, and is made in cotton, rayon, and linen yarns with the figure and ground in opposite sateen weaves; the figure usually being in weft sateen and the ground in warp satin (see *Watson's Advanced Textile Design*). The weaves generally used are the 5- and 8-thread sateens, and the terms single and double damask are sometimes used in order to distinguish linen fabrics made in the respective weaves. The best linen damasks are woven with about 50 per cent more picks than ends per inch, and properly the term double damask should only be used for 8-thread sateen cloths which contain such an excess of picks over ends. 42 tex warp, 24 tex weft, 32 ends and 54 picks per cm.

Delaine A plain woven fine worsted dress or blouse fabric which is usually more or less elaborately figured by printing either the warp or the cloth—20 tex botany warp, 13 tex botany weft, 26 ends and 27 picks per cm. Cotton delaine is a fine soft fabric made in imitation of wool delaine.

Denim A strong warp face cotton cloth used for overalls, jeans, skirts, etc., largely made in 3-and-1 twill weave. The cloth is sometimes piece-dyed, but generally the warp is yarn-dyed brown or blue and crossed with white weft. The colours should be fast to washing—33 tex warp, 42 tex weft, 36 ends and 24 picks per cm.

Dhooties Soft, light, cotton fabrics used in India for turbans, loin cloths, etc., and made traditionally in lengths of 2/5 yards, 2/6 yards, or 2/10 yards, etc., the two meaning that the cloth will be cut through the centre so as to form two garments. The body of the cloth is plain grey, and the ornamentation consists of headings and fancy borders, and in some cases of one or three prominent stripes away from the borders. In grey dhooties the border pattern is made simply by cramming grey or bleached ends in the reed (double ends in place of single ends may be employed), or by using thicker two-fold ends. Coloured dhooties are sometimes woven entirely plain with coloured ends forming border stripes, but frequently more or less elaborate figured stripes (termed flush borders) are made by means of extra threads. The borders are formed by the figure stripe which may also be introduced once at a third of the width from one side, or three times across the width at an equal distance apart—10 tex cotton ground warp, 7 tex cotton weft, 32 ground ends and 30 picks per cm in the grey cloth; 20/2 tex grey, bleached, and coloured warp for the stripe effects.

Dimity One type of cloth, used for bed covers, is woven in 4-thread warp and weft satinette weaves, which usually form stripes equal in size, so that the pattern is the same on both sides, the warp effect having a raised appearance in each case. A common size of stripe is four threads each of warp and weft face weave (see No. 50, *Figure A1.5*), and this may form the body of the cloth with broader stripes used as a border—38 tex warp, 25 tex weft, 22 ends and 31 picks per cm, about 20 per cent shrinkage in width. The term 'dimity' is also applied to a plain-woven cotton fabric that is piece-dyed or ornamented with cord threads. About 18 tex warp and weft, 28 ends and 26 picks per cm.

Doeskin A very fine woollen fabric composed of a high quality of merino wool, usually woven in 5-thread warp satin, a fine warp being used with the twist of the threads running in the same direction as the twill of the satin. The cloth is heavily milled and raised and finished with a dress face, and is similar to a beaver cloth, but is lighter and

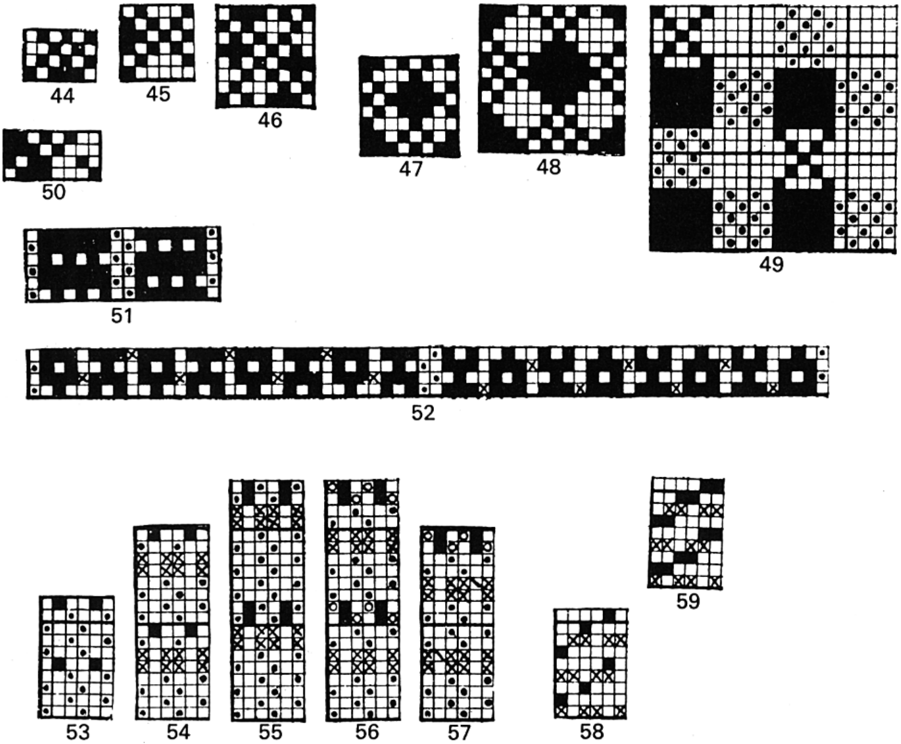

Figure A1.5

finer—95 to 75 tex warp, 180 to 135 tex weft, 20 to 26 ends and 12 to 14 picks per inch in the loom. Contraction, about 30 per cent in width and 25 per cent in length from the loom dimensions.

Domet An imitation of flannel made entirely of cotton or with cotton warp and a mixture of cotton and wool weft, and finished with a raised surface on both sides. Woven plain, and coloured in stripe form, suitable for shirtings and pyjamas (q.v.), for which it is largely used.

Donegal tweed A rough woollen cloth (similar to homespun) made from thick yarn in plain or 2-and-2 twill and finished with little or no milling. From 400 to 240 tex warp and weft, and from 4 to 8 ends and picks per cm.

Doria stripes Light, plain woven cotton cloths in which stripe patterns are formed by varying the denting of the ends, as, for example, 6 ends in six splits, 8 ends in four splits. A convenient method of making the style consists of placing the crowded ends 2 per mail and denting the mails regularly, and the above example might be woven 6 single ends in six splits, 4 double ends in four splits, 26 splits and 22 picks per cm, 10 tex cotton warp and 8 tex cotton weft.

Dress-face finished fabrics Heavily felted and raised woollen cloth, the surface of which is covered with a lustrous nap of short fibres, which are laid lengthways of the fabric and completely conceal the weave and structure. The texture is made dense and fibrous by the felting process, and the fibres are drawn on to the surface and straightened and combed in one direction by the operation of raising, while lustre is imparted to the surface by boiling the fabric. Cloths to which this type of finish is applied are doeskins, beavers, box cloths, billiard cloths, pilots, etc., which may be either wool, yarn, or piece-dyed.

Drills Warp-face fabrics largely made in cotton yarns, and woven in 3, 4, and 5-thread warp faced twills and 5-thread satin, with the twill lines running opposite to the direction of the twist of the warp yarn, in order that a prominent twill effect will be formed. It may be bleached or piece-dyed, or woven with coloured stripes in the warp with either white or dyed weft. The fineness of the yarns and the setting vary according to the weave and the weight required, satin drills being mostly made in fine yarns and setting, while a 3-and-1 twill fabric, termed Florentine, is woven with thicker yarns. In 5-thread satin—14 tex cotton warp, 16 tex cotton weft, 50 ends and 32 picks per cm or 27 tex warp, 46 tex weft, 44 ends and 28 picks per cm. In 4-thread twill—38 tex warp, 43 tex weft, 36 ends and 20 picks per cm.

The term 'pepperall drill' is applied to a very high quality of the cloth, and 'drillette' to a light make.

Duchesse satin A very rich and lustrous silk fabric woven in 7, 8, 10, or 12-thread warp satin. 2 tex filament warp, 18 tex spun silk weft, 144 ends and 36 picks per cm.

Duck Very heavy and strong plain woven cotton and linen canvas fabrics used for belting, sail cloth, awnings, and tents, and, when dyed black, for boot linings, etc. A heavy duck—250/6 tex cotton warp and weft, 13 ends and 10 picks per cm. A medium duck—170/5 tex cotton warp, 120/3 tex cotton weft, 18 ends and 12 picks per cm. The term 'duck' is also applied to a tropical suiting cloth woven in hopsack weaves.

Dungaree A strong cotton fabric used for overalls, similar to denim (q.v.), but usually yarn dyed in both warp and weft—38 tex warp, 27 tex weft, 32 ends and 26 picks per cm.

Elastic webbing A strong narrow ware fabric of special construction, and containing rubber threads in the warp; used for suspenders, belts, etc.

Eolienne A very fine piece-dyed silk warp fabric which is crossed with thick worsted or cotton weft, a warp rib effect being formed. The warp is usually in the form of singles, somewhat loosely twisted, and woven in the gum condition, the degumming being effected in the cloth—2 tex filament silk warp, 25 tex gassed cotton weft, 60 ends and 21 picks per cm.

Epingle A warp rib silk cloth largely used for ribbons and for making ties.

Estamene A milled cross-bred worsted cloth, piece-dyed, and finished with a rough fibrous surface; usually woven in 2-and-2 twill, sometimes 3-and-3 twill—38/2 to 25/2 tex warp, 25 to 21 tex weft, 20 to 26 ends and 20 to 25 picks per cm.

Estrella A crêpe de chine type of cloth (q.v.) woven plain with singles silk warp and hard-twisted botany weft, picked two right and two left twist alternately.

Faille A fine, soft, warp rib silk fabric in which the ribs are not prominent.

Felt The distinguishing feature of true felt is that it contains no threads, but is purely a fibrous structure. The wool fibres from a woollen carding machine are arranged layer upon layer until the desired thickness is built up the width of the card, and at the same time, by a continuous forward movement, the required length of material is obtained. This is submitted to a process of milling, while the fibres are moistened, as in the felting of woollen cloth (see Felted cloth). The fibres become interlocked and matted, and a compact texture is produced, which is used for felt hats, glove linings, table covers, floor coverings, etc., the quality and thickness varying according to its use.

Woven felt Fibrous faced woollen cloths which have been felted to such a degree that the fibres are compactly matted together so that the thread structure does not show and the texture has the appearance of felt. The construction of a woven felt may shrink 50 per cent in width and length, and the resultant structure is stronger, firmer, and more elastic than a similar carded felt.

Felted cloth In the felting, milling, or fulling process a wool cloth is moistened with warm soapy water, and is subjected to the intermittent application of pressure in length and in width. Under the influence of the pressure and moisture the fibres are matted and interlocked. The cloth shrinks in width and length, and from a bare thready structure as it leaves the loom it is changed to a dense, full, and compact structure. The matting and interlocking of the fibres is largely dependent on the prominence of the epithelial scale structure, and the best felting wools are the fine merinos and the poorest the smooth lustrous wools and hairs. Woollen fabrics will felt much more readily than worsted fabrics, and for heavy felting the yarns should be as soft spun as possible. As weft may be more slackly twisted than warp, the shrinkage is generally greater in width than in length, and a cloth should be set in the loom to allow for the amount of contraction that will take place in the felting process.

Flannel Plain or twill woven cloth with a very soft handle, which makes it particularly suitable for being worn next to the skin. The yarns are mostly woollen spun, and medium English wools and Colonial cross-breds are used for ordinary qualities and merino for fine textures. The cloths are milled and raised, and are usually finished with a fibrous face, but sometimes the surface is more or less clear. An ordinary plain woven flannel—95 to 80 tex warp, 84 to 74 tex weft, 10 to 11 ends and 11 to 14 picks per cm in the loom. Contraction, about 20 per cent in width and 15 per cent in length (see Molleton flannel.)

Flannelette A cotton texture largely made in plain weave, sometimes in 2-and-2 twill, and finished with a fibrous surface in imitation of wool flannel. The nap is produced almost entirely from the weft, which, usually, is soft spun and thick, in order to furnish a suitable foundation from which the surface fibre can be drawn (see Flannelette yarn). Recently harder spun weft has been used in order to produce a better wearing cloth, and to obtain a featureless texture the weft is twisted in the same direction as the warp. The cloths are mostly woven either grey (to be subsequently bleached or dyed), or in the form of coloured stripes. Sometimes the cloth is printed, the term 'velouté' being applied to printed flannelette. A plain weave cloth—25 tex warp, 50 tex weft, 20 ends and 19 picks per cm. A double-end plain cloth—27 tex warp, 46 tex weft, 38 ends and 16 picks per cm. A 2-and-2 twill cloth—25 tex warp, 40 tex weft, 27 ends and 28 picks per cm. The flannelette finish is applied to a large variety of cloths, such as cotton trouserings, rugs, blankets, dressing gown textures, in addition to ordinary underclothing fabrics, etc., which are raised on one or both sides according to requirements.

Foulard A fine, soft silk fabric, woven in 2-and-2 twill, in which a pattern is obtained by printing. Frequently the effect is a white spot upon a coloured ground—5 tex filament warp, 9 tex filament weft, 51 ends and 54 picks per cm.

French merino A similar cloth to the botany warp cashmere, except that the weave is 2-and-2 twill (see Cashmere). 15 tex botany warp, 11 tex botany weft, 24 ends and 76 picks per cm. The twill runs at a very flat angle in the cloth with the weft predominating on the surface.

Frieze A heavily felted and raised woollen fabric made of coarse or medium wools and finished with a rough fibrous surface. In ordinary friezes the surface fibres are laid in one direction, but in 'nap' friezes they are rubbed into small curls or beads. For 2-and-2 twill weave—about 270 tex warp and weft, 8 to 9 ends and picks per cm. Contraction, about 25 to 30 per cent in width and 20 per cent in length.

Fustian A generic term for velveteen, corduroy, moleskin, swansdown, beaverteen, cantoon or diagonal, and imperial cloth (q.v.). Woven with a very large number of picks per inch, the lighter structures being used for ladies' wear, and the heavier cloths for riding breeches and similar hard wearing clothing.

Gabardine A warp-face cloth, mostly woven in 2-and-2 twill, which produces a fine steep twill effect on account of the predominance of the warp over the weft, but lower qualities are sometimes made in 2-and-1 twill. Largely used for rainproof overcoatings, and made at first with botany worsted warp and cotton weft, but the warp is now more frequently composed of cotton or a blended yarn—27/2 tex botany warp, 20/2 tex cotton weft, 42 ends and 35 picks per cm. The cotton weft is yarn-dyed, but the wool warp may be dyed in the piece. A fine cotton gabardine—15/2 tex warp and weft, 64 ends and 42 picks per cm; and a lower quality—30/2 tex warp, 30 tex weft, 43 ends and 30 picks per cm. The cotton warp is frequently a 'grandrelle' yarn.

Gabardine costume cloths Have a similar warp surface to the overcoatings, but worsted warp and weft are used, and the cloth is much softer. A 3-and-1 warp twill cloth—36/2 tex botany warp, 24 tex botany or fine cross-bred weft, 40 ends and 25 picks per cm.

Gabercord A soft, all-cotton fabric, with a fine warp face twill effect (see No. 23, *Figure A1.3*), which shows very distinctly on the face—20 tex warp and 30 tex weft, soft spun, 58 ends and 24 picks per cm.

Galatea A coloured, warp-face twill, cotton cloth, similar to a regatta (q.v.), but lighter, and usually woven in 2-and-1 twill (sometimes 3-and-1 twill). In simple stripe patterns the fabric is used for nurses' uniforms, while for dresses sometimes fancy dobby effects are introduced—23 tex warp, 28 tex weft, 36 ends and 26 picks per cm.

Gauze or **leno** Cloths in which certain ends cross from side to side of adjacent ends. (See *Watson's Advanced Textile Design.*)

Georgette crêpe A fine silk fabric with a crêpe appearance, due to the use of very hard twisted threads which are arranged 2-and-2 of right and reverse twist in warp and weft (see Crêpe fabrics and cotton georgette). The cloth is woven plain and degummed and dyed in the piece—1.7 tex filament 2- or 3-thread yarns, 20 to 32 turns per cm, 43 ends and picks per cm.

Gingham A firm, plain woven, cotton fabric usually coloured in the warp, and frequently made in check form. Coarser qualities are used for aprons, etc., and finer cloths for blouses and shirtings. (See 'Zephyr'.)

Glacé A lustre dress fabric (see Bradford lustres). Glacé is also a French term applied to cloths which give a 'shot effect' (q.v.).

Glass cloth A good quality of linen, cotton, or linen and cotton cloth, woven grey and in stripe and check colourings, and used for drying and polishing glassware and china. 50 tex cotton or linen warp and weft, 18 ends and picks per cm.

Glen check The full name is 'Glen Urquhart check', and is applied to a colour and weave check effect in which 2-and-2 twill weave is used in conjunction with a compound of 2-and-2 with 4-and-4 colouring. (See example C in *Figure 10.7.*)

Gloria A strong, very firmly woven fabric composed of silk warp and worsted or cotton weft, usually made in plain weave; used for umbrella coverings and also dress goods.

Gossamer A very soft and flexible silk gauze fabric, one end crossing one end, used for veilings—2.5 tex warp, 4 tex weft, 18 ends and 32 picks per cm.

Grenadine A light dress fabric consisting entirely, or to a large extent, of a very open gauze structure. Stripe, check, and figured styles are formed in silk, worsted, and cotton yarns. (See *Watson's Advanced Textile Design.*)

Grey cloth A piece of cloth in the condition in which it leaves the loom.

Grosgrain A plain weave fabric with a prominent warp rib effect, made with fine silk warp closely set and thick silk, worsted, or cotton weft with comparatively few picks. Used for dresses and ribbons. The term 'gros' is applied to different kinds of ribbed silks e.g., *Gros de Londres* has broad and narrow ribs alternately, sometimes in different colours, while *Gros de Tours* is a heavy ribbed silk woven with two or more picks in a shed.

Gun club check A 2-and-2 twill fabric woven in three colours in warp and weft, arranged so that the solid squares formed by two of the colours are separately surrounded by the third colour, as, for example, 4 dark, 4 light, 4 mid, 4 light; or 6 dark, 6 mid, 6 light, 6 mid.

Habit cloth A fine woollen costume cloth largely made in 5-thread warp satin weave and finished with a dress face. A fine warp is used and rather thicker weft, as, for example, 54 tex warp, 66 tex weft, 21 ends and 13 picks per cm in the loom. Contraction about 25 per cent in width and 15 per cent in length.

Habutai A generic term applied to many Japanese silk fabrics, which are fine, soft, closely woven in plain, twill, or fancy weaves with ungummed threads, the cloth being boiled off and dyed in the piece.

Hairline In a true hairline the warp and weft colours are alike, and each colour of warp is intersected only by its own colour of weft, so that perfectly solid lines of colour are formed. The styles are produced in simple weaves (see *Figures 9.7* and *9.8*), and also in double plain and double twill weaves (see *Watson's Advanced Textile Design*). The term hairline is now applied rather generally to any fine, solid coloured, stripe effect.

Harris tweed A rough, fibrous, woollen tweed, understood to be spun, woven, dyed, and finished in Harris, Lewis, and other islands of the Outer Hebrides (see Homespun). About 250 tex warp and weft, 7 ends and picks per cm.

Henrietta Similar to cashmere (q.v.) as regards weave, weft, and relative number of picks to ends per inch, but silk warp is used in place of wool or cotton, and the cloth is finer. 10/2 to 8/2 tex spun silk warp, 12 to 11 tex botany weft, 26 to 29 ends and 62 to 66 picks per cm.

Hessian A plain woven, strong and coarse jute cloth, made in a great variety of qualities, and used for wrapping and packing purposes. Mangled hessian is smoother and has a more glazed appearance than the ordinary cloth, and frequently is better in quality.

Holland Plain woven linen cloth, used as furniture covering, and also as ladies' summer skirts, in the unbleached (brown) or partly bleached condition. About 51 tex warp and weft, 17 ends and picks per cm. (See Window Holland.)

Homespun Term applied to woollen cloths composed of yarns hand spun from local wools and woven on hand looms. The weave is usually plain or 2-and-2 twill, and the yarns are coarse and uneven, and frequently consist of a mixture of fibres in the natural colours, or dyed with natural dyes obtained from local sources. The cloth is usually a rough fibrous tweed in various 'heather mixture' shades, with the weave effect showing quite clearly.

Honeycomb fabrics Woven with honeycomb weaves (see *Figure 5.7* and Nos. 44, 45, and 46, *Figure A1.5*), which produce a cell-like appearance in the cloth. A botany dress fabric—30/2 tex warp, 30 tex weft, 36 ends and 36 picks per cm.

Huckaback cloth An absorbent fabric, used for towels and glass cloths, mostly made in cotton yarns (see *Figure 5.11*)—74 tex warp and weft, 16 ends and 38 picks per cm.

Imperial and **imperial sateen** See Swansdown.

Imperial cloth A fine piece-dyed worsted coating woven in 2-and-2 twill—35/2 to 30/2 tex botany warp, 24 to 18 tex botany weft, 27 to 30 ends and 32 to 28 picks per cm. Imperial serge, which is a similar cloth, but looser woven and softer, is used for costume fabrics.

Italian cloth A lining cloth which was originally made with a dyed cotton warp and grey botany weft, wool-dyed in the piece, and given a lustrous surface appearance in the finishing process. The brilliant lustre which can now be obtained in cotton fabrics by the operations of mercerising and schreinering has led to the substitution of cotton weft for the botany weft, and the cloths are now extensively made entirely of cotton, and woven grey and piece-dyed. A good warp and soft spun even weft are required, with many more picks than ends per inch, and the weave is 5-thread weft sateen arranged to twill in the same direction as the twist of the weft, in order that maximum smoothness of surface will be obtained. Cotton Italian—17 to 14 tex grey cotton warp, 14 tex combed and gassed Egyptian weft, 34 to 38 ends and 52 to 64 picks per cm.

Jean 2-and-1 twill cotton cloth made warp or weft face. When woven with a warp face in strong yarns a drill structure is formed (see Drills), which is used for corsets, boot linings, etc. 30 tex warp and weft, 36 ends and 26 picks per cm.

Jeanette A name applied to 3-thread weft faced twill fabrics.

Kersey A 2-and-2 twill cloth heavily milled and finished with a fibrous surface, and made from strong fibred Cheviot or cross-bred wool. The yarns are mostly spun on the woollen principle, but sometimes worsted yarns are used. 190 tex warp and weft, 10 ends and picks per cm. Contraction about 25 per cent in width and 15 to 20 per cent in length.

Khaki A Persian term meaning like the earth. A yellowish-brown fabric produced from a mixture of differently dyed fibres, and largely used for military purposes on account of the difficulty of distinguishing it from natural objects. The mixture of wool fibres to produce the khaki shade has been standardised as follows: 80 per cent olive brown, 5 per cent indigo, 15 per cent white.

Lambskin See Swansdown.

Lasting A strong cloth used for the tops of shoes and other purposes, which was formerly composed of worsted yarns, but is now made partly or entirely of cotton and/or synthetic materials. Various weaves are used, both single and weft-backed, and the fabric is made very strong, hard, and smooth.

Lawn Plain woven, bleached cotton cloth, very light, fine, and smooth, used for underwear and dresses. May have a soft pure finish, or be given a rather firm feel—8 to 6 tex yarns, 32 to 36 ends and picks per cm (see Cambric). Victoria lawn is a closely woven fabric with a somewhat stiff finish, Persian lawn is a soft finished cloth, while Bishop's lawn is bleached and given a bluish-white tint. Linen lawn is made of fine linen yarns.

Leno Applied generally to all classes of fabrics in which certain ends cross from side to side of other ends (see Gauze; also *Watson's Advanced Textile Design*).

Linsey A coarse fabric woven plain or 2-and-2 twill and composed of cotton warp and a union of cotton and waste wool weft. Used for heavy under-garments, and also woven in stripes across the width for use as skirts and aprons.

Limbric A plain cotton cloth with soft spun lustrous weft, thicker than the warp, and may have more picks than ends per inch. Used for dress fabrics and casement curtains.

London shrunk cloth All-wool cloth which, after the ordinary finishing operation, has been passed several times, without tension, through hot and then cold water, and afterwards slowly dried by hanging on poles in a warm chamber to make it thoroughly shrunk. In another method the cloth is folded in wet sheets, in which it lies for 24 hours, after which the wet sheets are removed, and the cloth lies for another 24 hours in a pile before it is hung up and dried. The thoroughly shrunk condition is particularly required by tailors in order that there will be no irregular shrinking of the cloth when it is damped and hot-pressed; the made-up garment also keeps its shape better during subsequent wear.

Longcloth A firm, plain woven, bleached cotton fabric, close in texture, without much size, and used for underwear—20 to 16 tex warp and weft, 28 to 32 ends and 28 to 40 picks per cm. India longcloth is a finer and softer fabric, more like cambric—12 to 9 tex warp and weft, 36 to 40 ends and 38 to 54 picks per cm.

Lump A length of cloth which is about double the usual piece length.

Madapolam Plain woven bleached cotton fabric, usually made coarser than such cloths as cambric, nainsook, lawn, etc., but it may be finished soft like nainsook—13 to 10 tex warp and weft, 27 to 34 ends, and 24 to 44 picks per cm.

Madras curtain fabrics Figured textures in which the ornamentation is produced by means of thick, soft spun, extra weft threads on a very fine and open gauze foundation. (See *Watson's Advanced Textile Design.*)

Madras handkerchiefs A plain cotton fabric woven in large coloured checks, and composed of yarns dyed with non-fast dyes which, during the finishing of the cloth, bleed, so that the different colours run into each other and give a resemblance to patterns produced by native block printing.

Madras shirting A fine, light, good quality zephyr fabric, chiefly woven in stripe patterns. The cloth has a plain foundation, and the ornamentation frequently consists of crammed silk stripes in satin weaves and extra warp spot and stripe effects (see Zephyr).

Matelasse Term now applied to boldly figured warp rib fabrics, but the real matelasse is a double or compound cloth in which wadding threads are introduced below the figure so as to give it a raised or embossed appearance.

Maud A checked woollen cloth, used as a plaid or travelling rug, in which different tones of grey yarns are used in forming the pattern.

Melange lustre See Bradford lustre fabrics.

Melton cloth A woollen cloth which is heavily milled, so as to form a firm foundation, and the fibres are drawn on to the surface by raising, but in the cropping process, which follows, the fibres are reduced in length so as to form a short, dense, non-lustrous pile. Usually woven plain or broken 2-and-2 twill—about 160 to 95 tex warp and weft, 10 to 14 ends and picks per cm in the loom. Contraction about 35 per cent in width and 25 per cent in length.

Mercerised cloth The process of mercerising cotton cloth is similar to that of mercerising cotton yarn, and consists of imparting a fine silky lustre to a fabric by subjecting it to tension while impregnated with a cold strong solution of caustic soda. Mercerised material (yarn or cloth) has a much greater affinity for dyestuffs than unmercerised cotton.

Moiré A generic term applied to 'watered' fabrics which have a distinctive wavy appearance due to the varied reflection of light from different parts of the surface of the cloth. Mostly produced in silk, cotton and rayon yarns, and the best results are obtained in fine warp and weft rib structures in which the face threads are very closely set, while the straight threads are hard and stiff. The usual process of watering consists of placing two pieces of the same texture, or folding the same piece, face to face, and subjecting the cloth while moistened with water to pressure between two heated bowls of a calendar. Where two rib lines of the cloths are against each other the surface threads are flattened, but where the rib lines of one cloth come between the rib lines of the other cloth the threads remain round. The cloth shows dark and light places which change when viewed from opposite sides, and the pattern is of a most varied character without repetition. In another method the surface of the cloth is acted upon by a roller upon which the required form of moiré design has been engraved. Polished cotton yarn is largely used for the straight threads, as it is so hard that the embossing action of the pressure rollers has full play on the surface threads so that a clearly defined watered effect results.

Moiré antique A rich silk moiré in which a very pronounced irregular effect is produced.

Moiré à retours A watered fabric in which the effect is the same in each half, but reversed, due to the cloth having been folded down the centre during the process of watering.

Moiré française A stripe moiré effect produced by means of an engraved roller.

Moirette A yarn dyed moiré, plain woven in cotton yarns, either warp or weft rib (see Moreen). Warp rib cloth—20/2 tex cotton warp, 30/2 tex polished cotton weft, 45 ends and 25 picks per cm.

Moleskin A very strong, tough, smooth, and leathery fustian cloth (q.v.), which is really an uncut cotton velveteen (see *Watson's Advanced Textile Design*), and the weave which is given at No. 58, *Figure A1.5* produces a 1-and-5 weft-face effect on the surface and a 1-and-2 weft-face twill on the underside. The system of interlacing enables a very large number of picks of thick weft to be inserted. The cloth is raised on the underside and is usually piece-dyed—72/2 to 60/2 tex warp, 38 to 33 tex weft, 14 to 16 ends, and 96 to 160 picks per cm; shrinkage in width, about 20 per cent.

Molleton flannel A high quality of 2-and-2 twill woollen flannel, heavily milled and raised, and finished with a dense fibrous nap, dyed in delicate colours, and used for such purposes as dressing gowns and jackets. About 62 tex warp and weft, 15 ends and 17 picks per cm in the loom.

Moreen Similar to 'moirette' (q.v.), except that it is piece-dyed, and in the grey state is known as grey poplin. Warp rib cloth—16/2 tex cotton warp, 60/3 tex cotton weft, 50 ends and 18 picks per cm. Weft rib cloth—60/3 tex cotton warp, 11 tex cotton weft, 17 ends and 56 picks per cm.

Moss finished cloth A soft-handling woollen cloth, mostly in fancy colourings, which is heavily milled and finished with a fibrous face through which the weave and structure show indistinctly.

Mull Very fine, plain cotton fabric, bleached and finished soft; used for dresses (see Cambric). A bluish-white, very light and fine fabric, termed sacharilla mull, is used for veils and turbans (see Swiss mull).

Muslin A generic term applied to soft, fine, open, plain woven fabrics made of silk, worsted, or cotton yarns. The most common are cotton muslins, which are woven entirely plain or are ornamented with cords and crammed stripes, and spots and figures in extra weft or warp (see *Watson's Advanced Textile Design*). Plain muslin and fabrics with simple ornamentation are used for summer dresses, aprons, etc. In Swiss muslins spotted effects are produced by embroidering the cloth after it is woven, and imitations of the fabrics are made on the clip-spot principle (see Clip spots), termed Anglo-Swiss muslin.

Nainsook A fine, light, bleached, plain woven cotton cloth, with a soft finish, and used for underwear (see Cambric). Made in many different qualities, and sometimes woven with cord stripes and used for dresses—8 tex warp and weft, 36 ends and 34 picks per cm, to 6 tex warp and weft, 44 ends and 56 picks per cm.

Diaphalene is a nainsook type of fabric, which is mercerised and dyed in delicate colours for use as underwear.

Nankeen The term nankeen is applied to a strong 2-and-1 warp-face twill cotton cloth, firmly set in the warp, and piece-dyed drab or other colour suitable for making pockets and corsets (see also Coutil).

Nap finish The fibres are first made to stand vertically from the foundation of a woollen cloth, as in the velvet pile finish (q.v.), and then are rubbed into the form of small curls or nubs.

Napped fabrics Term applied to wool or cotton cloths which are finished with a raised or fibrous surface.

Narrow wares See Small wares.

Ninon A fine, light, soft and open silk fabric, woven plain, used for summer dresses.

Nominal A term applied to cloths in which the actual particulars are understood to be inferior to the stated particulars. The actual width of the cloth, also, may be made rather less than the stated nominal width.

Nuns' veiling A very light and flimsy veiling texture made of silk, worsted, or cotton, sometimes with a border on one side, and used for mourning. A heavier, plain woven fabric, made of rather hard-twisted worsted yarns, and dyed in various colours, is used for blouses and dresses—24 tex worsted warp and weft, 22 ends and picks per cm.

Oatmeal crêpe A soft full fabric with an irregular appearance made in crêpe weaves of the type shown at Nos. 32 to 34, *Figure A1.4*, and used for costume and dress fabrics, and household purposes. Worsted, woollen, linen, or cotton yarns may be employed, but the weft should be soft spun, and sometimes condenser cotton weft is used, as, for instance, in the manufacture of printed cretonnes—30 tex cotton warp, 38 tex cotton weft, 26 ends and 28 picks per cm.

Ombré A shaded colour effect produced by employing a number of tones of a colour, and arranging them a few threads of each in order from light to dark. Ombré patterns are also formed in different colours.

Ondule or **wave effects** All or a portion of the ends are made to form waved lines in the cloth, by means of a deep rising and falling reed in which the wires are not placed vertically, but are arranged at varying angles. For example, 30 splits of the reed may occupy a space 2 cm wide at the bottom and 4 cm wide at the top, followed by 30 splits in the space of 2 cm at the top and 4 cm at the bottom, 60 splits thus occupying 6 cm. The arrangement is repeated across the width, and, on account of its appearance, the term fan or paquet is applied to the reed. The wires are at an equal distance apart midway between the top and bottom, and when the reed beats up in this place the ends are in the normal position. By means of a special mechanism, however, the reed is slowly raised and lowered, and the ends (except those in the central splits) are gradually moved, some to the right and others to the left of their normal position, and then back again. A V-shaped wave effect is formed, which usually extends over about 5 to 8 cm in length and width. All the warp is brought from one warp beam, so that additional strain is put on the ends which wave the most, while the straight ends in the centre contract more than they would under normal conditions.

A modification of the above style is made that is not a V-shaped effect, but all the ends wave alike in a vertical direction. A weft ondule effect, also, is sometimes made by arranging the warp in alternate sections (each, say, about 2 cm wide), under the control of two easing bars or two special sets of healds, by means of which the odd sections of ends are gradually tightened while the even sections are slowly slackened, and then vice versa. Where the warp is held tight the picks lie closer together than in the slack warp sections, hence the changes in the tension on the ends cause the picks to form a horizontal waved effect.

Organdie A light, fine, white cotton fabric of the muslin class with a stiff, wiry, and translucent finish, and used for frilling and similar purposes—7.5 tex warp, 6 tex weft twisted warp way, about 30 ends and picks per cm.

Orleans A plain Bradford lustre fabric (q.v.) mostly used as a lining—14 tex cotton warp, 32 to 28 tex lustre or demi-lustre worsted weft, 23 ends, and 19 to 26 picks per cm.

Ottoman A heavy warp rib fabric, with broad ribs, woven in a variety of materials. The term 'Ottoman cord' is applied to a fabric made with thick warp and fine weft in which the rib lines run lengthwise.

Padded back lining A fancy figure-printed fabric which is printed solid on the reverse side in order to prevent the figure effect from showing through from the face side.

Pahpoons Plain cotton cloths woven in contrasting colours of warp and weft so as to produce shot effects, with headings in strong colour contrast with the ground, as, for instance, red warp and blue weft with bright green weft for the headings. At each side a crammed border is made, about 1 cm wide, by placing two ends in each mail.

Paisley shawl Extensively manufactured in Paisley from the beginning of the nineteenth century until about the year 1870 when the fabric went out of fashion as an article of dress. The shawls, which were hand woven, were made in imitation of the soft, fine, wool shawls from Cashmere, and although the original designs were somewhat modified, the pine patterns (signifying fertility, reproduction, abundance) remained the characteristic feature of the Paisley fabric. The figures were produced in several colours of extra weft, and for winter wear the shawls were 'filled over'—that is, the design extended over the whole of the surface, but for lighter wear the centre was made solid white, red, or black without figure. The fabrics were mostly made one-sided with the figuring wefts floating somewhat loosely on the underside, but in some cases the shawls were perfectly reversible, except that the weft colours interchanged.

Palm beach suiting A mohair cloth used for tropical suitings.

Passementerie Heavy braids and fringes which are richly ornamented with silk, tinsel, beads, etc.

Peau de soie A fine, soft, high quality, silk fabric, 5-thread warp satin surface, with a rather dull lustre, woven single, or backed with weft in 15-thread sateen order.

Pekin Term applied to striped silk fabrics in which contrasting stripes of satin, plain, rib, gauze, velvet, etc., are combined (see also Bradford lustres).

Petersham A narrow belting type of fabric, used for the tops of skirts, woven as a narrow ware (q.v.), or with a number are made side by side on the split selvedge principle (see Splits). The cloth is woven plain with thick weft and finely set warp, a warp rib structure being produced.

Piece dyed cloth Woven with the yarn in the grey condition, scoured, and then dyed, this being the most convenient and economical method of applying colour to a fabric.

Pile fabrics Cloths in which a proportion of either the weft or the warp threads is made to project from the foundation in such a manner as to form a pile or nap on the surface (see *Watson's Advanced Textile Design*).

Pilot cloth A heavily milled woollen cloth made with a nap or curl surface; dyed blue, and used for overcoats and jackets. For 2-and-2 twill weave—200 to 140 tex warp, 300 to 230 tex weft, 11 to 13 ends, and 9 to 10 picks per cm in the loom. Contraction up to 35 per cent in width and 20 to 25 per cent in length.

Pina cloth Plain woven with threads composed of pine-apple fibres which are very stiff, wiry, and lustrous, similar to polished cotton or horse hair.

Piqué Same structure as welts and may be considered as a fancy welt (q.v.).

Plain cloth Most extensively used of any fabric, and includes structures in which there is the greatest variety as regards the relative counts of warp and weft, and ends and picks per unit space. In many cloths, such as muslins, lawns, cambrics, and voiles the warp and weft are similar, and there are about the same number of ends and picks per cm, whereas in poplins, bengalines, cords, etc., there is great diversity in the warp and weft yarns and ends and picks per cm (see Rib cloths and poplin).

Plush Term applied to distinguish a pile fabric with a long pile formed in silk, worsted, or mohair. Seal plush is made with a silk pile to imitate sealskin, the pile being laid in one direction.

Plush velveteen A cotton velveteen with a long pile (see *Watson's Advanced Textile*

Design).

Poncho cloth A stout twill, plain, or warp rib fabric frequently woven with cotton weft and worsted warp in different shades of grey and coffee brown forming bold stripes. Made about 140 cm square with an elaborate worsted fringe at each end, and worn as a cape with a slit in the centre through which the head is passed. Used in parts of South America—44/2 tex worsted warp, 39 tex cotton weft, 28 ends, and 14 picks per cm.

Pongee A plain woven light silk fabric, usually made of wild silk in the gum condition, and is degummed in the piece. An imitation of the cloth is made in fine mercerised cotton yarns, or the fabric may be mercerised and dyed in the piece—8 to 6 tex warp and weft, 38 to 43 ends and picks per cm.

Poplin A plain woven warp rib fabric with fine warp and thick weft (see Rib cloths). Originally made with silk in both warp and weft, but poplin is now applied to fine warp rib cloths whether made of silk, wool, cotton, or a combination of the yarns. Irish poplin is made with organzine silk warp and hard twisted and genapped worsted weft. Cotton poplin is now mostly mercerised, and this class of fabric is frequently given a moiré finish. Plain cotton poplin—14/2 tex combed and gassed Egyptian warp, 60 tex weft, 60 ends, and 14 picks per cm. Irish poplin—5 tex (2-thread) organzine warp, 68/3 tex genapped worsted weft, 80 ends and 14 to 22 picks per cm (see also Corkscrew repp).

Printers Well made, plain, cotton cloths, with pure sized warp, largely used for printing.

Pyjama cloths Made in silk, wool, union, and cotton yarns, and are similar in structure to many classes of shirtings (q.v.), but often woven in broader stripes and bolder colourings.

Quilts Heavy fabrics, usually figured, mostly made of cotton yarns, and employed for counterpanes and bed and dressing table covers. The chief varieties go under the following names: honeycomb, grecian, alhambra, broché, tapestry, repp, toileting and marseilles, and patent satin.

Honeycomb quilts Made in thick, soft-twisted, two- or three-fold warp and weft yarns. Large and bold designs are formed composed of warp and weft figure effects combined with various diamond-shaped and other forms of sections in which different sizes of ordinary and Brighton honeycombs and grecian weaves (Nos. 47 to 49, *Figure A1.5*) are used to give variety of pattern—74/2 tex cotton warp, 96/3 tex cotton weft, 18 to 22 ends, and 14 to 19 picks per cm.

Grecian quilts Similar in structure to honeycomb quilts, but a larger proportion of the surface is formed in ordinary weaves, such as twills and sateens, so that the cloth has a smoother surface. Both honeycomb and grecian quilts consist of one warp and one weft, and are woven in ordinary jacquards. Mostly they are bleached white, but sometimes a delicate colour is used in either warp or weft. A grecian quilt in mercerised yarns—66/2 tex white warp, 66/2 tex pale yellow weft, 19 ends, and 20 picks per cm.

Alhambra quilts The figure is formed in coloured, extra warp threads on a plain woven texture formed by a fine ground warp and a thick, soft spun, bleached weft (see *Watson's Advanced Textile Design*).

Broché and *tapestry quilts* Elaborately coloured fabrics woven end and end in two colours with thick, soft spun, dyed weft. In the broché quilt only one weft is used, and the figuring is done mostly by the warps, although subsidiary effects may be produced in a third colour by the weft. The tapestry quilt is woven with two or three colours of weft which are different from the warp shades and all the colours are used in forming the design.

Repp quilts A coloured cloth arranged end and end in the warp, either in two colours or a colour and white. Both warps are employed for figuring, and the same figure is formed on opposite sides of the cloth, a dark figure on one side corresponding to a light figure on the other side and vice versa, the fabric being reversible. The ground weave is plain, and, as very thick weft is used, a pronounced warp rib, or repp, ground effect is formed. 30 tex warp, woven 3-ply colour and 2-ply white, 400 tex weft, 8 ply ends each of white and colour, and 7 picks per cm; contraction of warp about 25 per cent, but very little contraction in width.

Toilet and *marseilles quilts* Compound textures, bleached in the piece, which consist of a fine, slack, plain face fabric, and tight back stitching ends, and the design is produced by the latter interweaving with the former so as to form a flat or sunk ground effect, while the unbound portion forms a raised or embossed figure (see *Watson's Advanced Textile Design*).

Patent satin quilts This type has very largely superseded the toilet quilt, and may be said to consist of two cloths—one fine and smooth and the other much coarser—which interchange with each other in forming the design (see *Watson's Advanced Textile Design*).

Ratiné A plain woven cloth with a rough surface, due to the use of thick spiral threads. Made in worsted, cotton, and union yarns, in solid and mixture colours, and in stripes and checks—about 125 tex spiral yarn in warp and weft, 7 to 8 ends and picks per cm. Also, 74/2 to 30/2 tex ordinary soft spun cotton warp, 170 to 130 tex cotton spiral weft, 10 to 16 ends, and 7 to 10 picks per cm.

Regatta A 2-and-1 warp-face twill cotton cloth, usually in stripe form, the colour being fast to washing. For use as working clothes or protective garments—27 tex cotton warp, 33 tex cotton weft, 32 ends, and 24 picks per cm.

Repp A warp rib structure in which the rib lines are prominently developed by using thick and fine threads alternately in warp and weft, and passing the thick ends over the thick picks, while the fine ends are held very tight (see Rib cloths, and diagram B in *Figure* 2.2). Repp structures are also made in such weaves as L to O in *Figure 3.1* in which two or more ends pass together over two or more picks, many more ends than picks per cm being employed (see Corkscrew repp).

Reversible cloths Similar in weave, colouring, and finish on both sides, so that either can be used as the right side. Particularly serviceable for hanging fabrics, tapestries, shawls, rugs, etc.

Reversible imperial See Swansdown.

Rib cloths Composed of bending threads in one direction and comparatively straight threads in the other direction with many more of the former threads per unit space than of the latter. The threads do not support each other the same as in ordinary cloths, and when a fabric is subjected to strain in the direction of the straight threads the bending threads tend to slide somewhat readily along the former if the cloth is not very well constructed. Broad rib effects are produced by employing warp and weft rib weaves, but the majority of rib clothes are woven in plain weave (see Poplin, also *Figure 2.2*).

Rug blankets Mostly made with cotton warp and woollen weft on the reversible weft face principle, either in solid colours or in figured styles. The cloths are woven in both coarse and fine wools and a special class of texture is made with lustre weft, and whereas the fine wool structures are mostly finished with a velvet pile surface on both sides (see Velvet pile finish), the fibres of the lustre weft are drawn on to the surface so as to form a long pile which is laid in one direction (see *Watson's Advanced Textile Design*).

Rugs All-wool travelling rugs are woven single and double in structure, and are finished with a fibrous surface on both sides. The single fabrics are largely made in twill weaves and bold check styles of colouring, while the double cloths frequently have different colour effects on opposite sides (see *Watson's Advanced Textile Design*). Woollen yarns are used composed of wools ranging from coarse cheviot and crossbred to fine crossbred and merino.

Russian cords Formed on the gauze principle, coloured crossing ends being traversed across the standard ends so as to form solid cord lines which are in strong colour contrast with the ground (see *Watson's Advanced Textile Design*).

Sarong A plain woven cotton cloth, used for women's wear in the East, and made with a rather simple coloured check pattern forming the bulk of the fabric, and a somewhat elaborate heading or 'capella', which commences about 30 cm from each end, and ranges from about 35 cm to 53 cm in depth. The pattern of the capella follows a certain definite form, and consists of two broad bars of colour with a narrow bar between followed by five narrow bars. This is repeated five times, then a division is made and usually the pattern is again repeated five times. For a woman's garment the cloth is made wide with a plain coloured border at each side, but for a girl it is made narrower with a border only at one side—20 to 16 tex warp, 19 to 15 tex weft, 22 to 24 ends, and 19 to 22 picks per cm.

Sari Used for dresses by women of India, and woven in different widths and lengths varying from 5 to 8 m. Made with borders and broad headings at both ends, and they may be elaborately figured and coloured in the headings, borders, and centre by means of extra threads, or by large printed effects.

Sateen A cotton fabric made in 5-thread weft face sateen, and woven like cotton Italians (see Italian cloth). Manufactured in many different qualities, and sold in the bleached, dyed, mercerised, schreinered, or printed condition. Good even yarns are required. When the direction of the sateen twill is the same as that of the twist of the weft the weave has an irregular appearance, and the term broken sateen is applied to the cloth.

Satin Used for ribbons, trimmings, dresses, linings, etc., and originally was an all-silk fabric with a fine rich glossy surface formed in a warp satin weave (see Duchesse). The warp is much finer and more closely set than the weft, and the latter, which only shows on the under side, is frequently composed of cotton. Double faced satins are made on the reversible warp backed principle, with one side differently coloured from the other (see *Watson's Advanced Textile Design*). The term satin is also applied to fine cotton warp satins used for shirtings and linings (see Cotton venetians).

Saxony cloths Woollen textures made from Saxony or merino quality of wool (as distinct from Cheviot cloths, which are made from coarser wool) with a fine smooth surface, soft handle, and compact structure. The fabrics are used for costumes, trouserings, suitings, and overcoatings, and are made single, backed, and double according to the weight and fineness of appearance required, and are finished clear or with varying degrees of fibre on the surface. For medium and light weight suitings in 2-and-2 twill—135 to 62 tex warp and weft, 13 to 19 ends and picks per cm in the loom.

Schreinered cloth Cotton cloth with a very high lustre produced by subjecting it to heavy pressure by a hot steel roller which is engraved with fine parallel lines varying from 80 to 160 per cm according to the cloth to be treated and effect desired. The finish is chiefly applied to cotton venetians, linings, sateens, and printed cloths, and produces the best results on fabrics which have been mercerised. The engraved lines run diagonally across the cloth in the same direction as the twist of the surface yarn, but the angle of inclination varies according to whether the fabric has a warp or a weft surface.

Scourers or floor cloths Thick, coarse fabrics used for scouring floors, woven 2-and-2 twill, and made of yarns which consist of waste wool and cotton spun on the woollen system—320 to 220 tex warp and weft, 7 to 9 ends and picks per cm.

Scrim A very loosely woven cotton muslin type of cloth; may be as low in quality as cheese cloth (q.v.), or finer according to its use. The finer fabrics are employed for drapery and cheap window curtains, while the lower qualities are stiffened and pasted to another cloth for use as hat shapes (see Buckram).

Seamless bags Coarse cloth woven in thick cotton or jute yarns on the double cloth principle without stitches, so that the textures are only joined at the sides, and form a tubular structure. Also produced on circular looms.

Selvedges A good selvedge helps to finish off a fabric and gives it a neat appearance which frequently makes it sell better. The ends used for the selvedges require to be strong (see Selvedge yarns), and they generally differ in material, colour, thickness, or number per unit space from those in the body of the cloth. Very light fabrics, such as voiles and crêpes, particularly require good selvages, which are made dense and compact by cramming the ends from 0.5 cm to 2 cm wide at each side. Two-fold yarns are largely used, and mostly a few double ends (tapes) are made at the outer edges. The use of too many double ends may be the cause of slack selvedges, as these ends tend to lie straight in the cloth, and not to contract as much as the ground ends.

Serge Twill cloth, generally understood to be of a crisp texture and somewhat rough appearance, and made of cross-bred worsted or woollen yarn.

Shadow effects Patterns of a somewhat indistinct or elusive character produced in cloths that are in the same shade or colour throughout. The effects generally run in stripe form, although similar styles can be obtained in the direction of the weft. Most frequently produced by arranging alternate sections of *z* and *s* twist yarns in the warp, which causes light from the same position to be reflected in opposite directions. In looking at a piece-dyed cloth from one side the sections composed of *z* twist yarns appear to be much darker than the other sections, but when the cloth is looked at from the opposite side, the *s* twist sections appear to be the darker. The difference of effect is clearly seen in a plain weave fabric, but it is still more apparent in a cloth in which a continuous warp face twill or satin is employed, as in the latter case there is, in addition, the formation of a more prominent twill effect in the sections in which the direction of the twill is opposite to the direction of the warp twist (see *Figure 2.12*). When both kinds of twist are used together the reverse twist yarn is tinted with a fugitive dye in order that it may be distinguished during the processes of manufacture.

In lustre weft cloths effective shadow stripes are formed by denting the ends irregularly (see Bradford lustre fabrics), and a good check style results from using ordinary and reverse twist weft along with an irregularly dented warp. Similar subtle styles can be obtained by arranging alternate sections of threads which differ in the amount of twist, in brightness, or in fineness, or by reversing the direction of a regular warp satin weave, or by slightly reducing the length of the warp float on the surface in alternate sections.

Shantung A plain woven, rather rough fabric, made of Tussah silk yarns, in the natural brown colour, and usually containing imperfections, such as lumps, slubs, etc. About 17 tex warp and weft, 30 ends, and 29 picks per cm. Cotton and spun rayon imitations are made with a weft that is spun with rather thick soft places at irregular intervals.

Sheeting Woven in linen and cotton yarns, the latter being generally known as Bolton sheeting. Made in comparatively thick yarns, in 2-and-2 twill or plain weave, from 140 to 300 cm wide, and sold grey or bleached—2-and-2 twill cotton sheeting—49 to 42 tex warp, 60 to 49 tex weft, 18 to 20 ends, and 25 to 28 picks per cm. Plain sheeting—33 tex warp, 38 tex weft, 18 ends and 18 to 24 picks per cm. Coarser cotton sheetings are woven with thick condenser weft (see Condenser cotton yarns), while flannelette sheetings are usually made of this weft in plain weave. Fine sheetings are also woven with cotton polyester blended yarns.

Shirtings Wide variety of materials and constructions are used in the production of these cloths. The main classes are listed in the following paragraphs, but in addition to woven constructions considerable quantities of warp-knit structures are used, made chiefly in polyamide fibres.

Plain white shirtings Better qualities of plain cotton shirtings, woven with pure sized warps, and bleached, are 27 tex warp, 38 tex weft, 22 ends, and from 26 to 28 picks per cm. Plain cotton shirtings are also mercerised in the piece or woven with mercerised yarns.

Fancy white shirtings These include cloths woven in ordinary mat weaves; mock lenos; broken warp ribs—termed Barathea—(example No. 4, *Figure A1.2*); honeycombs; Bedford cords (No. 52, *Figure A1.5*); welts and piqués (Nos. 53 to 57; *Figure A1.5*); crêpes (Nos. 26 to 34, *Figure A1.4*); sponge weaves (Nos. 35 to 38, *Figure A1.4*); and cord weaves (Nos. 2 and 3, *Figure A1.2*). The looser weaves allow fairly heavy and full handling cloths to be made, and if soft spun yarns—particularly in the weft—are used, excellent results are obtained. In 3-and-3 mat weave—24 to 18 tex cotton warp, 50 to 38 tex cotton weft, 24 to 26 ends, and 22 to 32 picks per cm. Fancy mat weave—38 tex cotton warp, 46 tex cotton weft, 25 ends, and 26 picks per cm. A light cloth in 4-and-4 mock leno weave—15 tex cotton warp and weft, 38 ends, and picks per cm. A heavy cloth in 5-and-5 mock leno weave—30 tex cotton warp, 50 tex cotton weft, 24 ends, and 22 picks per cm. Barathea or broken warp rib weave—16 tex cotton warp, 38 tex cotton weft, 48 ends, and 22 picks per cm; crêpe weave—24/2 tex mercerised cotton warp, 22 tex merino weft, 26 ends, and 25 picks per cm. Cord weave—21 tex cotton warp, 30 tex cotton weft, 32 ends, and 24 picks per cm. Diverse combinations of the preceding weaves are made, and they are also used in conjunction with stripes of warp satin, warp twill, and other effects. Such terms as the following are applied to white striped shirtings: striped Barathea, twill striped repp, striped Madras, corded cambric, corded batiste, mercerised stripe crêpe, satin striped cambric, corded lawn, embroidered lawn, mercerised stripe brocade, mercerised stripe piqué, striped ratiné, mercerised Oxford, striped cord weave, etc.

Cellular shirting An open gauze structure, largely made of cotton yarns, and, to some extent, of worsted and linen. Simple and fancy gauze effects are used alone or in combination with other weaves (see *Watson's Advanced Textile Design*).

Coloured shirtings The preceding styles, in addition to being made all white, are also ornamented by coloured threads in the form of stripe, check, and spot effects, but white or very light coloured grounds form the bulk of the surface.

The following shirtings are usually more heavily coloured, and the coloured threads require to be dyed fast to the cloth finishing processes, and to washing.

Poplin shirtings Plain weave warp-rib cloths, frequently piece-mercerised. Combed and gassed E. cotton—10/2 tex warp, 12/2 tex weft, 54 ends, 28 picks.

Zephyr shirtings Termed Madras in the United States (see Zephyr fabrics).

Oxford shirtings Double-end cotton cloths made all white in ordinary and mercerised yarns, but generally colours are introduced in the warp, and frequently fancy weave stripes are formed to give variety (see *Figures 7.8* and *7.9*). The term Oxford is now applied to other cloths than shirtings which are woven with two ends per mail.

Harvard shirtings Hard wearing cotton fabrics, with 2-and-2 twill ground on which more or less elaborate stripe effects are formed (see *Figure 7.10*)—38 to 33 tex warp and weft (both twisted warp way), 28 ends, and 26 to 29 picks per cm.

Grandrelle shirtings Largely used for workmen's shirts, and made in 5-thread warp satin weave with the bulk of the warp composed of coloured cotton twist threads (grandrelle) and white cotton weft. Single twist solid coloured and white threads are used in conjunction with the grandrelle twist threads, and in some cases the latter are replaced by mock grandrelle threads (see Marl yarns)—30/2 tex grandrelle and 30 tex single warp, 60 to 49 tex weft, 36 ends, and 26 picks per cm.

Union shirtings (see Union yarns) Usually woven plain, sometimes 2-and-2 twill, and are composed of both wool and cotton fibres, which may be introduced by employing wool yarns in one direction and cotton yarns in the other direction, or by using angola, llama, or merino yarns (q.v.) in the weft, warp, or both weft and warp. The presence of cotton in fibre mixture with wool reduces the tendency of the fabrics to shrink in washing. The same kind of finish is applied as to all-wool shirtings which are felted and raised, and the fibrous face that is formed so subdues the colours that very bold colourings can be introduced; and for the same reason fancy weaves are not suitable. For white or cream cloths the warp should be bleached in order to produce the best results, and in coloured fabrics the colours should be fast dyed to stand the felting process. The amount of wool in the cloths varies from as low as 5 per cent to 80 or 90 per cent.

Angola and *llama shirtings* Composed of woollen spun union yarns in both warp and weft, and are similar fabrics except that the llama structures are generally (but not necessarily) the finer (see angola and llama yarns)—64 tex warp, 50 tex weft, containing from 50 to 85 per cent wool, 15 ends, and 17 picks per cm.

Taffeta shirtings Very fine, plain woven, botany worsted cloths, in white, cream, or stripe colouring, and sometimes ornamented with crammed silk stripes in satin and other weaves. The cloth is also made with silk yarn in one direction and botany yarn in the other direction.

Woollen shirting Usually a moderately heavy cloth of good quality and mostly woven plain with woollen yarn in both warp and weft. A felted and raised finish is applied, and the fibrous surface that is formed enables only the simplest form of ornamentation to be introduced.

Polyester fibre/cotton shirting Fine shirtings in similar constructions to poplin are made in blended yarns containing 65 or 70% polyester fibre which imparts crease-resist properties to the cloth and improves its drying characteristics.

Shot effect A fabric woven in contrasting colours of warp and weft which are about equally on the surface, so that the cloth appears to be one colour from one point of view and the other colour from another point of view (see also Chameleon taffeta).

Showerproof cloth Partially repellent to water by chemical treatment, or by suitable selection of materials and construction.

Sicilian See Bradford lustre fabrics.

Silesia A twill or satin cotton lining, heavily starched, and dyed and finished with a glossy surface, but sometimes printed in stripe form. A 2-and-2 twill cloth—27 tex warp, 18 tex weft, 24 ends, and 48 picks per cm.

Small wares Narrow fabrics, such as tapes, braids, elastic webbing, etc., woven singly in narrow looms, or two or more side by side in broad looms, with a separate shuttle to each fabric.

Splits Narrow cloths woven two or more alongside each other in broad looms, with the weft stretching between them, which are cut or split apart. By means of a special motion perfectly firm inner selvedges can be made, but generally the split selvedge ends are retained in position by a simple arrangement by which the outer ends are interlaced on the gauze principle. In felted cloths which require to be split, such as narrow wool shirtings woven in broad looms, the milling makes the inner selvedges sufficiently firm without other aid.

Sponge cloth The sponge weave, given at C in *Figure* 5.4, when woven with soft yarns, produces a soft, spongy, honeycomb texture which is used for a variety of household and other purposes. In another kind of sponge cloth, employed for dress fabrics, and mostly woven plain, thick irregular nubby weft is used that is composed usually of cotton, but sometimes of wool or rayon. A sponge dress fabric, also, is made with soft irregular spiral yarns in warp and weft, and is rather similar to ratiné, but softer—about 140 tex cotton warp and weft, 7 ends, and picks per cm. A third class of sponge cloth is used for cleaning machinery, etc. (see Cleaning cloths).

Swansdown or imperial Term applied to a group of heavily wefted cotton fabrics (see Fustian) that includes imperial sateen, reversible imperial, and lambskin, which are finished with a raised or fibrous surface on one or both sides. Ordinary swansdown is woven with the 2-and-3 weft venetian weave (see No. 13, *Figure A1.3*) which, because of the large number of picks, gives a weft surface on both sides, so that either side can be used for the formation of a dense nap (see Flannelette)—33 tex warp, 40 tex weft, 19 ends, and 62 picks per cm.

Imperial sateen is a heavier fabric than the ordinary swansdown, and is woven in the weave given at No. 14, *Figure A1.3*, which is based on the 8-thread sateen, and gives a weft float of six on the surface. In this case also the heavy wefting enables a soft nap to be formed on the under side.

Lambskin is the term applied to 'imperial sateen' when the cloth is raised on the face side, the compact weft surface enabling a very soft nap to be formed.

Reversible imperial is woven in the 4-and-4 weave, based on the 8-thread sateen, given at No. 15, *Figure A1.3*, which, with very heavy wefting, produces a dense weft surface on both sides of the cloth. For imperial and lambskin cloths—66/2 to 49/2 tex warp, 38 to 21 tex weft, 19 to 25 ends, and 120 to 170 picks per cm.

Swiss mull Fine cotton muslin—8 to 6 tex warp and weft, 40 to 48 ends and picks per cm.

Swivel fabrics Extra weft figured textures, in which the ornamentation is produced by means of a series of small swivel shuttles, each of which is capable of separately forming a figure, or part of a figure, over a certain width of the cloth. Each swivel thread is traversed from side to side and bound into the foundation cloth only where figure is formed, so that there is no waste of the extra material between the figures (see *Watson's Advanced Textile Design*).

Table felting A thick reversible cotton fabric usually with a raised finish, made in coarse yarns, and used under an ordinary table cloth as padding.

Taffeta Originally a plain, closely woven, silk fabric used for dress fabrics and linings, and frequently the cloth is made with thicker weft than warp, and is set so as to produce a fine warp rib structure. The term taffeta is also used in conjunction with certain effects, thus taffeta glacé indicates a 'shot' silk taffeta.

Tartan Scotch tartans are 2-and-2 twill woollen or worsted cloths woven in more or less elaborately coloured check designs, and worn as shawls or plaids over the shoulder, and as kilts. Each Highland clan has its own particular design, and many of the clans have more than one tartan—e.g., hunting, mourning, or dress tartan. A design may be varied as regards the size of the repeat, but the different sections of the pattern require to be exactly in proportion. The cloth is made with an exact number of repeats of the colour scheme across the width of 67/70 cm, and the same tartan design may have, say, 4, 6, or 8 repeats, the smaller sizes being used for boys' or youths' wear, and the largest for men's wear—90 tex woollen warp and weft, and 16 ends and picks per cm; or 27/2 tex botany worsted, 28 ends and picks per cm. Many modifications of tartan designs have been made in cotton, rayon, etc., yarns, and crêpe and other fancy weaves have been introduced.

Terry or **turkish towelling** A looped warp pile fabric, made in linen and cotton yarns, and used for towels, bath mats, bed covers, dressing gowns, etc. (see *Watson's Advanced Textile Design*).

Thread harness muslin A fine, extra-weft, figured muslin fabric, woven in an ordinary jacquard which controls every warp thread. The loose floats of weft, extending between the figures, are cut away so as to leave a light, open ground (see *Watson's Advanced Textile Design*).

Ticking A strong, somewhat stiff fabric used for mattresses and pillowcases, and made in 2-, 3-, and 4-thread twill, and 5- and 8-thread satin weaves in bold warp stripe colourings. The cloths may be all linen, or all cotton, or a combination of the two, and sometimes the coloured stripes are cotton, and the remainder of the cloth linen. 2-and-1 twill linen cloth—56 tex warp, 75 tex tow weft, 28 ends, and 19 picks per cm. 5-thread satin cotton fabric—60 tex warp, 50 tex weft, 30 ends, and 22 picks per cm.

Toiletings (See Quilts.)

Towel fabrics See Honeycomb, huckaback, terry, and crash.

Tow fabrics Heavy and coarse cloths composed of flax tow yarns, which, in the weft, may be soft spun so as to produce a full handling and absorbent texture (see Crash towelling).

Tricotine A piece dyed worsted serge costume cloth woven in a warp face weave forming fine steep twill lines (see Nos. 21 and 22, *Figure A1.3*)—34/2 tex botany warp, 28 tex worsted weft, 20 ends, and from 20 to 24 picks per cm. The term is also applied to a worsted weft and cotton warp cloth with a weft face in which fine flat twill lines are formed, and to a silk warp and cotton weft cloth, woven plain, and showing fine horizontal rib lines.

Turn back checks A type of cloth that consists mainly of a small 2-colour check pattern, but with a border at each side in which only one of the wefts is interwoven with the warp. That is, one of the wefts 'turns back' without interweaving with a certain width of warp at each side, these ends being drawn on separate healds which are not operated when the particular weft is inserted. Thus, a fabric may be warped and wefted 2 blue and 2 white, but the blue weft 'turns back' from about 10 to 15 cm from each edge of the piece, so that the border consists of a narrow stripe effect, and the centre of a small check pattern. The border necessarily contains only half as many picks as the centre.

Tussore Originally a light brown, fawn, or natural coloured plain woven silk fabric; also made in cotton yarns and mercerised and dyed to imitate the colour of the silk cloth. The structure is that of a plain woven warp rib (q.v.), and in some cases a few darker threads are introduced at a place so as to form stripes—30 tex cotton warp, 50 tex cotton weft, 36 ends, and 14 picks per cm.

Tweed Term applied to a wide range of woollen cloths used for suitings, and overcoatings, which include on the one hand all kinds of cheviot fabrics, and, on the other hand, fine Saxony textures, which are finished with either a dress face or a clear finish.

Utrecht velvet A silk, or mohair, warp pile fabric which is used for upholstery purposes (see *Watson's Advanced Textile Design*).

Velours Woollen costume cloth which has been felted and raised, and finished with a fibrous surface.

Velvet A cut warp pile fabric with a short, soft, dense pile (see *Watson's Advanced Textile Design*).

Velveteen A stout, heavily wefted cotton fabric, uniformly covered with a short dense pile of fibres, which is formed after the cloth has been woven by cutting certain picks of weft that float somewhat loosely on the surface (see *Watson's Advanced Textile Design*).

Velvet pile finish The fibres form an erect pile on the surface of a woollen cloth instead of being laid in one direction, as in the dress-face finish. The texture is heavily milled and raised, and then, while stretched face down between rollers, it is beaten on the back with rods which causes the fibres to project vertically from the foundation. The cropping process follows, but this is done only to equalise the length of the fibres, and the cloth is covered with a dense vertical non-lustrous pile which conceals the weave and structure.

Venetian overcoating Similar to covert coating (q.v.), but in addition to showing a mixture effect with a clear finish, the cloth is sometimes made in solid colour, piece dyed, and finished with a fibrous surface. The term venetian is also applied to a lustrous warp satin cotton fabric (see Cotton venetian).

Vicuna cloth Usually a worsted warp and woollen weft cloth made backed or double in structure. A felted and raised finish is applied, but the fibres are cut sufficiently close to the surface to show the weave distinctly. The cloth is largely made double in structure with 2-and-2 twill face and plain back, the threads being arranged 2 face to 1 back in warp and weft. 35/2 tex worsted warp, 54 tex woollen weft, 36 ends, and 32 picks per cm.

Voile A plain woven, open fabric made from hard twisted warp and weft yarn which is combed and gassed in order that the threads will be smooth, and produce a clear, crisp fabric (see Voile yarn). Made in both worsted and cotton yarns which vary extremely in thickness in different makes. A worsted voile—110/3 tex warp and weft, 9 ends and picks per cm. A cotton voile—24/2 tex warp and weft, 14 ends, and 15 picks per cm; or, 12/2 tex warp and weft, 23 ends, and 22 picks per cm. For cotton fabrics combed and gassed, hard twisted, single yarn of 12 to 10 tex has been substituted to some extent for two-fold yarn. On account of the openness of the fabric good selvedges are required, and these are frequently made 1.25 cm or more in width, an ordinary yarn being used which is crammed in the reed so as to give the necessary density. The voile ends are woven one per split, and the cloths are ornamented by means of crammed stripes, extra warp and weft figures, etc., in mercerised cotton, silk, and rayon yarns.

Voile and *rayon stripes* The rayon ends require to be crammed in the reed, and 22 to 28 tex filament yarn is suitable to use with 12/2 tex cotton voile yarn, the former at the rate of 44 ends per cm, and the latter 22 ends per cm. Trouble is frequently found in weaving the voile and rayon ends in the same fineness of reed, on account of the former requiring to be one end per split, and reeds are therefore made to fit the warp stripe, the sections for the voile ends containing twice as many wires per unit space as the sections for the rayon ends. Thus, for the preceding example, the rayon stripe sections will have 11 splits per cm, dented 4 ends per split, and the voile sections, 22 splits per cm, dented 1 end per split.

Warp printed cloth See Chiné or chené.

Watered fabrics See Moire.

Waterproofed cloth Made impervious to water by the application of a coating of rubber or other water-resisting substance to the surface of the material, or between two thin textures which are thereby cemented together.

Welts A class of fabric, similar in structure to piques (q.v.), which is used for vestings, shirts, ties, etc. (see Nos. 53 to 57, *Figure A1.5*)—20 to 10 tex face warp, 30 to 20/2 tex back warp, 15 to 8 tex face weft, 33 to 25 tex wadding weft, 36 to 52 ends, and 38 to 64 face picks per cm, wadding picks extra.

Whip cord cloths Show prominent steep twill lines, the warp lines forming ridges, and the weft lines furrows. The direction of the twill should be opposite to the direction of the warp twist (see Nos. 18 to 24, *Figure A1.3*).

Wigan Medium weight cotton cloth woven plain or 2-and-2 twill, used for domestic purposes. Plain Wigan—about 50 tex warp and weft, 16 ends, and 25 picks per cm. 2-and-2 twill Wigan—about 42 tex warp and weft, 18 ends, and 33 picks per cm.

Wincey Used for underclothing, pyjamas, and blouses. A cream underclothing fabric—23 tex bleached cotton warp, 56 to 49 tex weft containing 40 per cent wool, 25 ends and 20 to 22 picks per cm.

Window Holland Medium weight cotton (occasionally linen) cloth used for blinds. Produced in plain weave, starch finished and frequently glazed. Piece dyed in fast to light colours.

Wool dyed cloth Cloth in which the yarns have been spun from wool dyed in the fibre or the sliver or 'top' condition (see Slubbing dyed yarns). Each thread may be composed of fibres of one colour only, or of a mixture of differently dyed fibres (see Mixture yarns).

Woollen cloths Composed of woollen yarns (q.v.), and the majority of the cloths are largely dependent upon the finishing operations for the density of structure, fine surface appearance, softness and flexibility, and richness of colour of the finished fabric. A cloth which on leaving the loom has a bare, thready appearance may be completely altered, and, further, the kind of finished effect that is obtained may be of a very diverse nature according to the manner in which the processes of felting, raising, and cropping are carried out (see Dress-face, velvet-pile, and clear finish, also felted, cheviot, saxony, nap, and melton cloths).

Worsted cloths (see Worsted yarns) The brightness of colour, clearness of weave, and density of structure of most worsted cloths, as they leave the loom, are nearly the same as in the finished textures, and the finishing processes are employed to clean the fabric and to improve its appearance and handle. A few classes of worsted fabrics are milled and raised and finished with a more or less fibrous surface, but mostly the cloths are not milled, and a clear surface is formed. For certain kinds of fine worsted suitings, and overcoatings, light felting is employed, as this imparts a softness and fulness which can be obtained in no other way, but the cloths are afterwards finished clear in order to show the weave and colour pattern clearly.

Woven linings Heavy overcoatings, etc., woven on the centre stitched double cloth principle (see *Watson's Advanced Textile Design*), with solid or simple colour effects on one side and diverse stripe and check patterns on the reverse side which forms the lining. The cloths are made in both worsted and woollen yarns, and the two sides may be alike or different in weave, fineness, material, or finish. In some cases an imitation woven lining effect is obtained by introducing extra warp and weft threads only in places where a prominent overcheck pattern is formed on the under side of a single cloth.

Yarn dyed cloth Made from warp and weft which have been previously dyed in the yarn form.

Zephyr fabrics Fine cotton cloths, used for shirts, blouses, and dresses, chiefly plain weave, and made with white or coloured weft and white, solid coloured, or stripe coloured warp, also in check colouring, and ornamented with cord threads, crammed effects, and simple and elaborate figures (see *Figures 7.13* to *7.17*, and *7.11*). The term 'gingham' and 'madras' are applied to Zephyr cloths, a gingham being a zephyr which is used for blouses and dresses, while a madras is a shirting fabric.

Zibeline A heavy wool costume fabric, somewhat heavily milled and raised, and finished with a long pile of fibres on the surface laid in one direction. The weave is entirely concealed, and generally such special fibres as mohair are included in the yarns which, when drawn out on the surface, produce a characteristic appearance.

List of works for further reference:

1. *Textile Terms and Definitions*, 6th edn, The Textile Institute, 1970.
2. 'The "Mercury" Dictionary of Textile Terms', Textile Mercury Limited, 1950.

Appendix II

Man-made Textile Materials

The desirable features and properties of a textile material. Survey of the manufacture, properties and uses of man-made textile materials. Identification of textile materials. Glossary of the more important yarn terms used in respect of man-made materials.

THE DESIRABLE FEATURES AND PROPERTIES OF A TEXTILE MATERIAL

Prior to the study of specific examples of the man-made textile materials it will be useful to postulate the desirable properties which such materials should possess, and to find out the effect which various commonly encountered agencies may have upon their performance. Knowledge of these facts enables the designer by a process of comparison and elimination to select the most suitable material for a particular end use.

The properties of special interest to the designer may be listed as follows.

Strength	Lustre
Extensibility and elastic recovery	Warmth
Fineness	Dye affinity

In addition, a designer in order to avoid the use of a material in unsuitable circumstances should be acquainted with the reaction of materials in the presence of certain agents. He should also be able to foresee whether in its intended use the material is liable to come into contact with a given agent, and if so—whether the agent is likely to have an injurious effect. The following is a list of the various agencies to the action of which most textile fibres are subjected during processing or during ordinary usage:

Heat	Alkalis
Seaming during making-up	Bleaches
Water	Dry-cleaning agents
Acids	Insects and micro-organisms

Strength A textile material must be strong. If an article is to hold together and resist wear it needs a degree of strength. In measuring this quality in fibres or yarns, the basis on which it is quoted must be known otherwise misleading statements or claims may result. There are two ways in which strength may be measured. In one, a fixed weight of the material is taken and tested, in the other, a fixed thickness of the material is used. Where a fixed weight of the material is used, the result would be quoted against the count of the material (e.g. grams per denier) and where the fixed thickness is used, the result quoted against the area of the cross-section (e.g. grams per square centimetre). Two terms are used to differentiate these methods. Tenacity is the breaking force in terms of the yarn number while tensile strength is the breaking force in terms of the unit area. Normally this point is one of little concern to the designer but with the introduction of man-made materials of lower density than the natural fibres it becomes a point of note. To take an example, the case of nylon and cotton may be quoted. If the tenacity of these materials is measured, because of the lower density of nylon and therefore greater thickness of material for a given weight, it may be that nylon would be stronger than cotton. If on the other hand, the tensile strength of the materials is obtained, because the same area of each is tested, the positions may be reversed. The designer must therefore bear in mind the end use of the fabric and if it is one where thickness of material is important then the figures for comparison of materials should be the tensile strength, but if the weight of the fabric is the criterion then tenacity would be of more value.

Extensibility and elastic recovery These two features are of interest both to the manufacturer and to the consumer. From the manufacturer's view point, extensibility is a desirable property as it enables the yarns to be manipulated easily. If the material also has good elastic recovery then any stretch imparted during the processing will be recovered and the fabric performance in no way suffers. The consumer's interest concerns mainly the appearance and the serviceability. These are enhanced by the use of materials with good elastic recovery, as otherwise, such functions as bending, sitting, etc., which cause stretching would result in permanent distortion of the garment. For apparel fabrics the designer will, therefore, select materials which possess these valuable properties, but for certain special cloths which require maximum rigidity, materials which are comparatively inextensible will be employed.

Fineness It is considered that fine fabrics can only be made from fine yarns, and in turn, fine yarns can normally be made only from fine fibres. Equally well, fine fibres can be employed also in the manufacture of heavy yarns and heavy fabrics. Fineness, therefore, is a desirable property as it does not impose any limitations on the range of applications of a given material.

The position with regard to the fineness of man-made fibres needs, however, some clarification as here it is possible to create continuous filament yarn of fine diameter either by the extrusion of mono-filament in which the fibre and the yarn are one, or, by the multi-filament extrusion process in which the yarn is composed of a number of very fine filaments. The two different yarns may be equally fine, and yet the former has no fine fibre elements in its make-up. Both can be used to produce fine fabrics, but cloths constructed from the mono-filament threads will have poorer 'cover', lower moisture absorption and poorer draping quality. For these reasons it is generally preferable to use the multi-filament yarns for apparel cloths, and the mono-filament materials in certain special circumstances where their regularity, comparative stiffness and the sheer construction are of particular value.

Lustre With regard to consumer appeal this is a very important feature and its presence or absence frequently determines the field in which a given material can be employed. Lustre is an inherent characteristic of most man-made materials and as such it could have been a factor limiting the range of applications. Fortunately, it is possible to modify the brightness of these materials so that a complete range is available from the harsh, metallic lustre at one end of the scale to completely dull fibres at the other.

Warmth The warmth of a fabric is dependent mainly on four features—the thermal insulation value of the material, the amount of air entrapped in the fabric, the moisture absorption of the material and the smoothness of the fabric. The thermal insulation value determines whether the material is a good insulator or a good conductor and other things being equal, the material which is a good insulator will give the warmest fabric. The amount of air entrapped is of vital importance as air itself is a good insulator so that a fabric holding a large amount of air will be warmer than one which does not. The moisture absorption while only influencing slightly the heat retaining properties of a fabric does alter the handle of a fabric considerably. Thus a material with a low moisture absorption may feel cold and clammy in humid conditions due to excess moisture condensing on the fabric while a similar fabric made of a material with a high moisture absorbing capacity in similar conditions would feel quite warm. A smooth fabric if worn near the skin will make contact with a large area of the body immediately giving a cold impression but a rougher fabric even of similar material will not make an equally intimate contact and therefore will feel warmer. Allied with this feature is the closeness of the weave itself and a closely woven fabric when used in a strong wind may be warmer than an open fabric made from a superior insulating material. The designer can do little about the thermal insulation value or the moisture absorption capacity except to choose a material giving the required values, other characteristics, however, can be altered readily to meet the exact functional requirements. For example, to entrap a large amount of air, bulked yarn can be used; to prevent close contact with the body a broken, irregular construction may be employed; and finally, if low air permeability is desired it could be achieved by close yarn settings combined with a tight interlacing.

Dye affinity An affinity for a large number of dyestuffs is a valuable asset in any fibre. It enables the designer to produce widely divergent ranges of fabrics suitable for all types of markets and for various end uses. Fortunately, with the advances in dye chemistry there are comparatively few classes of materials where the designer is not completely satisfied with the available colour ranges. In many instances the range of dyestuffs may be further supplemented by the use of pigments in the spinning solution prior to extrusion (see Spun-dyed yarns). Exclusive affinity of a material for a particular type of dyestuff offers an additional interesting possibility of cross-dyeing in the piece.

Combined with the question of dye-affinity is the question of dye fastness and close study of this aspect is essential, as in many instances colours with good fastness to some agencies, e.g. washing, may exhibit inferior fastness to others, e.g. light. Correct selection of the right class of dyestuff for a given end use will ensure satisfactory performance in the circumstances for which the fabric has been designed.

Effect of heat Apart from the question of flammability of materials the reaction to heat may take the form of melting or shrinking. The first point is of particular importance in designing cloths for children's wear, and for use in public institutions (e.g. hospitals, theatres, etc.) where greater than normal fire risks exist. In this respect most man-made materials of the synthetic type are safe, but this is the group which on the whole exhibits low stability to heat on account of the low melting point. This factor largely determines the finishing routine of such cloths and may prove a source of annoyance in the home (ironing, drying). As the synthetic materials require little ironing and dry rapidly the remedy against mishaps appears to lie in the education of the consumer and in informative labelling.

Effect of seaming This particular feature is becoming increasingly important. Prior to the advent of man-made materials, little difficulty was encountered in converting fabrics to garments as most natural materials have a good resistance to seam slippage, that is, they are sufficiently rough to grip each other and also the sewing thread firmly, thus giving a firm seam. The one exception to this was silk, but then as now, the cost of silk was such as would accommodate an extra charge to be spent on using special seams. The man-made materials are, in the main, extremely smooth and the problem is now brought down to the competitive market where additional costs for special seams may not be possible. Knowing this point, the designer can aid the garment manufacturer by altering the setting or structure of the fabric depending on the material so as to eliminate seam slippage as much as possible.

Effect of water This may be considered from two main points of view—the moisture absorption and the effect of wet treatment. In the former case the behaviour of a material depends on its intrinsic properties and it would be obviously unwise to employ hydrophobic materials in circumstances in which high moisture absorption is of advantage. Admittedly, there may be other advantages which will outweigh this consideration on certain occasions and in such cases the ability of a fabric to hold moisture may be enhanced by suitable choice of the yarn and the fabric structure.

The wet treatment may involve the use of cold water, hot water and steam, and the reaction of a fibre to such treatments must be known in order to prevent damage due to misuse of materials. Certain man-made materials become very weak when wet and the use of such materials in circumstances which demand, for instance, frequent and severe laundering should be avoided.

Effect of acids, alkalis, bleaches, and organic solvents Knowledge of the reaction of a textile material to the above agents is necessary not only to determine the finishing routine and the cleaning methods, but also in selecting specific end uses for a given fibre. Materials which are susceptible to any agent should not be employed where such an agent is liable to be encountered. If damage is likely to occur due to an action of a common domestic cleaning agent the fabric should be clearly labelled to warn the consumer against the use of such a medium. Informative labelling would also be helpful to commercial laundries and dry cleaning establishments who could select detergents and organic solvents compatible with the processed material.

Effect of insects and micro-organisms In general man-made fibres exhibit good resistance to biological attack and in the majority of cases such faults as, for instance, the growth of mildew may be ascribed to the sizing or finishing agent incorporated in the cloth rather than to the fibre itself. Nevertheless, as such an attack is liable to damage or discolour the fibre it should be guarded against by ensuring correct storage conditions, or by including antiseptic substances which inhibit or prevent completely the undesirable occurrences.

SURVEY OF THE MANUFACTURE, PROPERTIES AND USES OF MAN-MADE TEXTILE MATERIALS

The number of man-made textile materials available for the textile designer is already considerable and increases continually. In a survey of this type it would be impossible to deal with each fibre exhaustively and for this reason this section is devoted to a study of those that are at the moment most important. To simplify the study the whole multifarious field of man-made fibres available may be classified under the following main headings.

1. Regenerated and modified natural polymers—
   (a) rayons, (b) cellulose esters, (c) protein fibres.
2. Synthetic polymers—
   (a) polyamides, (b) polyesters, (c) polyolefines, (d) polyvinyl derivatives, (e) polyurethane elastomers.
3. Mineral based materials—
   (a) glass, (b) metallic yarns.

The above list provides a classification primarily according to the chemical base and this, as will be seen later, predetermines to some extent the mode of manufacture.

Considering the physical form of these materials they exist either in the form of continuous filaments, or as staple (cut) fibres although originally they are all extruded as filaments. Some materials may be available in the market only in one form and not in the other. Yarns made from these materials will normally consist of finer units which may be of either type the one exception being the mono-filament yarn mentioned in the previous chapter.

A continuous filament yarn is made up of a number of units equal in length to the length of the yarn itself but thinner in diameter. The actual number of units comprising a given yarn thickness may vary as the diameters of the constituent filaments can be varied themselves. This in itself will alter materially the yarn characteristics in respect of flexibility, covering power, thermal insulation value, etc., and serves to extend the range of uses and applications of these materials. A yarn of the above type requires very little twist to remain a cohesive unit and is represented at A in *Figure A2.1*.

The material required to be used in the fibre form, after extrusion as a filament, is cut or broken at intervals to provide a given staple length. The length and the thickness of the staple depends on the method of spinning which it is intended to employ subsequently. The fibre yarn (or, the discontinuous filament yarn) consists, therefore, of units which are not only finer in diameter than the yarn itself, but also shorter in length and to exist as a cohesive entity the yarn depends on the twist to hold the constituent units together. Upon untwisting the short units fall apart and the yarn disintegrates.

Figure A2.1

This type of yarn is represented schematically at B in *Figure A2.1*. Man-made materials in the staple fibre form can be employed on their own, or they can be used in blends with natural fibres or with other man-made fibres. Whichever use is made of them they are produced in the thickness and in the length determined by the spinning system to be employed and Table 15 gives some common sizes used.

Table 15

Spinning method	*Length* (mm)	*Thickness*
Cotton	37	1.7 decitex
Woollen	50	5.0 decitex
Worsted	100	3.4 decitex
Linen	100	4.4 decitex
Jute	200	8.9 decitex

It will be noted that the thickness of the fibres is quoted in the terms of 'decitex'. This provides a generally accepted and useful base for comparison, but it must be understood that the term is not strictly correct as this value does not take into account the density of the material so that two fibres of the same decitex may yet vary in respect of their thickness due to differences in density.

In the more detailed studies of the man-made materials which follow it is intended to give a survey of properties and applications of the selected members of each group. Brief references are also given in the glossary in respect of some less common materials and at the end a bibliography is provided for any designers who may require further information impossible to encompass within an Appendix to a work primarily concerned with woven cloth construction.

1. Regenerated and modified natural polymers

A study of natural fibres has shown that they are composed of long and slender molecules consisting mainly of cellulose (vegetable fibres), or protein (animal fibres). It was also found that similar molecules existed in nature in considerable abundance in non-fibrous form. In this form they were unsuitable for textile purposes because they were either combined with undesirable impurities, or were incorrectly aligned. From this knowledge an idea was conceived that if the impurities could be eliminated, or the molecules re-aligned in the required manner, artificial fibres similar to the natural ones could be produced from the non-fibrous sources. After a long period of experimental work a way was eventually found to achieve the above aims, and a number of different fibres were produced, based mainly on regenerated or modified cellulose or proteins.

(a) **Rayons** These are regenerated cellulose fibres for which the cellulose is derived either from wood pulp or from cotton linters. There are two important members of this group—the viscose rayon and the cuprammonium rayon—and although the former occupies a predominant position in respect of the quantity produced, the latter is of considerable interest to a designer in certain specialised fields. Viscose rayon is described more fully in the following paragraphs whilst cuprammonium rayon is dealt with briefly in the glossary.

Manufacture of viscose rayon The manufacture of viscose rayon may be said to date from 1892 when Cross and Bevan discovered that cellulose, when treated with alkali, reacted with carbon bisulphide to form a water soluble substance—cellulose xanthate. After many trials and errors the process as we know it today was developed. Essentially this consists of the following steps.

(1) Purifying wood pulp from spruce trees and pressing it into the form of large sheets resembling blotting paper.
(2) The sheets are soaked in caustic soda and the excess solution squeezed out. By means of 'grinding' knives, the sheets are broken down into crumbs and ripened by storing in controlled conditions. In this form the cellulose is known as alkali cellulose.
(3) Alkali cellulose is treated with carbon bisulphide to yield cellulose xanthate which still has the crumb-like appearance but is now yellow in colour.
(4) Cellulose xanthate is dissolved in a weak solution of caustic soda giving a golden brown syrupy liquid of a certain viscosity (hence the name viscose rayon).
(5) The viscose solution is filtered and stored under vacuum to remove air bubbles. When the solution has matured and is at the correct viscosity, it is ready for spinning.
(6) Spinning consists of extruding the viscose solution from the storage tank through a 'spinneret'. The spinneret is immersed in acid and as the viscose solution enters this acid bath it is coagulated into numbers of fine filaments, the number of filaments depending on the number of holes in the spinneret. The filaments are collected, washed, dried, twisted, and finally wound on to bobbins in one continuous process.

If the cut staple (fibre) form of the yarn is required, a much larger spinneret with many more holes is used, the holes being of a size suitable for the form of staple being made, e.g. for cotton spinning system 1.7 d tex, for worsted 3.4 d tex. The rope of filaments emerging from the spinneret is cut into short lengths governed by the machinery on which it will ultimately be processed—cotton 37 mm, worsted 100 mm, etc.

Modifications The viscose rayon yarn made as suggested above is capable of various modifications. A few of these are:

(a) *Delustring* The normal viscose rayon yarn has a metallic lustre and in this form is known as 'bright'. This is, however, not suitable for all purposes as sometimes a more subdued lustre is wanted. To effect this a delustring agent is added to the viscose solution prior to extrusion which after spinning is retained in the yarn as an integral part of it. This agent (titanium dioxide) has the effect of breaking up light reflection giving the rayon a soft milky lustre. This can of course be varied by altering the amount of agent in the solution. The titanium dioxide particles can be seen in a microscopical view of the filaments.
(b) *Spin dyeing* In a like manner to delustring, it is also possible to incorporate coloured pigments in the spinning solution so that the resultant filaments are coloured. The particles of pigment embedded in the yarn also exert a delustring effect so that yarns from this type of rayon tend to be softer in lustre than conventionally dyed yarns. The fastness of the colour is usually high, but the range of shades is rather limited.
(c) *Basifying* or *animalising* Viscose rayon has an affinity for certain dyestuffs, normally those which dye cotton so that when mixed with wool to form a wool/viscose blend, solid shades cause some difficulty. To aid this, it is possible to modify viscose so that it has the same affinity for dyes as wool, when it is known as basified or animalised.
(d) *Stretch spinning* In order to increase the strength of viscose rayon a stretching process is incorporated in the interval between extrusion and coagulation. This, by aligning the molecules in the filaments in a more regular order increases their strength both wet and dry. Accompanying this there is a loss of extensibility and decreased moisture absorption but for certain purposes (tyre cord fabrics) this is an advantage.

Table 16

Properties	Unless otherwise stated these figures refer to the normal type.
Tenacity: Normal	Dry 0.14 to 0.18 N/tex. Wet 0.06 to 0.09 N/tex.
Stretch spun	Dry 0.27 to 0.32 N/tex. Wet 0.17 to 0.20 N/tex.
Elongation at break: Normal	Dry 15 to 30 per cent at 65 per cent R.H. Wet 20 to 35 per cent.
Stretch spun	Dry 9 to 17 per cent at 65 per cent R.H. Wet 14 to 20 per cent.
Elastic recovery:	74 per cent at 4 per cent stretch. 58 per cent at 14 per cent stretch.
Specific gravity:	1.52.
Regain:	11 per cent at 20°C and 65 per cent R.H.
Burning rate:	Fast.
Resistance to heat:	Decomposes rapidly at temperatures above 150°C and at lower temperatures on prolonged exposure.
Softening point:	Decomposes without melting.
Effect of age:	Slight.
Effect of sunlight:	Loses strength on prolonged exposure.
Effect of acids:	Weak solutions have little effect. Hot dilute solutions and cold concentrated solutions of strong acids will attack and disintegrate rapidly.
Effect of alkalis:	Dilute solutions have little effect but concentrated solutions of strong alkalis will cause swelling and loss of strength.
Effect of other chemicals:	Strong oxidising agents will attack but under normal conditions, hypochlorite or peroxide bleaches have little effect. In water, viscose rayon swells.
Organic solvents:	Insoluble. Soluble in cuprammonium solution and certain other selected compounds.
Dye affinity:	Generally same types as cotton, e.g. direct, vat, azoic.
Moths:	Unattacked.
Mildew:	Attacked if damp and alkaline.

Uses Although chemically similar to cotton, the designer is well advised not to substitute viscose rayon for cotton in fabrics without first considering all the implications. On its own properties viscose is worthy of design styles and types of its own. Its fineness in filament form makes it particularly suitable for such sheer fabrics as voiles and georgettes, and as it swells to a greater degree than cotton when wet, it is of more use in crêpe fabrics. In its fibre form it cannot be spun to so fine a yarn as cotton therefore is normally found in the heavier fabrics. Losing strength when wet and being more extensible in that state suggests that care is required in washing and also that the designer should consider the amount of washing a fabric will have to withstand before suggesting viscose rayon. The fact that its lustre can be varied makes it an ideal material for a wide range of fabrics ranging from metallic lustred linings to soft sheened sharkskin and poults. Where high dry strength is important, viscose is of greater use than cotton, for example, in such things as tyre fabrics where working conditions are hot, therefore the yarns used will be dry. Untreated viscose rayon is readily creased and therefore a crease resist finish is usually given to fabrics where creasing is a possibility. This finish as well as aiding crease recovery improves dye fastness, reduces total water absorbency, combats mildew and also gives a stabilised form to the fabric.

(b) **Cellulose esters** The group of fibres classified under this heading consists of secondary cellulose acetate and cellulose triacetate. Cotton linters are the normal raw material of both these fibres but the cellulose which still forms the basis of the fibres is modified through the replacement of hydroxyl groups in the molecule by the acetyl groups. This converts the cellulose into a cellulose acetate. The two types of acetate fibres are chemically very closely related the triacetate being a more completely acetylated form of cellulose than the secondary acetate. Despite the close chemical similarity the physical properties of these fibres show a degree of divergence in several important aspects. Although the secondary acetate was produced commercially long before the triacetate, the significance of the latter has grown recently to such proportions that it has replaced the former in a number of important applications. For this reason it is the triacetate fibre which has been selected as the representative of this group.

Manufacture of cellulose triacetate Cotton linters are treated with acetic acid and acetic anhydride in the presence of a catalyst until acetylation is complete, i.e. until all the hydroxyl groups of the cellulose have been substituted by the acetyl groups. From the resulting solution the triacetate is precipitated, then washed and dried forming at this stage a white flake. The flake is made into spinning solution by dissolving it in methylene chloride containing some alcohol. Prior to spinning the solution is diluted, filtered and de-aerated in the usual manner. Similarly to the secondary acetate the triacetate is dry spun, the filaments extruded through a spinneret solidifying in the current of warm air which evaporates the solvent. The filaments are gathered together, twisted slightly and wound onto suitable packages. It is usual at this stage to lubricate the yarns with an oil mainly as an antistatic measure. Staple fibre of varying deniers can also be produced the process being similar to that described with reference to viscose rayon, but additionally the fibres are crimped permanently to assist their bulking properties.

Modifications Delustring is a common modification carried out in a manner similar to that used for viscose rayon. Bulked yarns (q.v.) are also produced in triacetate fibre.

Table 17

Properties	
Tenacity:	Dry 0.11 to 0.13 N/tex. Wet 0.06 to 0.07 N/tex.
Elongation at break:	Dry 25 to 30 per cent, wet 30 to 40 per cent.
Elastic recovery:	60 per cent at 4 per cent stretch, 30 per cent at 14 per cent stretch.
Specific gravity:	1.3.
Regain:	4.5 at 20°C and 65 per cent r.h. (after heat treatment only 2.5 to 3 per cent).
Resistance to heat:	Heat treatment stabilises the fibre dimensionally by increasing the crystallinity and molecular orientation, it increases the softening point and reduces moisture absorbency. Heat setting of triacetate fibres to retain given shape is one of the important features of this material. No appreciable loss of strength in temperatures of up to 120°C.
Softening point:	After heat treatment 225°C, fuses at approximately 300°C.
Effect of age:	Slight.
Effect of sunlight:	Slight.
Effect of acids:	Resistant to dilute acid solutions. Concentrated solutions of strong acids cause decomposition.
Effect of alkalis:	Good resistance to saponification except in the presence of strong alkalis.
Effect of other chemicals:	Good resistance to chemicals commonly encountered in processing or normal use.
Effect of organic solvents:	Soluble, or otherwise affected by a wide range of organic solvents. Completely unaffected by others—careful selection of dry cleaning agents required.
Dye affinity:	Requires special dyestuffs of the dispersed type.
Moths:	Unattacked.
Mildew:	Unaffected.

Uses Cellulose triacetate possesses many attractive features which enable it to be used for a wide variety of fabrics. One of its main attributes is the retention of shape after heat treatment. This implies also good resistance to creasing and as a result the fibre is used extensively for garments with permanent pleats and creases (skirts, slacks), and also for such articles where creasing and deformation would be particularly disadvantageous (ties, blouses, dresses). Low moisture absorption after heat treatment promotes quick drying and this combined with the previously mentioned characteristics makes it particularly suitable for garments of the 'minimum care' type. The fibre swells to only a negligible extent in water and there is, therefore, no tendency to produce the degree of relaxation shrinkage which characterises viscose rayon and secondary cellulose acetate fabrics; as a result, to arrive at the same final settings the original settings with triacetate yarns must be correspondingly higher. Combined with the low moisture absorption is the high degree of strength retention in the wet state in which aspect triacetate differs markedly from most other regenerated materials. The specific dye affinity of the fibre also lends itself to the creation of attractive cross-dyed styles.

In addition to its function as a textile fibre in its own right triacetate is extensively and advantageously employed in blends with cotton, staple viscose rayon, wool and linen. Its presence in the blend in sufficient quantity (usually 60 to 70 per cent) confers upon the blended material after heat treatment the stabilising and shape retaining properties of the triacetate. In blends it is made into suitings, light weight trouserings, summer dresses, skirts and similar articles.

(c) **Regenerated protein fibres** Efforts have been made since the beginning of this century to produce a textile fibre from proteins. The main incentive was the possibility of using the fibre as a substitute for wool which commanded a relatively high price in comparison with most other natural materials. Between 1930 and 1950 several good fibres were produced with characteristics approaching in some respects those of the wool fibre and these were used mainly in blends with wool or cotton, especially in times when wool was in short supply. Unfortunately, no really outstanding fibres were produced in this group and their very low tenacity, particularly when wet, mitigated against wider acceptance. At present limited quantities of staple fibre based on animal casein are produced and these are used in the clothing field mainly in blends with other fibres.

2. Synthetic polymers

These fibres represent a significant step forward in textile technology and their origins date back mainly to the work of Carothers in the late 1920s and also to the efforts of various industrial countries during World War II to introduce synthetic materials in place of various natural products which may have been difficult to procure under wartime conditions.

Although theoretically it would be possible to synthesise these materials by starting with pure elements (mainly carbon, oxygen, hydrogen, nitrogen, and chlorine), in practice intermediate chemicals are used which often represent a half-way stage towards the finished product and thus reduce the number of operations necessary to obtain a synthetic fibre. Derivatives from coal and petroleum represent a valuable source of these intermediate chemicals.

The formation of fibrous materials depends upon the chemical being able to polymerise into long chain molecular arrangements. In this respect man imitates nature where the fibres are invariably produced in the form of long chain polymers. The process of polymerisation requires normally rigidly controlled conditions to yield the desired product and two different forms of this process are recognised—the *addition polymerisation* and the *condensation polymerisation*.

In the former type of reaction the molecules of the selected chemical, known at this stage as the monomer, literally add themselves one to another and this can be represented graphically as follows:

$$— A — A — A — A — A — A — A —$$

A in the above diagram represents the monomer which under suitable conditions has formed itself into a long chain molecule capable of producing a fibre when combined with other identical molecules. This type of reaction is typical of the polyolefines.

The *condensation polymerisation* is normally a rather more complicated reaction in which the monomer molecules combine together simultaneously eliminating a by-product molecule—usually water. This form of polymerisation occurs, amongst others, in the manufacture of polyamide fibres. In the production of these fibres two different chemical substances, capable of combining with one another, are joined together followed by subsequent junctions of the compounded substance. In simple terms the process can be represented graphically in the following manner:

```
          Water                       Water    Water    Water    Water
Stage I  A ⊥ B → A B   Stage II  A B ⊥ A B ⊥ A B ⊥ A B ⊥ A B —
```

The above two examples show schematically the two types of polymerisation reactions in which the single building units of the polymer are identical. Further extension of this idea includes the polymerisation of different units which results in the formation of *co-polymers*, and these can be *alternating*, e.g.

— X — Y — X — Y — X — Y —

or *block*, e.g.

— X — X — X — X — X — Y — Y — Y — Y — Y —

or *random*, e.g.

— X — Y — Y — X — Y — X — Y — Y — Y — X —

or *grafted*, in which case additional units are linked with one or the other of the existing substances to form branches or side-chains, e.g.

```
                                            Z
                                            |
— X — X — X — X — X — X — X — X — X — X —
      |
      Z
```

Normally, long slender molecules are preferred as these have the capacity to pack closely together during extrusion and drawing to give the necessary strength and any bulky groups at the side which would prevent the close packing are undesirable. Occasionally, however, it may be necessary to sacrifice a degree of strength to gain better extensibility or other desirable properties and in such instances side groups would be introduced deliberately. The degree of close packing or alignment of molecules along the longitudinal axis of the fibre is known as the orientation and in many fibre forming polymers a high degree of orientation is induced after extrusion by a process known as drawing without which the material may be useless from the textile point of view. As a general statement it may be said that highly orientated fibres are strong, rigid, lustrous, have low water absorption and are resistant to chemical attack and although, on the whole, the above properties are desirable an excessive propensity in any one particular direction may be objectionable, and may, therefore, require modification.

From the above general description it will be understood that many properties of the synthetic fibres are under a good measure of control and indeed, in many instances they can be modified to suit exactly a specific purpose. This permits the selection of the most suitable material for a given end use and in this respect the wealth of variety in fibres available is beneficial. It calls upon the designer, however, to possess more extensive knowledge than before, as without it the dangers of misuse are at least as considerable as are the benefits conferred by the large choice.

In view of the vast range of materials available in each major class of synthetic fibre one type only is selected and described more fully. As other members of the class are usually closely related their characteristics are frequently similar. It must not be taken for granted, however, that all the properties of the members of the same class are similar.

With the degree of fibre specialisation now possible a particular feature in a fibre may be developed to an outstanding degree and if such is the case the fibre in question may to some extent lose its identity with the other members of its own group.

(a) **Polyamides** This group encompasses several different polymers which are all products of a condensation reaction and which are commonly referred to as nylons. The polymer may be formed following a union of a diamine with a dibasic acid, or it may result from the self-condensation of an amino acid. All the fibres in this group have basically similar properties although some divergence may be expected in certain specific aspects. The numbering system which is used to describe these polymers as nylon 66, or 610, or 6, or 11, refers to the number of carbon atoms in their constituents taking the diamine (if present) first.

Manufacture of nylon 66 This was the first polyamide fibre developed on a commercial scale and it still represents a considerable proportion of the nylons produced in bulk today. It is obtained from hexamethylene diamine and adipic acid which combine together to form a salt. Upon treatment, under suitable conditions of temperature and pressure, the salt condenses to produce the nylon polymer which at this stage is extruded in the form of a long ribbon chopped after solidifying into short lengths known as 'chips'. The spinning process now follows and in the first stage the chips are melted in a heating unit. The melt is then forced through a spinneret, the filaments solidify in a cooling stream of air, and after passing through a conditioning tube are collected on a bobbin. At this stage the fibre is not yet ready for use due to poor molecular alignment, therefore, a further stage of processing known as cold drawing is introduced. In this operation the filaments are extended until the desired degree of molecular alignment has taken place and the material becomes suitable for textile purposes. The effect of cold drawing can be illustrated by Table 18.

Table 18 shows clearly that certain properties of the fibre are materially affected by the extent of drawing and this feature is used to increase the versatility of this material.

Table 18

	Strength	*Extensibility*	*Elastic Recovery*
Undrawn	Low	High	Low
Cold drawn—5 times	Medium	Medium	Medium
Cold drawn—beyond 5 times	High	Low	Low

Table 19

Properties—(The properties refer to normal nylon 66)	
Tenacity:	0.43 to 0.48 N/tex.
Elongation at break:	18 to 25 per cent.
Specific gravity:	1.14.
Regain:	4 per cent at 20°C and 65 per cent r.h.
Burning rate:	Fuses.
Resistance to heat:	Loses strength if stored above 100°C.
Melting point:	250°C. Above 200°C sticking begins, at 230°C it is damaged.
Effect of age:	Slight.
Effect of sunlight:	Degraded (as all textiles) on prolonged exposure particularly when delustred.
Effect of acids:	Attacked by strong mineral acids particularly if hot. Hot or concentrated organic acids may also cause damage.
Effect of alkalis:	Very resistant to all types.
Effect of other chemicals:	Chlorine type bleaches cause degradation particularly if neutral. Hydrogen peroxide also attacks but is less severe.
Organic solvents:	Soluble in some phenols, dilute phenols may cause some shrinkage.

Table 19 continues

Table 19 *(continued)*

Dye affinity:	Disperse type as used for acetate are suitable as are also some acid and direct dyes.
Moths:	Unattacked.
Mildew:	Unattacked.

Uses Great care is required in deciding where to use nylon, for although it has many valuable properties, it also has certain disadvantages which make it unsuitable for certain uses. These disadvantages are its low moisture absorption and its comparatively low melting point. The fact that nylon absorbs very little moisture means that after washing, garments dry rapidly. While this is of immense value especially to travellers it has the disadvantage of making fabrics feel damp or clammy in moist conditions. This might not be noticed on an outer garment, but in underwear and hose, perspiration might not be completely absorbed resulting in uncomfortable wearing conditions. Nylon is also a poor conductor of electricity and static charges are liable to collect on the fabric or garment when subjected to friction (as for example the rubbing of the leg on an underskirt). These charges attract particles of grit or dust with opposite polarity from the atmosphere so that at areas of friction, grimy marks develop. This fault is known as *fog marking* and is very difficult to remove. In the properties quoted, the groups of dyestuffs suitable for nylon were given, but as the moisture absorption is low, good absorption of the dyestuff is hindered. Deep shades are therefore not so easy to obtain as on other materials and it may be found in some mixtures that the nylon portion may dye a little lighter than the other portions. The melting point of 250°C is not so low as to cause any major difficulty in processing. Trouble may arise however once the fabric or garment reaches the consumer who is not always sufficiently careful. Obviously, nylon should not be used for fabrics or garments where under normal conditions a temperature of 250°C would be exceeded.

Despite these disadvantages, nylon has other features which make it ideal for certain purposes. It is possible to 'heat set' nylon fabrics or garments to any desired shape so that providing the setting temperature is not exceeded in any subsequent process, the fabric or garment will always return to that shape. The value of this in tie fabrics, pleated garments, stockings, etc., is unquestionable and when coupled with its good elastic recovery properties makes for garments which retain their shape over a long period. Nylon's resistance to abrasion is exceptionally high and even a small quantity mixed with other materials increases their resistance to abrasion by an appreciable amount. As its resistance to bending is also high, in fabrics or garments where abrasion and bending are normal conditions of wear, nylon has few rivals.

Particular uses where its properties are very suitable are listed below showing how wide is the range of fabrics possible from nylon, a range which can be extended further by the designer realising the full potentialities of the material and matching the properties with the consumer's requirements.

Table 20

Fineness:	Voiles, marquisettes, stockings, lace.
Smoothness:	Lining fabrics, filters.
Elasticity:	Ties, stockings, undergarments.
Strength:	Tow ropes, bead strings, fishing nets.
Ease of washing:	Shirts, underwear.
Low density:	Raincoats, foundation garments, laundry bags, body armour.
Wear resistance:	Overalls, gloves, stocking reinforcement.
Resistance to fungi:	Laces, ropes, mosquito netting for humid conditions.
Non-toxic properties:	Surgical webbing, sutures.

Nylon is also used extensively in blends with other fibres where its high abrasion resistance and excellent resiliency add materially to the performance of articles made from the blended yarns. Mixed in varying proportions with other fibres nylon is particularly valuable in the manufacture of undergarments, suitings and carpet pile yarns. The range of applications is further increased through the use of textured or bulked yarns (q.v.) which due to their construction improve the moisture absorption and the thermal insulation properties of this material.

(b) **Polyesters** The fibres in this group are also products of a condensation reaction and the polymer results usually from a combination of a dihydric alcohol with a dibasic acid. The fibre described in this group is the 'Terylene' produced by I.C.I. Ltd., and the properties and the manufacturing process of this polymer are broadly representative of the whole class.

Manufacture of Terylene The substance from which this fibre is produced is known as the polyethylene terephthalate which is obtained by combining terephthalic acid with ethylene glycol both of which are originally derived from petroleum. Chemically, polyethylene terephthalate is quite different from the polyamides but the manufacturing process of Terylene is similar to that of nylon. As in the latter, the polymer is melt-spun and solidifies in the current of cold air. The subsequent process of drawing is, however, different in as much as it is carried out at high temperature (hot drawing) but as with nylon the extent to which the filaments are drawn determines the tensile and elastic properties of the material and a wide range of qualities is possible. 'Terylene' is produced in the filament and in the cut (staple) fibre form. The latter is usually crimped to enhance its spinning and bulking properties and is made in various lengths and diameters as shown below.

Table 21

37 mm	—2.2 d tex crimped fibres for cotton system
100 mm	—4.4 d tex crimped fibres for worsted system
63 mm	—4.4 d tex crimped fibres for woollen system
100 mm	—4.4 d tex uncrimped fibres for linen system

Table 22

Properties	
Tenacity:	Normal: 0.40 to 0.50 N/tex. High tenacity: 0.54 to 0.63 N/tex.
Elongation at break:	Normal: 15 to 25 per cent. High tenacity: 7.5 to 12.5 per cent.
Elastic recovery:	85 per cent at 4 per cent stretch. 50 per cent at 14 per cent stretch.
Specific gravity:	1.38.
Regain:	0.4 per cent.
Burning rate:	Fuses.
Resistance to heat:	Very high. Shrinks at elevated temperatures in relaxed state.
Softening point:	260°C. Becomes sticky at 230 to 240°C.
Effect of age:	Slight.
Effect of sunlight:	Eventually degraded, but is equal to the best of the natural fibres.
Effect of acids:	Very high resistance. Decomposed by concentrated sulphuric acid.
Effect of alkalis:	Hydrolised by alkalis, but adequate resistance to most commercial processes except kier boiling under pressure.
Effect of other chemicals:	Excellent resistance to oxidising agents, hypochlorites and hydrosulphite.
Organic solvents:	Cold no effect except chloroform which causes some shrinkage, but hot solvents may cause shrinkage. Phenols swell or dissolve.
Dye affinity:	Disperse dyes as used for cellulose acetate and nylon, and

Table 22 continues

Table 22 *(continued)*

	azoic dyes, the latter giving good intense shades. The low moisture absorption frequently necessitates dyeing at an elevated temperature in pressurised vessels.
Moths:	Excellent resistance.
Mildew:	Excellent resistance.

Uses It is possible to heat set Terylene in a like manner to nylon thus making it very useful for fabrics or garments subjected to creasing such as ties, skirts, blouses, etc. As its resistance to abrasion is high it is suitable alone or in admixture with other materials where rubbing is likely to occur such as in stockings or raincoats. Terylene itself has a wide range of uses such as ropes, lace, ties, underwear, overalls, filter cloths, curtains, and tablecloths, but the field of applications of this fibre is considerably extended when its uses in the staple form in blends with other fibres are considered. Particularly valuable is the aspect of shape retention after heat treatment and this is fully utilised in the production of permanently pleated and creased garments (skirts, trousers) where the presence of 55–70 per cent of Terylene is sufficient to confer upon the cloth this valuable quality. Self-smoothing characteristics combined with rapid drying are the other important attributes of this fibre. Textured or bulked yarns, some of special stabilised type (q.v.) further increase the usefulness of Terylene.

(c) **Polyolefines** These are a small group of fibres which are chemically the least complex in structure of all man-made materials, and which are the product of the addition polymerisation of unsaturated hydrocarbons. Polyolefines are quite different from the other man-made fibres in two important aspects—the very low density (being the only fibres with specific gravity lower than water), and the low melting point. These features although limiting the range of applications of this type of fibre are quite valuable in certain specific circumstances.

The polyolefines are produced by a process of melt spinning followed by drawing similar to the one described in the manufacture of polyamides, and currently two chemically different materials are in production—polyethylene and polypropylene. Polyethylene may be obtained as a low density or a high density material. The former is very soft, comparatively weak and has a melting point of 115°C but actual softening of the fibre commences even before the boiling point of water is reached. The latter type is a much tougher material which has good tenacity and an improved melting point of 135°C. Unfortunately the filaments of this fibre tend to fibrillate. These disadvantages preclude the use of polyethylene in normal textile applications but it has a number of merits which make it useful in certain specialised fields. Its specific gravity is low (0.92–0.96), it has good resistance to most chemicals, is not subject to biological attack and has good abrasion and electrical resistance. In addition, it does not absorb any moisture. These special properties make it possible to employ polyethylene in washable upholstery fabrics, filter cloths, ropes, nets, insulating and surgical materials, and the low melting point makes it useful as the fusing element in laminated cloths (semi-stiff collars, etc.).

The other member of the group—the polypropylene—has a wider application and from the textile point of view is a much more promising fibre. It has all the special properties of polyethylene including the low specific gravity (0.91), is much tougher, does not fibrillate, and although its melting point of 165°C is lower than that of polyamides and polyesters it is sufficiently high to make it suitable for quite a wide range of uses. Polypropylene yarns can be bulked by the heat setting process and the fibre is also available in staple form with the usual range of thicknesses and lengths for blending with other fibres. Due to its low density the use of the system to describe the size of the filaments may be somewhat misleading and it must be remembered that for equal decitex number the polypropylene yarns will be thicker, the ratio of diameters being approximately 5:4 respectively between the propylene and most other natural and man-made materials. To overcome this difficulty the yarns may be sold at 'nominal' values. The commercially available polypropylene contains stabilisers which appreciably enhance the resistance of the fibre to light and weather. Without the stabilisers polypropylene has low resistance to the above agencies. Poor dyeing affinity due to negligible moisture absorption imposes some limitation on the range of colours available although coloured yarns can be obtained through spin-dyeing techniques.

Polypropylene fibre can be satisfactorily employed in most fields of application mentioned in respect of the polyethylene but in addition its higher melting point, bulking properties and good resiliency enable it to give very adequate performance in such fabrics as sackings, blankets and upholstery, and as pile yarns and backing cloth in carpets. Its potential cheapness will no doubt increase its range of uses.

(d) **Polyvinyl derivatives** This large group embraces rather heterogeneous materials which differ widely chemically and physically. The general title commonly adopted is perhaps rather unhappy in as much as it tends to be used to cover not only the vinyl but also vinylidene derivatives. It might be more correct to refer to these materials simply as olefine substitution products obtained by the process of addition polymerisation. Although many members of this group are valuable only within a comparatively narrow range of applications due to their highly specialised properties one class of fibre has found a very wide acceptance in many branches of the textile industry. This is the polyvinyl cyanide, perhaps better known as the polyacrylonitrile fibre obtainable commercially under the wellknown trade names of 'Orlon' and 'Acrilan', each available in a wide range of different types and qualities.

Manufacture of polyacrylonitrile fibre Melt spinning is not satisfactory in the case of this fibre and a solvent method is usually adopted. The polymer is dissolved in a suitable solvent and then extruded in a conventional manner, coagulation being effected either by a wet spinning process (similar to viscose rayon), or by a dry spinning process (similar to cellulose acetate). After spinning the yarn is stretched to improve its properties and may also be crimped. Wide variety of qualities can be produced with different tensile and elastic properties. The fibre is mainly used in staple form either by itself or in blends, and for the latter purpose it is produced in various deniers (1.7 to 6.8 d tex) and staple lengths.

Table 23

Properties	
Tenacity:	Dry: 0.16 to 0.24 N/tex. Wet: 0.13 to 0.22 N/tex.
Elongation at break:	Dry: 20–40 per cent. Wet: 25–50 per cent.
Elastic recovery:	Good.
Specific gravity:	1.17–1.20.
Regain:	1.5–1.7 per cent.
Burning rate:	Fast.
Resistance to heat:	Good.
Softening point:	Depending on type becomes sticky at between 260–450°C.
Effect of age:	High resistance.
Effect of sunlight:	High resistance.
Effect of acids:	High resistance.
Effect of alkalis:	Adequate resistance for textile purposes.
Effect of other chemicals:	High resistance to degradation by common bleaches.
Organic solvents:	Unaffected by common solvents.
Dye affinity:	Disperse, basic, vat and special dyeing technique (cuprous ion).
Moths:	Unattacked.
Mildew:	Unattacked.

Uses The high resistance of polyacrylonitrile fibres to chemical attack and their ability to withstand exposure to sunlight are the features on which many of its uses are based. It, therefore, finds applications industrially for such purposes as filter cloths, tarpaulins, sunshades, etc., and for normal domestic purposes as curtain linings, swimsuits, and window blinds. Apart from these uses the fibre can be employed for more conventional fabrics such as all types of apparel cloths either alone or in various blends, furnishing fabrics, carpets, rugs, and blankets. Its many attributes include light weight combined with good bulking, toughness and at the same time luxurious and soft hand, excellent retention of shape and dimensional stability after heat setting, with rapid drying characteristics. Although polyacrylonitrile fibres have low moisture regain they do not feel 'clammy' in wear—either due to good bulking characteristics, or, in some types, due to peculiar 'dog-bone' cross-sectional appearance which permits a degree of surface capillarity. Another interesting instance of the versatility of this class of materials is the permanently crimped bicomponent fibre (q.v.) which finds increasing use in the apparel wear.

(e) **Polyurethane elastomers** This is a group of chemically complex fibres which have highly elastic properties and are used in applications where previously rubber threads were the only satisfactory material. The construction of these polymers consists of short rigid regions where a degree of molecular alignment exists (X in *Figure A2.2*), interspersed with completely unaligned regions where the molecules are coiled in a somewhat random fashion (Y in *Figure A2.2*). The latter uncoil to a remarkable extent upon application of strain and when released have the capacity to return to the original position, the short rigid sections acting as 'brakes' to prevent non-returnable slippage of the strained coiled fraction of the system.

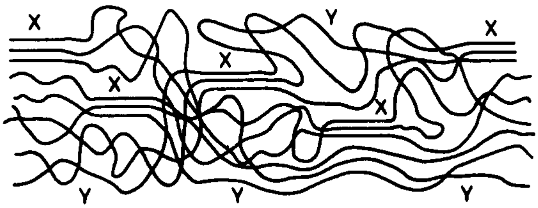

Figure A2.2

These elastomeric fibres, also known under the term spandex, are normally extruded in the form of a multifilament in which the single components immediately upon extrusion adhere to one another thus in effect producing a monofilament yarn. Spandex yarns show good sunlight and chemical resistance and do not deteriorate through oxidation. They are very light (specific gravity approximately 1.00–1.20) and have a high melting point. The disadvantages are the low tensile strength and susceptibility to certain organic solvents. The former, however, due to highly elastic properties of the material is rarely tested in use, whilst the latter can be overcome by careful selection of agents should dry-cleaning become necessary.

Spandex yarns are used extensively in all types of sportswear where freedom of movement is as essential as good fit (ski slacks, swimsuits, etc.), in foundation garments, in surgical wear and as support threads in elasticated hose tops, cuffs, etc. They can be dyed by a wide variety of dyestuffs and where shape retention is of importance the garments can be heat-set to ensure stability.

3. **Mineral based materials** This is the smallest section of the man-made materials. The reason for this is that minerals do not generally exhibit the properties necessary for textile purposes, e.g. extensibility and elastic recovery, moisture absorption, etc. However, some of these fibres have considerable value in certain industrial applications, or as highly ornamental materials and, indeed, metallic threads (gold, silver) could be regarded as the first man-made textile material of all, having been known and used for centuries.

The modern fibres in this group could be divided into three main classes—glass, ceramic, and metallic. The first forms the most important class and is described in some detail. The ceramic fibres are mainly used for industrial purposes where high temperatures are involved as they are capable of standing up to temperatures upward of 1000°C which represents the upper safety limit for glass and asbestos fibres. Metallic threads are used mainly for decorative or protective purposes. For the ordinary range of applications the metallic thread is now often produced as a laminated material in which a thin sheet of metal foil is pressed between two layers of plastic film. The laminated sheet is then cut into thin ribbons of yarn. The width of the flat yarn thus produced may vary according to requirements and the plastic film in which the metallic strip (usually aluminium) is enclosed effectively prevents tarnishing. The threads find uses as the decorative elements in ladies' suitings, dresses, swim suits and furnishing fabrics.

Manufacture of glass fibre The glass which is used is carefully selected and refined in order to give filaments and cut staple fibres of uniformity and with the desired qualities. It is first produced as small marbles which can then be loaded in a chute above an electrically heated furnace. The marbles are allowed to run down this chute into the furnace at a determined rate and are melted in the furnace. From the furnace the filaments flow out through a spinneret by gravity and are cooled and wound on to a drum. If cut filament form is desired, the filaments are cut by means of jets of air or steam and are then collected to form a sliver when a fibre yarn can be formed by the insertion of twist.

Table 24

Properties	
Tensile strength:	0.58 N/tex.
Elongation at break:	2 to 3 per cent.
Elastic recovery:	100 per cent.
Specific gravity:	2.54.
Regain:	0.4 per cent.
Burning rate:	None. (Note: Emulsions, etc., used in spinning may burn.)
Resistance to heat:	Begins to lose strength at temperatures over 315°C.
Softening point:	Begins to soften at 815°C.
Effect of age:	None.
Effect of sunlight:	None.
Effect of acids:	Unaffected by acids except hydrofluoric acid and phosphoric acid.
Effect of alkalis:	Attacked by hot solutions of weak alkali and cold solutions of strong alkali.
Effect of other chemicals:	Resistant to most chemicals.
Effect of organic solvents:	Insoluble in all organic solvents.
Dye affinity:	No affinity for ordinary dyes but can be coloured by resin bonded pigment dyes.
Moths:	Unattacked.
Mildew:	Unattacked.

Uses The main uses of glass as a textile material are in fabrics where non-flammability and resistance to chemical attack other than by alkali are of prime importance. Industrially it has therefore many important uses but it is still possible to utilise it for ornamental fabrics. As it has a high tensile strength and is unaffected by age and sunlight it is obviously an ideal material for curtainings. A disadvantage here is the difficulty of dyeing but attractive fabrics are still possible using the range of colours available. It is not an easy material to launder as it absorbs little or no water and if folded and pressed too heavily, cracking may develop. Sponging in many cases is sufficient to freshen the fabric. Glass has little use in the clothing sphere as it is cold and unsympathetic to the touch but in the furnishing field it has many possibilities based on its high strength and the fact that it does not support bacteria growth.

IDENTIFICATION OF TEXTILE MATERIALS

Identification of textile materials was comparatively simple when only the natural fibres were in existence. With the advent of man-made materials the subject has become one of considerable complexity with the difficulties of identification even further complicated by the fact that the various fibres are not only encountered on their own but also in bi-, and tri- component blends with other fibres. In addition, the materials may contain a variety of finishing agents, themselves synthetic in origin, which may cause misleading reactions.

Obviously, in the space available in this work it is impossible to cover the whole complex field exhaustively and the main intention is to give the designer some guidance on the possibility of reaching a reasonable approximation of the identity of a material without the services of a fully equipped laboratory. The simple approach outlined in the following pages is advanced with the full knowledge that in view of the variety of materials in production it may be on occasions inadequate, and for this reason references are provided at the end of the Appendix to exhaustive books on the subject.

There are five stages in this simple scheme of identification: (1) visual examination, (2) untwisting, (3) burning test, (4) elimination, (5) summary. The methods to be followed and the reasoning adopted are given below.

(1) Visual examination. The material to be identified is examined critically and points such as lustre, whether metallic or soft, smoothness or hairiness, harsh handle or soft handle, colour, and strength noted.

(2) Untwisting. The material is untwisted and if it consists of continuous filaments then it can only be silk or one of the man-made materials. Should it prove to be of fibre construction, then it can be any textile material, both man-made and natural. As an aid to further identification, the length of the individual fibres in fibre yarns should be noted and also whether they are all of the same length or if they vary considerably. Where fibres are all of the same length then the possibility is that the material is man-made as natural fibres vary considerably in length and complete uniformity is rarely attained.

(3) The burning test involves taking a small quantity of the material slowly into a flame, noting how the material burns or if non-inflammable whether it melts or maintains the same shape but glows. Six distinct types of reaction may be observed:

(a) The material burns freely leaving a fine powdery ash, the smoke smelling of burnt paper.

Any natural or man-made cellulosic material (except cellulose acetate) will give this reaction.

(b) The material burns rapidly leaving a hard tarry bead residue and a faint vinegar-like smell. Cellulose acetate is the only material with this reaction.

(c) The material recedes before the flame, but upon ignition burns freely with a smoky flame leaving a charred, tarry residue.

This indicates a polyacrylic fibre. Similar reaction is produced by polyurethane fibres which, however, burn with a clear, smokeless flame.

(d) The material burns with difficulty, there is a tendency towards spluttering, a crushable cinder residue remains and there is a distinct odour of burning hair or feathers. This type of burning indicates either natural protein matter (wool, silk, etc.) or any of the man-made materials based on protein.

(e) The material does not burn but as it is brought near to the flame it melts and recedes forming a bead. If brought into the flame too quickly, it may ignite. Such a reaction is typical of a number of synthetic polymers, e.g. polyamides, polyesters, polyolefines and some polyolefine substitution products.

(f) The material does not ignite but if kept in the flame it will glow and retain its shape. Mineral fibre would be indicated by this reaction.

Note: Lubricating oils or other finishing agents if present, may ignite on the surface of the non-inflammable fibres, thus confusing the observations.

(4) Elimination. The information now available is studied and materials eliminated which do not have the observed reactions. For example, burning reaction (f) eliminates all materials except the mineral based fibres.

(5) Summary. An attempt is now made to eliminate still further from the range of materials that the unknown one could be. This involves a good knowledge of textiles generally as well as the properties of materials.

The two examples given below will serve to illustrate the method.

Sample 1. Visual examination. Metallic lustred, smooth, bright coloured, medium strength yarn.

Untwisting. Filament.

Burning test. Reaction (a).

Elimination. The material cannot be cellulose acetate, any protein material, any synthetic polymer, glass or asbestos.

Summary. The material is either viscose rayon or cuprammonium rayon. If it is exceptionally fine, it is possibly cuprammonium otherwise without recourse to more involved methods of identification, this is as far as can be gone with this method.

Sample 2. Visual examination. Soft lustred, crimped, lofty, medium strength yarn.

Untwisting. Fibre yarn, fibres 75 mm long, regular.

Burning test. Reaction (c).

Elimination. The burning test eliminates all cellulose and protein materials, cellulose acetate, all synthetic polymers except acrylonitrile fibres, all mineral based fibres.

Summary. The appearance of the material and the burning reaction clearly indicate the polyacrylonitrile group and the fibre could be one of about eight or ten types available in that group. Again no closer approximation than this can be made with this simple scheme.

The scheme indicated above although not entirely positive is frequently helpful and with experience it often makes it possible to arrive at a definite conclusion bearing in mind the type of cloth in which the material was encountered, its cost, suitability, availability, etc. However, although at times positive identification is very difficult even for experts backed with formidable laboratory facilities certain aids in many instances are sufficient to provide the correct answer. Staining techniques, for example, are easy to apply and very useful in identifying undyed materials. Best known in this field are the Shirlastains and Neocarmine. A simple microscope is often quite positive as many fibres have characteristic cross-sectional or longitudinal appearance, and comparisons with known samples or with illustrations help in identifying the distinctive features. The 'difficult' group of synthetic polymers, many of which have similar microscopic appearance, can be further separated by the use of specific organic solvents, and the fact that a given material dissolves in one and not in another solvent is often sufficient to determine exactly its origin. The above indicate the simplest identification techniques but use can also be made of more sophisticated aids such as the density gradient tube, microscopic mountants with varying refractive indices, reaction to dilute or concentrated, hot or cold acids and alkalis and so on and although the difficulties of positive determination are quite real in most cases they need not be regarded as insurmountable.

GLOSSARY OF THE MORE IMPORTANT YARN TERMS USED IN RESPECT OF MAN-MADE MATERIALS

Aerated yarn Man-made filament which contains enclosed air pockets. These may form continuous hollow centre, or they may be distributed at random as small bubbles. The presence of the air-pockets increases buoyancy and resiliency of the material and reduces its specific gravity.

Alginate fibres The treatment of seaweed with sodium carbonate solution causes the plant to disintegrate as a thick gelatinous mass. This is diluted with water and filtered, and the filtrate, after bleaching and sterilising, is acidified with hydrochloric acid to precipitate the alginic acid which may be prepared as a spinning solution from which alginic acid rayon yarns can be spun. It is more usual, however, to neutralise the alginic acid by further treatment with sodium carbonate to produce sodium alginate solution which, when ready for spinning, may contain about 9 per cent of air-dry sodium alginate. This solution is extruded (as in the spinning of viscose rayon) into a coagulating bath containing calcium chloride, dilute hydrochloric acid, and emulsified olive oil, to produce calcium alginate rayon. The filaments are stretched during spinning, and the yarns are satisfactory in appearance, handle, tenacity (0.15 to 0.18 N/tex), extensibility and fineness (as fine as 2 decitex filaments) for weaving and knitting purposes. At this stage, however, alginate rayon is readily soluble in a dilute solution of soap and soda and must be made alkali resistant. The material in yarn form, or during the finishing of woven or knitted fabrics, is therefore treated in a bath containing metallic salts (beryllium salts leave alginate rayon uncoloured) which makes it not only alkali resistant but also non-inflammable, so that metallic alginate rayon could be useful for curtains and other furnishing fabrics. Calcium-beryllium alginate rayon is very hygroscopic, and the yarns, when wet, have about 80 per cent of the tenacity of air-dry yarns. The number of dyestuffs suitable for dyeing alginate fibres are sufficient to produce a range of colours of satisfactory fastness to light and washing.

The solubility of alginate fibres can be made use of in producing special effects in cloths. Thus a calcium alginate yarn may be twisted with a non-soluble yarn, which contains little or no twist, or is very fine, in order to give strength to the latter for weaving. The soluble yarn is then removed from the woven cloth simply by washing with soap and water, the principle being the same as in the production of 'extracted cloth' where the cotton scaffolding thread was removed by acid carbonisation process from a wool/cotton mixture.

An extra process, in which acid is used, is not required to remove the soluble alginate material, and the latter may be employed in combination with any other kind of textile fibre with no injurious result. The principle offers considerable scope for the production of special effects, as for instance: by twisting groups of fibres with the soluble yarn, or the latter may be twisted with a yarn of greater length; certain threads in a cloth may be interwoven with alginate threads, etc., so that when the soluble material is dissolved in the scouring process the groups of fibres or portions of the non-soluble threads are released and tufts, curls, loops, etc., are formed on one or both sides of the fabric.

Bi-component yarn This yarn is achieved by fusing together longitudinally during extrusion two filaments of different chemical composition. This ensures that the twin fibres' components behave in a somewhat different manner when subjected to the influence of certain agencies. Particularly useful in this respect is the differential shrinkage property of each component when subjected to the action of heat. This property causes the development of twists and kinks in the yarn thus assisting materially in increasing its bulking properties. The heat-induced spirality is removed in water but returns again upon drying if the fabric or garment is laid out flat after washing. Thus, in each laundering cycle there is a continual movement and reconstitution of yarns in slightly different convolutions which assist in maintaining the cover, and the formation of new fibre entanglements helps to rejuvenate the fabric appearance. Other bi-component yarns may be produced as a concentric combination of a different core within a different sheath.

Bulked yarns Yarns treated in such a manner as to increase their apparent volume. Such yarns are also sometimes termed 'textured' and some have the capacity to recover fully after stretching and are known as stretch yarns. Bulked yarns improve the cover of fabrics made from them and in some instances savings of up to 40 per cent in weight are possible for cloths of similar appearance. The process also improves the thermal insulation value of the yarn and its moisture absorbency and garments produced from these yarns are lighter, fit better and are generally more comfortable in wear than similar garments produced from identical but non-bulked material.

Most processes used to produce this type of yarn depend upon thermoplastic properties of the treated fibre and the sequence of operations may be generally described as: heating to plasticise the material, deformation whilst in plastic state followed by cooling which ensures that the deformation is permanently retained. The deforming may be achieved in various ways, e.g. by passing the yarn over an edge, between toothed gears, over feeding into a stuffer box and by a twist-untwist method. In each of these processes the temperature conditions are the most critical part of the operation and any deviations at that stage will greatly affect the yarn performance and its characteristics. Most of the yarns produced in the above manner possess the ability to recover from stretch and are, therefore, also classified as stretch yarns.

Different processes are used to produce bulked yarn from non-thermoplastic materials (but can be used for thermoplastic fibres as well) and these depend upon a strong current of compressed air creating numerous loops in the individual filaments of a multi-filament yarn, combined with an overfeed principle to ensure that the filaments are free to form the loops. Yarns produced in this way increase their bulk or apparent volume but as the main core of the yarn remains undisturbed, elastic properties of the final product are largely unaffected.

Core yarn A composite yarn produced at the spinning frame by feeding-in a ready made central yarn and spinning around it an envelope or a 'wrapper' of staple fibre. The central core may be a staple fibre, or a filament yarn. These yarns are produced for decorative purposes and the central core, acting as the strengthening element during fabrication, is frequently removed during finishing by chemical action to leave a lofty, almost twistless product (see Alginate fibres). In other cases the core is allowed to remain in the yarn permanently.

Crêpe rayon yarns These have largely superseded the crêpe silk yarns (q.v.) formerly used in fine quality crêpe cloths. Viscose and cuprammonium rayons have been most popular for crêping purposes, their use as weft, in conjunction with cellulose acetate or silk warp, having been found very advantageous. Crêpe cellulose acetate yarn is produced which will give the same degree of shrinkage as the other rayons, but with ordinary twist its special properties have rendered it of particular use as the non-shrinking element of crêpe cloths. The actual counts of crêpe viscose yarn range chiefly from 84 to 110 d tex, and the turns per cm from 22 to 24, but these figures are by no means the limit, and, as a rule, the threads are composed of fine filaments. Cuprammonium crêpe yarn, as fine as 45 d tex, with about 24 turns per cm, is used for both warp and weft in fine types of Georgette crêpe cloth.

The effect of increasing the twist in rayon yarns above the normal turns per inch is, at first, to increase the strength, but beyond from 8 to 10 turns per cm in ordinary counts the additional twist tends to weaken the yarn progressively. The lustre of the yarn is reduced in proportion to the amount of twist inserted, and the thread becomes shorter and the tex count higher. A wide variation in the amount of twist in crêpe yarns results in uneven crêping, or 'river marking', as the defect is termed, in the cloth.

Previous to the crêpe twisting operation, in order that the required high degree of twist may be inserted without injury to the filaments, and to increase the flexibility of the threads, it is customary to treat the material with a light size, by which the filaments are coated with an exceedingly thin film that acts as a lubricant and assists in controlling the twist. The kind of size that is suitable varies according to the class of crêpe finish that is required in the cloth, a gelatine size being preferable for viscose crêpe yarn when a distinct pebble finish is wanted, and an oil size in order to produce a flatter surface.

In the majority of crêpe fabrics both right and left twist threads are used, and in order that the two kinds of twist may be distinguished during the preparatory and weaving processes one of the yarns is tinted, or the two kinds are tinted in contrasting colours, previous to the insertion of the crêpe twist. Also, to distinguish weft yarns further they are wound on differently coloured pirns and, in addition, the two different kinds of twist may be wound on the pirns in opposite directions (winding spindles are geared to rotate either right or left way), so that the unwinding of the threads in weaving will not increase the twist of one yarn and decrease that of the other.

The standard method of crêpe twisting single filament rayon yarn is from bobbin to bobbin, but ring twisting is now also employed. The twist may be inserted at two operations, and on a dual machine up-twisting from bobbins, etc., is now combined with down-twisting by the ring method in a continuous operation.

Staple fibre yarns, also, are crêpe twisted, the counts ranging from 38 tex to 14 tex and upwards, and the number of turns per cm from 18 to 20. 'Single-spun' staple fibre crêpe yarn has the crêpe twist inserted at the one operation of spinning, whereas the yarn is termed 'double-spun' when it is first spun with normal twist and then has the required additional turns inserted in a twisting frame in which, if required, it may be passed through water. In the second spinning the single thread is twisted round its own axis with the result that it has a more 'pebbled' appearance than the single-spun yarn. Two-fold crêpe yarns consist of two normally spun single threads which are twisted together, usually in a ring doubling frame, the direction of the twist generally being in the same direction as the twist of the singles.

After the twisting operation crêpe threads are liable to snarl or kink up, owing to the high twist, if they are held without tension, and in order to set the yarn and produce the necessary inactivity for successful working it is subjected to heated humidity. Steaming the yarn is mostly employed and the process is carried out on the material in the form in which it has been wound—in cones, cheeses, bobbins, or pirns; and the treatment requires to be uniform throughout the yarn or the pebble in the cloth will be affected. A vacuum steamer may be used in which the yarn is placed on suitable containers, and after the cover has been closed and sealed, air is withdrawn by means of a pump and the steam is admitted. Some manufacturers, however, prefer that viscose crêpe yarns on pirns are not steamed, because of the possibility that the process may be detrimental to the effect that is desired in the finished cloth.

Crimped viscose rayon Filaments produced with thicker skin on one side than the other. As this affects the moisture absorbency the fibre of this type becomes unbalanced and develops a crimp which improves its bulking properties and resiliency. Ordinary crimped viscose rayon shows the normal corrugated cross-sectional appearance but for carpets a special fibre with a smooth cross-section has been developed in order to prevent soiling and to improve the wear properties.

Cuprammonium rayon A regenerated cellulose fibre, now also known by the term cupro. In the production of this rayon, cellulose is dissolved in a cuprammonium solution, extruded into a current of water which induces a degree of stretch, and coagulated in a bath of acid. This material is more costly to produce than viscose rayon and for this reason its uses are confined to more luxurious goods. It is particularly suitable for very fine denier yarns and is made into chiffons, ninons and similar fabrics in which its excellent handle, good draping property and comparatively high tenacity are advantageously displayed.

Denier System used as the standard count for filament silk and most man-made fibres. The denier number refers to the weight in grammes of 9000 metres of yarn or filament.

Drawn yarn A man-made yarn which has been subjected after extrusion to a drawing or stretching process (non-returnable stretch) designed to induce more perfect molecular alignment within the filaments. Drawing usually increases the strength of materials but reduces their extensibility (see High tenacity yarn, also, section on Synthetic polymers).

Fancy rayon yarns Rayon, either as filament or staple fibre yarn, may be introduced as the special thread in nearly all classes of fancy yarns (q.v.).

Boucle A typical and popular fancy yarn in which the effect ranges from a more or less distinct curl to small spots or nubs. The yarn may be composed entirely of rayon, or the effect thread may be of rayon and the foundation threads of cotton, or wool, or both. There may be two or three foundation threads, and one effect thread which, in the twisting, has an excess delivery of from 50 to 75 cm to each metre of twist.

Random slub A spun viscose slub yarn so produced that patterning in any width of cloth is avoided.

High tenacity yarn Term used to denote a material with tensile strength higher than in 'normal' fibre. Produced specifically for tyre cord fabrics, conveyor belts and similar industrial applications. Can be achieved by cold or hot drawing of synthetic materials or by stretching during coagulation of viscose rayon. The higher strength is due to better alignment of molecules along the longitudinal axis of filaments. This increase is usually accompanied by reduced extensibility.

Lactron thread and **lastex yarn** 'Latex' is the water dispersion of natural rubber, or an emulsion of synthetic rubber, which is suitably prepared so as to produce a liquid of a certain degree of viscosity. 'Lactron thread' is the term applied to the round rubber filaments that are produced by extruding the prepared latex through small apertures into a coagulating bath in which they are solidified. The threads then pass to conveyors on which they are washed under water sprays, are dried and vulcanised in hot chambers, inspected while being passed across a table, and finally are wound on bobbins, all in a continuous operation. This round continuous rubber thread is used in place of the square thread of limited length which, formerly, was cut from sheet rubber. The principal sizes of fine round thread are 75s, 100s, and 125s, each number representing the number of threads that can be laid side by side in one inch; that is, 100s thread has a diameter of $\frac{1}{100}$ in. (0.254 mm).

'Lastex yarn' is produced by covering lactron thread with two layers of material by twisting two threads in opposite directions round the rubber core. The lactron thread passes through two rotating hollow spindles which respectively carry the inner and outer covering thread, and rotate in opposite directions. During the twisting operation the rubber thread is under tension in order that it will have the required degree of elongation, while care is taken that the two covering threads are given in at an equal rate so that both will subsequently permit of the same amount of stretch. The ultimate elongation of lastex yarn is limited by the covering threads, and a fabric containing the elastic yarn cannot stretch beyond the distance allowed by the non-elastic threads.

Lastex yarn is produced with an elongation that ranges from 55 per cent to 300 per cent, but usually it is from 105 per cent to 175 per cent, while the number of metres per kg in the covered form runs from 1800 to 36 000. The covering threads vary in thickness from coarse woollen counts to the finest silk and rayon; cotton covering threads, however, are most frequently employed. The latter are usually fine in counts, and the inner covering thread may be single or two-ply, and the outer thread single, two-ply, or three-ply. The lactron core may form about 30 per cent of the compound thread, with the cotton covering threads in equal proportions, or with the outer covering thread as, say, three parts to two of the inner thread.

Lastex yarn is used for corsets, bathing costumes, tight fitting under garments, waist bands, caps, and tops of socks; to impart a local grip at the end of sleeves, etc., and to form tuck and ruched effects. In woven fabrics various crêpon, undulating, and crinkled styles can be obtained by introducing one or two threads of lastex yarn at intervals. When the yarn is inserted in fabrics it has to be elongated at the time of insertion to the same degree as the finished fabric is required to be stretched. The natural latex yarns are now frequently replaced by the polyurethane elastomers in certain fields of application.

Plastic coated yarns Cotton, rayon, fibreglass, etc., yarns are coated with exceedingly fine coverings of plastic solutions in order to make them stronger, brighter or duller, different in colour, resistant to water, chemicals, perspiration, oil and grease, and fireproof, weatherproof, and rot proof. The number of coatings that is applied varies according to the ultimate use of the thread.

Polynosic fibres These are modified viscose rayon fibres with high dry and wet tenacity, the latter being particularly valuable in achieving dimensionally stable fabrics. The crisp handle, low water imbibition (therefore reduced swelling) and good lustre make these materials very attractive. They are frequently used in applications suited for mercerised cotton which they resemble in many respects.

Split film fibre yarn A type of yarn used in twines and ropes and obtained from fibre made by splitting a sheet of film. The film is fibrillated into thin strands (usually by mechanical action), these are then gathered into bundles of suitable thickness and twisted together, thus forming a yarn. The materials particularly suitable for this process belong mostly to the polyolefines which exhibit a natural propensity towards fibrillation. Sackings and backing cloth used in the manufacture of tufted carpets are other important outlets for this type of yarn.

Spun-dyed yarns Applied to man-made materials in which colour is due to the presence of pigment particles incorporated in the spinning dope prior to extrusion. Particularly useful in fibres with poor dye affinity where it may be the only way of achieving coloured yarns. The presence of pigment particles in the fibre usually results also in the modification of the intensity of lustre.

Staple fibre Man-made fibrous material resulting from cutting or breaking of a tow (q.v.) of filaments. The choice of staple length and filament fineness is governed by the method of spinning to be subsequently employed. (Lengths produced as standard vary from 31 mm to 457 mm, counts from 0.6 d tex to 56 d tex.) Any man-made material could be produced in staple form if desired. (See varied length staple fibre yarn.)

Staplised yarn A class of mock staple fibre yarn is produced continuously from filament yarn which possesses the characteristic features of staple fibre yarn. In one method of production each group of filaments, while subjected to a downward twisting operation, is caused to balloon round the winding package and is brought in contact with an abrasive or cutting device. Only a few of the filaments are severed at a time so that the continuity of the group is retained, and a continuous product is spun which has the appearance of being composed of staple fibre. By the preceding method the yarns retain the original thickness of the filament threads, but the principle of rupturing is now applied to continuous filaments in the form of roving of much greater count which, after staplising, merely passes through the final stages of drawing and the spinning that are customary in the spinning of a staple fibre yarn. The filaments never lose their parallel arrangement, and the final count of the yarn is determined by the amount of drafting employed.

Stretch spinning A method of spinning used to produce high tenacity yarns (q.v.) involving stretching of filaments between the coagulation and the winding-on stages.

Stretch yarn Term used to denote yarns from thermoplastic fibres which have the property of rapid recovery from stretch induced by a process of deformation followed by heat setting (see Bulked yarns).

Tow A large number of filaments collected after extrusion into the form of a loose rope preliminary to the making of man-made staple fibre. The tow may be cut at intervals to supply staple of regular length in loose fibre form for subsequent spinning, or, the tow after cutting or breaking may be converted directly into a sliver in a continuous process known as the tow-to-top system.

Tyre cord yarns In Appendix I reference was made to cotton tyre yarns used in the manufacture of tyre cord fabrics. In the man-made fibre field motor car tyre industry represents one of the major outlets which is keenly sought after by both, the manufacturers of high tenacity rayon yarns and the manufacturers of nylon yarns.

Motor tyre cords, made from high tenacity viscose rayon yarns, have been found particularly serviceable, as compared with cotton cord yarns, when the tyres are run continuously for a long time at high speeds with heavy loads. Under such severe conditions the temperature in the cords tends to rise to a degree that is injurious to cotton cords, whereas, within certain limits, the strength of viscose rayon cords increases. The temperature in the tyres of heavy vehicles ordinarily rises to about 100 C and may reach 140°C, and high tenacity viscose cords have been specifically designed to withstand great strains and stresses under these conditions. Yarns which have been produced under such extreme stretching that the elongation is greatly reduced are not suitable for tyre cords.

Nylon tyre cord yarns have made their appearance in the 1950s and have captured a good proportion of the market despite the higher cost on the grounds of their excellent tenacity and elastic properties. Originally many makers favoured nylon 66 for this application as this type has a higher softening and melting point than nylon 6. The latter, however, may eventually prove to be the better suited fibre as it exhibits good thermal stability, much better adhesion to rubber and superior flex resistance. The higher cost of nylon as opposed to high tenacity rayon (about 2:1) is partially offset by the smaller quantity of nylon which needs to be used to produce an equally serviceable tyre fabric. This is due to higher strength of nylon yarns. One disadvantage of nylon based tyres is their tendency to deform temporarily when the car is parked after a long journey with the tyres quite hot. The part of the tyre on which the car rests tends to flatten out and will return to the normal shape only after several hundred yards after re-starting. This fault may eventually be eliminated either by modification in the drawing treatment, or in the chemical nature of the fibre.

Variable denier rayon yarn Threads of varying denier are produced by modifying the speed at which the continuously issuing stream of filaments is drawn away from the extrusion device. The variations can be so controlled that the periodicity of spacing and the possibility of patterning are avoided.

Varied-length staple fibre yarn Staple fibre that contains fibres which vary in length is produced for use in the worsted spinning industry. The distribution of the different fibre lengths is so controlled that an analysis shows the characteristic sloping shoulder of a wool top diagram. The material is provided in lots in which the length declines gradually from 152 mm to 88 mm, 127 mm to 88 mm, and 76 mm to 63 mm, but in other respects it is similar to the same class of staple fibre. It is claimed that in producing a wool and rayon mixture yarn the blending of the fibres is more thorough when the lengths of the two components are similarly varied and that a more evenly spun yarn results.

List of works for further reference:

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Appendix III

Basic Yarn and Cloth Relationships in Simple Woven Fabrics

Cloth settings in woven fabrics have evolved over a considerable number of years as a result of extensive trial and error procedures combined with practical experience and in many instances are a compromise between what is acceptable and what can be provided within a given price range. Even in standard classes of cloth they vary widely ranging from the minimum marketable quality to a desirable maximum for a particular end use. Neither the top, nor the bottom qualities represent rigid and well defined values and may vary between countries and areas due to differences in climate, fashion, habits or affluence of the various groups of people. The quality also fluctuates over a time scale and compared with clothing favoured by the Victorians which almost possessed the solidity and the permanence of heritable property, the present day constructions look decidedly flimsy.

In cloth types which use standard yarns and well known materials the traditional settings and thread counts are used which with some modifications provide wide and useful ranges of fabrics capable of satisfying most tastes and demands and there is little need for experimentation. However, when new fibres are brought into production, or when new uses for certain cloths are contemplated the trial and error procedures necessary to arrive at a correct setting may be costly and time consuming and this is a point at which a theoretical approach which gives an approximately correct starting point reduces the number and the cost of trials.

Cloth setting theories were developed in the second half of the last century with the intention of providing a designer with a ready made formula which would enable him to produce a useful cloth of a certain weight, by stipulating weaves, yarn counts or settings. The work was carried out independently by a number of workers and the investigations commenced by, amongst others, Ashenhurst and Armitage were later continued by Law and then developed by Peirce into a concept of cloth geometry.

Formulae provided for the calculation of cloth cover, or density of yarn setting depended largely on certain assumptions concerned with yarn diameters and the various constants or factors were usually calculated in terms of cotton, worsted or woollen yarn count systems. In this book all yarns are numbered according to the tex system and, therefore, this system has been adopted in all calculations which follow. The use of a direct, metric system of yarn numbering considerably simplifies the arithmetic involved and the existence of conversion tables will make it easy to compare the tex-numbers with the counts for those who are more accustomed to work on the traditional systems.

Cloth setting or density of thread spacing This is expressed as the number of threads over a convenient linear measure such as an inch, a centimetre, or 100 mm. Two values are necessary, the first defining the number of ends, the second the number of picks per unit space.

In the previous chapters of this book the unit of one cm has been used to specify cloth settings but in this Appendix a unit of 100 mm has been adopted. This is well suited for calculations expressed in terms of the tex system and is sufficiently large to avoid fractional values which occur frequently when coarser fabrics are specified over the space of one cm. Also, being very nearly equal to 4 inches (101.6 mm), the unit provides an easy base for conversion of a given setting into threads per inch.

Yarn diameter As textile yarns are easily compressible their thickness is not usually specified as a given gauge or diameter but as a weight/length relationship known as yarn count or yarn number. However, for the purpose of calculating cloth cover, especially when dealing with new materials, new structures, or new modifications it is necessary to consider yarn diameter.

In the tex system the yarn number, N tex, indicates the weight in grammes of 1000 m of yarn, therefore, assuming constant yarn density, it will be proportional to the area of yarn cross-section. If circular cross-section is assumed the yarn can be imagined as a cylinder whose diameter can be obtained from the following relationship:

$$\text{Area of cross section} = \frac{\text{volume}}{\text{length}}$$

$$\text{or,} \qquad \pi r^2 = \frac{\pi d^2}{4} = \frac{v}{l}$$

$$\therefore \qquad d^2 = \frac{4v}{\pi l}$$

$$\text{and,} \qquad d = \sqrt{\frac{4v}{\pi l}}$$

The length is fixed at 1000 m so to find a numerical value for d it is necessary to find the volume of the yarn and this could be obtained if the density or the specific volume of the yarn were known. Densities of the textile fibres are known and the specific volume of any *fibre* can be accurately determined as it is a reciprocal of density. Yarn, however, is a composite of fibres and air, and the relative amounts of air and fibre within a yarn will vary depending on the density of the material (or materials, in blended yarns), fibre thickness, fibre alignment, degree of twist and the amount of tension applied. Peirce in his experimental work on cotton yarns estimated that the specific volume of such yarns under moderate pressures (such as can be expected to exist in a cloth) is of the order of 1.1 cm^3/g. As the density of cotton is 1.52 g/cm^3, and its specific volume 0.658 cm^3/g, the specific volume of 1.1 cm^3/g represents a yarn composed of approximately 60 per cent fibre and 40 per cent air space. In the tex system the actual volume of yarn equals *tex* × *specific volume* and, therefore, assuming the specific volume of 1.1 cm^3/g, the formula for yarn diameter may be given as:

$$d = \sqrt{\frac{4 \times N \times 1.1}{1000\pi}}$$

From this it is possible to calculate a constant to simplify the formula to:

$$d = \sqrt{\frac{N}{F}}$$

which for yarns of specific volume of 1.1 cm^3/g would be:

$$d\ \text{mm} = \sqrt{\frac{N}{26.7}}$$

or, otherwise, the formula could be employed for yarns of any specific volume, V, in the following manner:

$$d \text{ mm} = \frac{\sqrt{V \times N}}{28}$$

The specific volume of 1.1 cm^3/g established for cotton yarns is surprisingly close for most other fibre and multi-filament yarns irrespective of the material content but it would be inappropriate to use it for mono-filament and bulked yarns on account of vastly different fibre to air space ratios, or for poly-olefine and certain mineral yarns due to considerable differences between the densities of these materials and most of the other textile fibres. Where closer approximations to actual specific volumes are known these should, of course, be used in preference to 1.1 cm^3/g.

In the above calculations a circular yarn cross-section has been assumed. This would be true in respect of monofilament and very hard twisted yarns but most of the other types of yarns tend to flatten to some extent and some workers have proposed an elliptical or a race-track cross-section as being closer to the actual appearance of yarn in a cloth. Apart from the intrinsic yarn characteristics the degree of flattening is dependent on the density of setting, which determines the amount of space available for spreading, and the tension exercised by the transverse yarn members, and should be preferably specified separately for each situation rather than used as a general proposition.

Cloth cover The diagrams in *Figure A3.1* show projected views of two woven cloths of different construction. At A the warp and the weft threads cover the area of the cloth only partially, but at B the cloth area is covered completely with no spaces left between

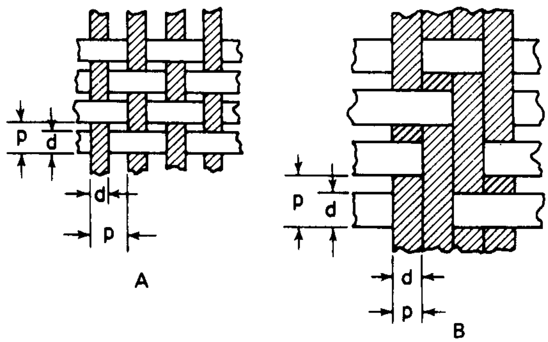

Figure A3.1

the adjacent warp yarns, and it will be seen that the relative closeness of yarns in a woven cloth is dependent upon the ratio of yarn diameter, d, to yarn spacing, p. This ratio known as relative cover, can be defined as the proportion of a projected view of a given area of cloth which is covered by threads, and will have a scale from 0 to 1, although it may also be expressed as percentage cover with a scale from 0 to 100 per cent.

$$\frac{d}{p} = \text{relative cover} \qquad \frac{d \times 100}{p} = \text{percentage cover}$$

It is preferable to express warp and weft relative cover separately, as the cumulative value of cloth cover does not indicate the comparative importance of each set of yarns which is essential for the determination of certain cloth characteristics.

From the relationship shown above it will be obvious that if $d = p$, the value of relative cover is one, and this is regarded as the theoretical maximum cover. In practice, however, this value can be exceeded considerably in any one direction, either through yarn distortion, or, by forcing the threads into different planes, especially if the relative cover of the opposite set of threads is reduced correspondingly.

The relative cover for one thread system can be calculated as follows by considering an area of 100 × 100 mm:

$$\text{Area per thread} = 100 \times d$$

$$\text{Area covered by } n \text{ threads of one system} = n \times 100 \times d$$

$$\therefore \text{ Relative cover} = \frac{n \times 100 \times d}{100 \times 100} = \frac{n \times d}{100}$$

Examples: (1) The cloth represented at A in *Figure A3.1* is specified as follows: Warp—25 tex cotton, 267 ends/100 mm; weft—36 tex cotton, 334 picks/100 mm. Find the relative warp and weft cover. (Subscript 1 refers to warp, subscript 2 to weft.)

$$\text{Warp relative cover} = \frac{n_1 \times d_1}{100}$$

$$= \frac{267 \times \dfrac{\sqrt{25}}{26.7}}{100} = 0.50$$

$$\text{Weft relative cover} = \frac{n_2 \times d_2}{100}$$

$$= \frac{334 \times \dfrac{\sqrt{36}}{26.7}}{100} = 0.75$$

(2) Find the relative warp and weft cover of the cloth represented at B in *Figure A3.1*, which is specified as follows: Warp—64 tex cotton, 334 ends/100 mm; weft—81 tex cotton, 198 picks/100 mm.

$$\text{Warp relative cover} = \frac{334 \times \dfrac{\sqrt{64}}{26.7}}{100} = 1.00$$

$$\text{Weft relative cover} = \frac{198 \times \dfrac{\sqrt{81}}{26.7}}{100} = 0.67$$

In most circumstances the cumulative value for cloth cover is of little use, but in some special cases, such as in considering air permeability, or porosity of cloths it may be of considerable interest, and should be specified. Simple addition of the relative warp and weft covers does not give the correct result because in this way the areas where one set of threads crosses the other are counted twice. These areas equal to

$$n_1 \times n_2 \times d_1 \times d_2, \text{ hence}$$

$$\text{Relative cloth cover} = (\text{Relative warp cover} + \text{relative weft cover}) - (\text{Relative warp cover} \times \text{relative weft cover}).$$

For the fabric represented at A in *Figure A3.1* the relative cloth cover would, therefore, be:

$$(0.50 + 0.75) - (0.50 \times 0.75) = 0.88$$

Expressed as a percentage it would indicate that 88 per cent of the total cloth surface was covered by yarn, with the remaining 12 per cent of the area consisting of open spaces.

The calculations involving the degree of yarn cover in cloth can be simplified considerably if an index or cover factor is derived which will obviate the need for the cumbersome calculation of yarn diameter which is necessary to establish the relative cover value. This can be achieved in the following manner:

$$d \text{ mm} = \frac{\sqrt{N}}{26.7} \quad \text{(for yarns of specific volume 1.1 cm}^3\text{/g)}$$

$$p \text{ mm} = \frac{100}{n} \quad \text{(where } n \text{ is the number of threads per 100 mm)}$$

$$\frac{d}{p} = \text{relative cover and this has a value of 1.00 when } d = p.$$

From the above the following relationship can be established:

$$\frac{d}{p} = \frac{\sqrt{N}}{26.7} \div \frac{100}{n} = \frac{n\sqrt{N}}{2670}$$

If the numerical factor is now eliminated a cover factor, K, can be expressed as: $K = n\sqrt{N}$. the value of K being 2670 when $d = p$, i.e. when the maximum theoretical cover value is reached. In this way a direct relationship is established between the cover factor, K, the number of threads per 100 mm, and the tex yarn number, N, to the exclusion of yarn diameter calculation provided that only yarns of specific volume of 1.1 cm^3/g are considered. It will be appreciated that for the relative cover of 0.50, K has the value of 1335; for relative cover of 0.33 it has the value of 890, and so on.

Many authorities consider that the figure of 2670 is too unwieldy as a factor and, therefore, it has been recommended that the value of 267 be accepted as the tex cover factor, which will be correct for the relationship derived above if n is taken to equal the number of threads per 10 mm. The exact numerical value of K has no particular significance as long as it is understood what it represents.

Examples:

(1) It is required to produce a cloth with 50 per cent warp cover using 25 tex multifilament rayon yarn. How many ends per 100 mm should be employed?

$$n = \frac{K}{\sqrt{N}} = \frac{1335}{\sqrt{25}} = 267$$

(2) It is desired to achieve the relative weft cover of 0.67 in a cloth woven with 178 picks of cotton yarn per 100 mm. What yarn number should be used?

$$\sqrt{N} = \frac{K}{n} = \frac{1780}{178} = 10, \therefore \text{ 100 tex yarn should be used.}$$

(3) What is the warp cover factor in a cloth made from 64 tex worsted warp with 220 ends per 100 mm?

$$K = n\sqrt{N} = 220 \times \sqrt{64} = 1760$$

What is the percentage warp cover in this cloth?

$$\frac{1760 \times 100}{2670} = 66 \text{ per cent}$$

Cloth Geometry In the concept of cloth cover presented above only the packing of threads parallel to each other is considered. No account is taken at this stage of the interference of the transverse threads with this relationship and the result indicates simply the ratio of a projected area of cloth covered by the threads to the total area. Even this ratio will only be accurate if the threads in question retain their circular cross-section. In practice some yarns tend to flatten and spread out and if this occurs the cloth surface will be fully covered at relative cover values below the theoretical maximum of 1.00. Apart from the possibility of yarn flattening the settings in actual cloths are affected by the frequency with which the transverse threads intersect the plane of the opposite thread system and this must be taken into account in considering the number of threads which it will be possible to place side by side.

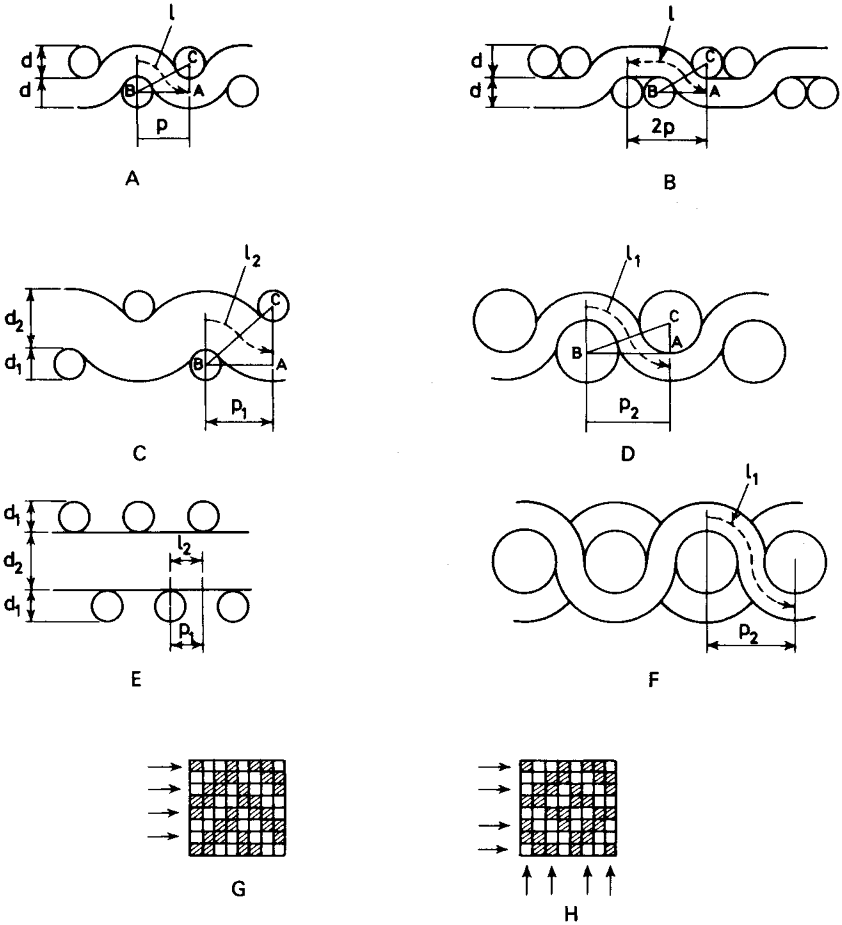

Figure A3.2

The cloth cross-section given at A, in *Figure A3.2* represents a plain weave fabric produced with identical yarns and settings in both directions. As the warp and the weft sectional views of such a fabric are the same, only one cross-section need be considered. The thread spacing represented in the diagram is the closest possible and it can be, therefore, determined that as AC = 1*d*, and CB = 2*d*, the thread spacing, *p*, is:

$$p = AB = \sqrt{3}d, \text{ or, } 1.732d,$$

and this represents the closest thread setting attainable without thread distortion in a square set plain weave constructed from the same yarns in both directions. The value of the cloth cover factor, *K*, for this cloth will be:

$$K = \frac{2670}{1.732} = 1542$$

The other important parameter obtainable from the model given at A, *Figure A3.2*, is the length, *l*, of the transverse thread. This, when expressed as a relationship of l/p gives the value of yarn crimp which, apart from being essential in determining the quantities of yarn to be ordered for the production of a given cloth, also determines many cloth characteristics such as tensile strength, rigidity, air permeability, etc. In the diagram the axis of the transverse thread shown as a dotted line follows an arcuate path whose length over the spacing p consists of two arcs of 60 degrees each. The radius of each arc is equal to $d(\frac{1}{2}d$ of one thread system + $\frac{1}{2}d$ of the other), therefore the total length of the thread over the specified distance, described sometimes as the modular length, can be expressed as:

$$l = 2\frac{2\pi d}{6} = \frac{2\pi d}{3}$$

As p equals $1.732d$, the ratio of l/p can be given as follows:

$$\frac{l}{p} = \frac{2\pi d}{3 \times 1.732d} = 1.209$$

or, expressed as a percentage excess of l over p, or yarn crimp, it equals to 20.9 per cent.

In practice a plain weave fabric constructed to above cover specification would be too boardy for most purposes and as a result of thread flattening it is possible to produce fully covered plain cloths at K values of between 1000 to 1400, depending on the degree of yarn spreading. Yarn flattening is also responsible for the reduction in cloth thickness and yarn crimp values from those shown in the model.

A very similar approach to the one outlined above in respect of, both, the cover factor and the yarn crimp, could be applied for other than plain weave constructions. As an example, B, in *Figure A3.2* shows a cross-sectional view of yarn intersections in a $\frac{2}{2}$ twill cloth constructed from identical yarns at a theoretical maximum square setting. The modular length, in this structure involves two adjacent parallel threads and one point of yarn intersection, the thread spacing, p, being different between the threads whose lie is not disturbed by the intersecting transverse thread, and those which the transverse thread intersects. For the sake of simplicity it is best to consider an average thread spacing, p_a, which has a value of one half of $2p$ indicated in the diagram. As the relationship of the two threads at the point of intersection is exactly the same as that calculated for the plain weave, p_a can be established as follows:

$$2p = \sqrt{3}d + d = 2.732d$$

$$\therefore \quad p_a = \frac{2.732d}{2} = 1.366d$$

and the cover factor for this cloth will have the value of:

$$K = \frac{2670}{1.366} = 1955$$

Modular length of the transverse thread for the space of $2p$ is:

$$l = \frac{2\pi d}{3} + d = 3.09$$

$$\therefore \quad \frac{l}{2p} = \frac{3.09d}{2.732d} = 1.131$$

$$\therefore \quad \text{Yarn crimp} = 13.1 \text{ per cent}$$

From the above considerations it will be clear that in all square set cloths produced with identical yarns in both directions the calculations of yarn spacing at the point of intersection will be identical and, therefore, the density of spacing will be dependent entirely on the frequency with which the intersections occur. In more complex structures in which the interval between each yarn intersection is variable it may be necessary to calculate the spacing per full repeat of the weave and to establish the average thread spacing, p_a, by dividing the repeat spacing by the number of threads in the repeat.

The solutions considered above can be extended to encompass constructions in which different settings and different yarns are used in warp and weft. As in such fabrics the warp and the weft sections are different it is necessary to show and to consider each one separately. Diagrams C and D in *Figure A3.2* show respectively the warp and the weft section of a plain cloth constructed with a fine warp yarn and a coarse weft with a maximum theoretical setting in each direction. In order to simplify the arithmetic the weft yarn diameter has been taken to be twice that of the warp ($d_2 = 2d_1$).

Warp thread spacing:

$$AC = \tfrac{1}{2}d_1 + \tfrac{3}{4}d_2 = 2d_1$$
$$BC = \tfrac{1}{2}d_1 + d_2 + \tfrac{1}{2}d_1 = 3d_1$$
$$AB = p_1 = \sqrt{5}d_1 = 2.236d_1$$
$$\therefore K_1 = \frac{2670}{2.236} = 1194$$

The low cover factor is entirely to be expected as the coarse weft will throw the adjacent ends further apart than a fine weft.

Weft thread spacing:

$$AC = \tfrac{1}{2}d_2 = d_1$$
$$BC = \tfrac{1}{2}d_2 + d_1 + \tfrac{1}{2}d_2 = 3d_1$$
$$AB = p_2 = \sqrt{8}d_1 = 2.828d_1\text{, but } d_1 = \tfrac{1}{2}d_2,$$
$$\therefore = p_2 = 1.414d_2$$
$$\therefore K_2 = \frac{2670}{1.414} = 1888$$

A cloth of this type will also exhibit considerable differences in the warp and weft crimp values.

Weft crimp—the broken line, l_2, in diagram C is composed of two arcs, each of 48° (approx.); the radius of each arc $= \tfrac{1}{2}d_1 + \tfrac{1}{2}d_2 = 1\tfrac{1}{2}d_1$, therefore,

$$l_2 = 2\frac{3\pi d_1}{7.5} = 2.51d_1$$
$$\frac{l_2}{p_1} = \frac{2.51d_1}{2.236d_1} = 1.122$$
$$\therefore \text{crimp} = 12.2 \text{ per cent}$$

Warp crimp—l_1 in diagram D consists of two arcs of 70° with the radii $= \tfrac{1}{2}d_2 + \tfrac{1}{2}d_1 = 1\tfrac{1}{2}d_1$, therefore,

$$l_1 = 2\frac{3\pi d_1 \times 70}{360} = 3.663d_1$$
$$\frac{l_1}{p_2} = \frac{3.663d_1}{1.414d_2} = \frac{3.663d_1}{2.828d_1} = 1.295$$
$$\therefore \text{crimp} = 29.5 \text{ per cent}$$

Diagrams E and F in *Figure A3.2* represent respectively the warp and the weft sections of an unbalanced plain weave cloth of the warp rib type in which the warp yarn diameter is one half that of the weft ($d_2 = 2d_1$). As can be seen at E, $d_1 = p_1$ and, therefore, the warp cover factor in this cloth will have the value of 2670. As $l_2 = p_1$ there is no weft crimp, i.e. the weft lies perfectly straight deflecting the warp threads into two separate planes. In this situation each weft pick is separated from its neighbour by the full diameter of the warp end and, therefore:

$$p_2 = d_2 + d_1 = 1\tfrac{1}{2}d_2$$

and the maximum cover factor for weft, K_2, is:

$$K_2 = \frac{2670}{1.5} = 1760$$

The warp will exhibit a very high degree of crimp which may be given as follows:

The broken line, l_1, in diagram F is composed of two arcs of 90° each; the radius of each arc = $\frac{1}{2}d_2 + \frac{1}{2}d_1 = 1\frac{1}{2}d_1$, therefore:

$$l_1 = 2\frac{3\pi d_1}{4} = 4.71d_1$$

$$\frac{l_1}{p_2} = \frac{4.71d_1}{1.5d_2} = \frac{4.71d_1}{3d_1} = 1.57$$

$$\therefore \text{crimp} = 57 \text{ per cent}$$

The method used above in examples A to F can be readily adapted for other simple weaves and is generally applicable for constructions in which the length of float does not exceed two threads. Even in this comparatively limited range of constructions there are certain considerations which must be taken into account to avoid errors. A good example of these is the case of an ordinary 2-and-2 twill and the same twill arranged in herringbone order. An ordinary square set twill may be produced with a cover factor of 1955 as given for example B. A broad herringbone stripe in the same twill can also be produced with the same cover factor but a narrow stripe in which the direction of twill is changed after every four ends as at G, *Figure A3.2*, can only be produced at a very much reduced *K* value. This is due to the fact that on every alternate pick floats of one thread are occurring owing to the method of reversal. Even more severe reduction of the *K* value would be required in the case of 2-and-2 twill diaper given at H where floats of one occur in both directions.

In mat weaves and in weaves in which the float length exceeds two threads it is customary to add a certain fixed percentage to the calculated number of threads in order to achieve a degree of firmness corresponding to plain and 2-and-2 twill weave fabrics. The commonly used percentages are those worked out by Law which may be summarised as follows.

(1) Mat weaves—
  2-and-2 mat weave—add 4.5 per cent
  Other mat weaves—add 4.5 per cent + 9.5 per cent × (float length − 2)
(2) Twill weaves—
  Add 5 per cent × (float length − 2)
  Thus, a 4-and-4 twill warrants an addition of 10 per cent
(3) Sateen and satin weaves—
  Add 5.5 per cent × (float length − 2)
  ∴ addition for 5-end satin or sateen = 5.5 × (4−2) = 11 per cent
  ∴ addition for 6-end satin or sateen = 5.5 × (5 − 2) = 16.5 per cent
  ∴ addition for 8-end satin or sateen = 5.5 × (7 − 2) = 27.5 per cent

At this point it is useful to note the discrepancy between additions required for an 8-end twill and an 8-end satin. These arise not only because the 4-and-4 twill has a shorter float but mainly because in a regular twill the thread intersections occur in a consecutive order whilst in satins they are staggered which results in a greater freedom of movement available to the floating yarns. As a result of the additions sateens and satins are usually produced with cover factors about or above the maximum value of 2670 in the direction of the face yarns, i.e. weft for sateens and warp for satins with considerably lower *K* values for the opposite thread direction (usually between 1400 to 1600).

Constructions in which a large variety of different weaves is employed within a repeat, such as brocades, cannot be approached in the same manner as the simple structures and in such cases the designer is guided mainly by experience and precedent. However, in figured cloths in which one weave occupies a predominant position the normal rules of cloth geometry can be applied quite successfully.

Relationship of cloth cover to cloth weight In many instances cloths are constructed to conform to a certain weight per unit area and this specification is of considerable importance not only in determining the cloth characteristics but also as a basis for costing. The weight may be expressed in ounces per running yard, ounces per square yard, or in grammes per square metre, the latter having been adopted in this chapter.

In planning a new cloth construction it is necessary to correlate all fabric parameters and for this purpose it is useful to establish a relationship between the weight and the cover of the cloth. This may be done in the following manner:

$K = n\sqrt{N}$, n being the number of threads per 100 mm.

$W = \text{g/m}^2$

Cover for warp and weft yarns $= K_1 + K_2 = n_1\sqrt{N_1} + n_2\sqrt{N_2}$

$$W = \frac{(10n_1 \times N_1) + (10n_2 \times N_2)}{1000} = \frac{n_1N_1 + n_2N_2}{100}$$

$$\therefore\ 100W = n_1N_1 + n_2N_2, \text{ but } n_1 = \frac{K_1}{\sqrt{N_1}}, \text{ and } n_2 = \frac{K_2}{\sqrt{N_2}}$$

therefore, the above equation could also be expressed as:

$$100W = \frac{K_1N_1}{\sqrt{N_1}} + \frac{K_2N_2}{\sqrt{N_2}}$$

which, when simplified:

$$100W = \frac{K_1N_1}{\sqrt{N_1}} \times \frac{\sqrt{N_1}}{\sqrt{N_1}} + \frac{K_2N_2}{\sqrt{N_2}} \times \frac{\sqrt{N_2}}{\sqrt{N_2}}$$

results in the following relationship:

$$100W = K_1\sqrt{N_1} + K_2\sqrt{N_2}$$

The relationship provides a useful basis for estimates but it must be realised that in this form it does not include the crimp of the threads and, therefore, the weight given would be, in fact, lower than the actual weight of cloth by a fraction equal to an aggregate value represented by the warp and weft crimps.

List of works for further reference

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