

The principle of the huckaback weave is also used in the construction of designs which repeat upon a larger number of threads and contain longer floats, as shown in the design K in Fig. 85. The term "honeycomb-huckaback" is applied to this weave. A further development is illustrated by the design L which, when woven in coarse yarns, belongs to a class termed "Grecian." Fig. 86 represents the appearance of the design L in the woven fabric.

IMITATION GAUZE OR MOCK LENO WEAVES

The weaves included under this head, when properly carried out, produce effects that are similar in appearance to styles obtained with the aid of a doup mounting. Two kinds of structures are produced by the weaves—viz. (1) perforated fabrics in imitation of open gauze effects, an illustration of which in stripe form is given in Fig. 88; (2) distorted thread effects in imitation of "spider" or "net" leno styles, examples of which are represented in Figs. 90 and 93.

Perforated Fabrics.—Illustrations of weaves of this class are given in Fig. 87, in which A, B, and C respectively show the 3×3 , 4×4 , and 5×5 imitation gauzes. Each weave is constructed by reversing a small unit, which in A, B, and C is indicated by the crosses. The weaves are in sections which oppose one another, and there is a tendency for the outer threads of adjacent sections to be forced apart, whereas in each section the order of interweaving permits the threads to readily approach each other. The warp threads thus run in groups with a space between, and are crossed by weft threads which are grouped together in a similar manner. The open appearance of the cloth, however, can be either improved or obscured by the system of denting that is employed. If the last

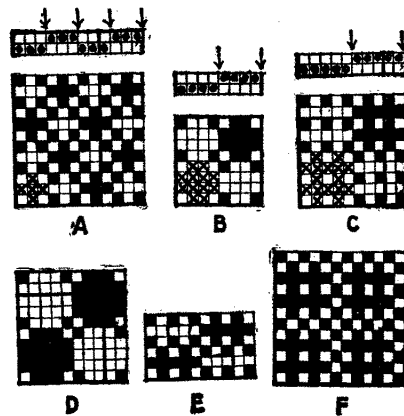


Fig. 87.

end of one group is passed through the same split as the first end of the next group, the tendency of the threads to run together is counteracted; but if each group of ends is passed through a separate split the reed naturally assists in drawing the threads together in groups. Thus the designs A, B, and C should be dented 3, 4, and 5 ends respectively per split as shown above the plans. The open appearance of the weaves may be further increased by using a rather fine reed and missing alternate splits; the arrows above the denting plans in Fig. 87 indicating the positions of empty splits.

The design D in Fig. 87 is simply a modification of B, and E of C, and both weaves should be dented five ends per split. The design F shows a style in which the ends and picks one to five group together, and are clearly separated from the sixth end and pick. In a coarse reed the ends may be dented five and one per split alternately; in a reed of medium fineness, five in two splits, one split missed, one per split, one split missed; while in a fine reed (40 to 50 splits per inch) a suitable order of denting is two, one, and two ends per split, one split missed, one per split,

one split missed. In the design F only one yarn is floated on the surface, whereas in the other designs the warp and weft are floated equally.

The open gauze weaves are sometimes used alone, as in canvas cloths, and in cheap fabrics for window curtains; but for light dress fabrics, blouses, aprons, etc. they are, to a large extent, employed in combination with other weaves. In Fig. 88

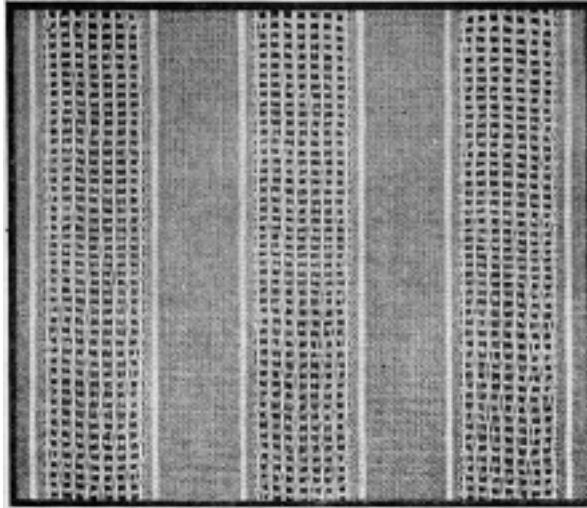


Fig. 88.

the 3×3 imitation gauze weave, given at A in Fig. 87, is shown arranged in stripe form with plain weave, while the 4×4 structure indicated at B, is shown as a ground weave to a figure in Fig. 280. When the same threads have to form both an open effect and ordinary interlacing, as shown in Fig. 280, it is, of course impracticable to leave splits of the reed empty; and in some cases, in order that the figure will be

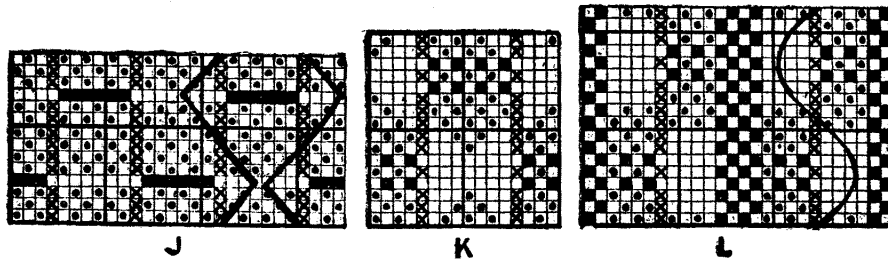


Fig. 89.

properly developed, each group of threads is placed in more than one split, but care is taken to split the groups of threads by the reed in regular order. Imitations of open leno effects are obtained in plain weave simply by missing splits in the reed; as for instance, a stripe effect might be woven in a fine reed with 3 plain ends in one split alternating with two splits missed.

Distorted Thread Effects.—The imitation gauze weaves of this class may be arranged to distort certain threads in either the weft or the warp, or in both weft and warp. J in Fig. 89 illustrates one of the simplest methods of producing a distorted warp effect. The ground structure is plain weave, and the fourth and eleventh ends, which are distorted, float over all the plain picks (the marks indicate warp up), but pass under the fourth and eleventh picks. The latter float over one group of plain ends, and under the next group in alternate order. The distorted ends are placed on a separate beam and are given in more rapidly than the ground ends, hence they are drawn towards each other where the picks four and eleven float over the ground ends. As the latter floats occur in alternate order, the ends are drawn together in pairs, and then separated, as indicated by the zig-zag lines on the right of J.

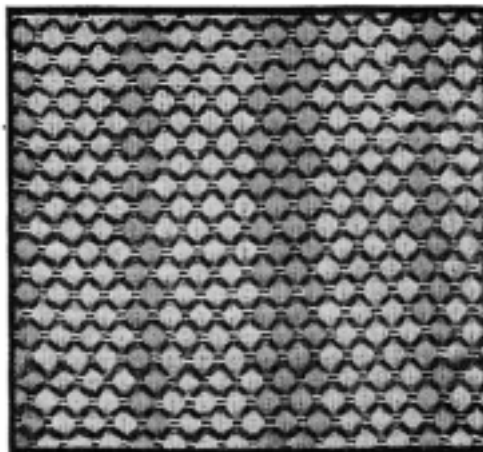


Fig. 90.

The design K in Fig. 89 produces a similar effect to J, but the distorted ends (5 and 13), and the picks (4, 6, 12, and 14) which float over them, are more firmly interwoven. Also the ground ends float loosely on the back of the cloth where the distorted ends are drawn together, the bending of the ends being thus facilitated. The fabric represented in Fig. 90 corresponds with the design K.

The design L in Fig. 89 shows a modification of K, in which all the distorted ends work alike, and produce independent zig-zag lines in the cloth, as indicated on the right of the design.

The distorted warp effects are chiefly used in combination with other weaves in stripe form, and an example is given in Fig. 91 (the marks in this

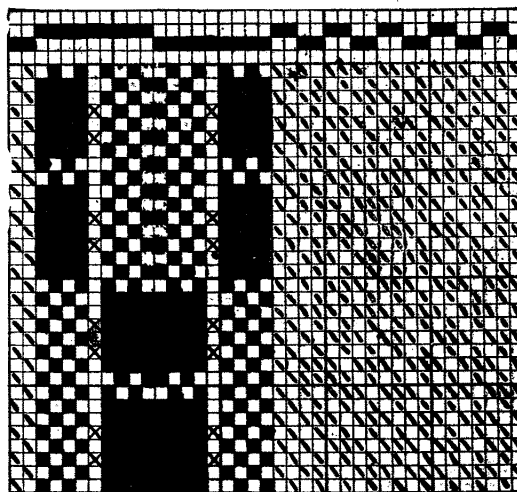


Fig. 91.

case indicating weft up) which corresponds with the pattern shown at the sides of the figured stripe represented in Fig. 346. When used in stripe form the ends which form the zig-zag effect should be somewhat crowded in the reed; and in producing the pattern represented in Fig. 346, the nine ends which form

each group, as indicated above the plan given in Fig. 91, were dented in three splits, while the ground ends were woven two per split.

Examples of distorted weft effects are given at R and S in Fig. 92, in which the marks indicate warp up. The design R is arranged with plain ground on the same principle as J in Fig. 89. The floating ends pass over all the distorted picks,

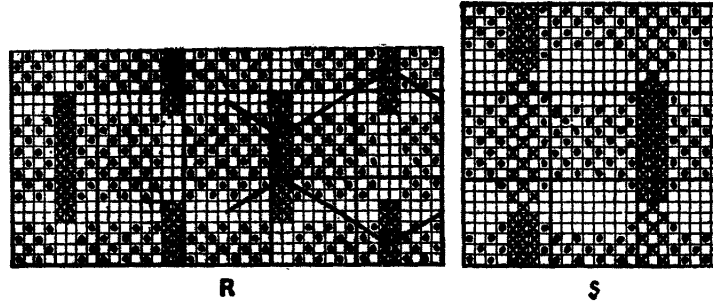


Fig. 92.

and alternately over the ground picks between; therefore the distorted picks, which float over all the ground ends, are alternately drawn together and separated, as shown by the zig-zag lines on the right of R. Fig. 93 represents a fabric woven in the design R. In this method, the degree of distortion varies according to the

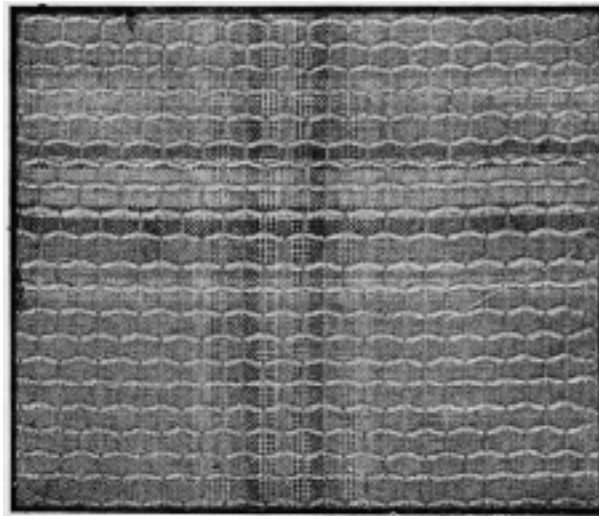


Fig. 93.

difference in the shrinking of the distorted picks, which float loosely, and the ground picks, which interweave frequently; hence the best results are obtained when a ground texture is formed that shrinks considerably in width.

The design S in Fig. 92, illustrates a style which is used to some extent in thick yarns. In order to more fully develop the zig-zag effect two picks are floated on both sides of each distorted pick, and the ends, which draw the floating picks together alternately float and interweave plain. The loosely-woven picks are beaten up close together so that those in the centre are forced prominently to the surface, and are in a proper position for being drawn together, and then the plain interweaving of the floating ends produces the most suitable conditions for forcing the distorted picks apart.

In combining distorted warp and weft effects, a stripe, in which the threads interweave on the principle illustrated at K in Fig. 89, may be overchecked with a weave similar to R in Fig. 92, the bulk of the check being composed of plain or other simple weave. Colours may be introduced either in the floating threads or the ground threads, and Fig. 93 represents a cloth with a coloured check foundation.

CHAPTER VII

SPECIAL RIB AND CORD STRUCTURES

Rib and Cord Effects produced in Plain Weave—Methods of Increasing the Prominence of the Ribs—Soleil Weaves—Combination of Weft Cords with other Weaves. *Corkscrew Weaves*—Warp Corkscrew Weaves—Weft Corkscrew Weaves. Modified Rib and Cord Weaves—Longitudinal Warp Cords—Diagonal and Waved Ribs—Diamond Ribs. *Bedford Cords*—Plain-Face Bedford Cords—Wadded Bedford Cords—Crepon Bedford Cords—Bedford Cords arranged with alternate Picks—Twill Face Bedford Cords. *Welts and Piques*—Ordinary Welt Structures—Weft Wadded Welts—Fast-Back Welts—Waved Piques.

Rib and Cord Effects produced in Plain Weave.—In addition to the rib weaves, which are produced by extending the plain weave in the methods illustrated at A to N in Fig. 3 (p. 5), rib and cord effects are produced in a number of different ways. (The term cord is frequently applied to ribs that run the length of the cloth in order to distinguish them from those that run horizontally.) A rib or cord structure is largely due to the manner in which the warp and weft threads are proportioned as regards thickness, and number per unit space. Thus, in pure plain weave, if the number of ends per unit space largely exceeds the number of picks, the latter tend to lie straight in the cloth with the former bending round them, and a warp rib structure results. If the opposite conditions prevail, the ends tend to lie straight with the picks bending round them, a weft rib structure being formed. In each case the prominence of the rib is accentuated if the straight threads are thicker than those which bend. If all the warp threads are similar in thickness, and all the weft threads also similar, rib lines are formed on both sides of the cloth which are uniform in size, as shown at A in Fig. 94. A different form of rib structure is produced in plain weave, however, if a thick and a fine thread alternately are employed in warp and weft, as shown at B in Fig. 94. In forming a warp rib the thick ends always pass over the thick picks, and under the fine picks; whereas in forming a weft rib, the thick picks always pass over the thick ends and under the fine ends. In the warp ribs there should be more ends per unit space than picks, and in the weft ribs more picks than ends. In this case, the rib lines, which are separated from each other by fine lines, show prominently on one side of the cloth only.

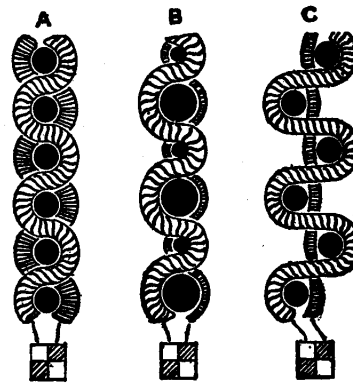


Fig. 94.

In another method of producing a warp rib structure in plain weave the odd ends are brought from one warp beam, and the even ends from another beam. One beam is much more heavily tensioned than the other, with the result that the heavily tensioned ends lie almost straight in the cloth and force the picks into two lines. The lightly tensioned ends are therefore compelled to bend round the picks in the manner illustrated at C in Fig. 94, so that horizontal ridges and depressions are formed in the cloth. The rib formation is quite prominent if all the ends are equal in thickness, but it is still more pronounced if the lightly tensioned ends are thicker than the others.

Methods of Increasing the Prominence of the Ribs.—In warp ribs, instead of one very thick end, two or more ends (which work together as one) may be employed to each fine end, and the ends may be placed at different tensions; while the weft may be either all alike, or arranged in the order of a thick and a fine pick alternately. The structures are similar to that represented at B in Fig. 94, except that the ends which form the rib spread out more and cover the surface better. A cotton cloth which is made in imitation of "pique," is constructed on the principle illustrated at C in Fig. 94, but with two slack ends to each fine tight end, and the following

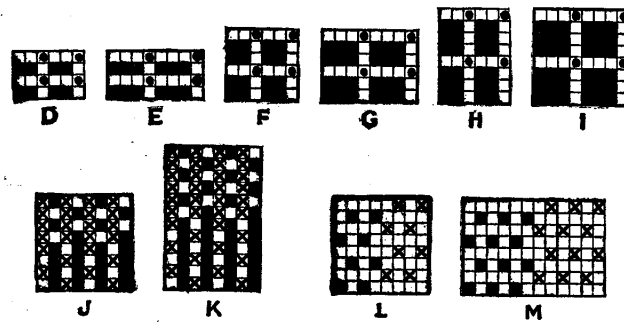


Fig. 95.

are suitable particulars:—32's cotton warp, 126 ends per inch; 16's cotton weft, 40 picks per inch. If consecutive ends that work alike are passed through the same mail, the latter should be provided with a separate eye for each thread.

Warp rib structures with two and three ends to each fine end are represented in full on design paper at D and E respectively in Fig. 95. The weave D is exactly the same as that given at L in Fig. 3 (p. 5), which is described as a weft rib, from which it will be evident that the same weave can be used in producing entirely different structures. If the number of ends per unit space largely exceeds the number of picks, the weave D produces a warp rib, but under the opposite conditions a weft rib is formed, the structure also being affected by the relative thicknesses of the threads. For example, the weave given at D in Fig. 95 yields a warp-rib structure with the particulars given above for an imitation pique; whereas with the following weaving particulars, a weft-rib structure is formed:—Warp—2 ends, 2/30's cotton, 1 end, 40's cotton, 50 ends per inch; weft—20's cotton, 104 picks per inch.

The rib lines may be made to show more prominently by passing the ends which form the rib over two thick picks and under one fine pick, in which case the weaves will be represented in full on design paper, as shown at F and G in Fig. 95; while still greater prominence is imparted to the rib lines by arranging the weaves, as shown at H and I, to suit a 3-and-1 order of wefting. In looms with changing

boxes at one side only, a 2-and-2 order of wefting may be employed for the designs H and I; one of the fine picks going into the same shed as the two thick picks. The weaves D to I in Fig. 95 form the foundation of "matelasse" fabrics; and good warp-rib structures result, if the warp is properly set, when the weft is all of the same thickness.

Soleil Weaves.—The designs, given at J and K in Fig. 95, produce a type of warp rib to which the term "soleil" is applied. In order to more fully develop the horizontal rib lines the warp threads are sometimes arranged alternately right and left hand twist, the direction of the twist in one rib line being thus opposite to that in the next line. For piece-dyed fabrics the reverse twist yarn is usually

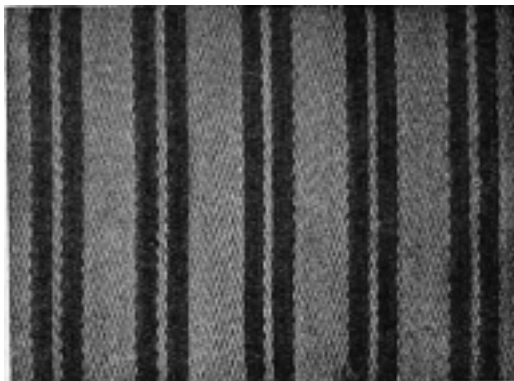


Fig. 96.

tinted with a fugitive colour in order that it may be distinguished from the grey ordinary twist yarn during the beaming, healding, and weaving operations.

The designs L and M in Fig. 95 are constructed on the same principle as J and K, but in this case the surface of the cloth is covered by longitudinal weft cords (the marks indicate warp up). A pick-and-pick order of wefting, either in different colours, twists, or materials, may be employed.

Combination of Weft Cords with Other Weaves.—The arrangement of weft cords in stripe form with another weave is illustrated by the fabric represented in Fig. 96, and by the designs N to V in Fig. 97.

A weft-cord stripe is produced in plain cloth by introducing one or more thick ends, or by working together several ends of the ground warp, at intervals. (A plain corded zephyr fabric is represented at E in Fig. 2, p. 3.) The cord ends do not take up so rapidly as the ground ends, therefore unless they

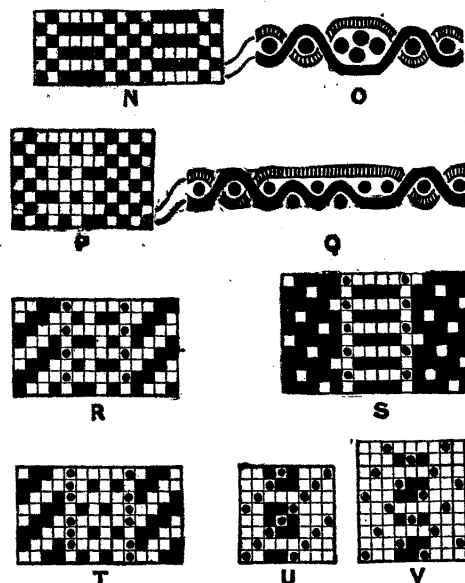


Fig. 97.

are brought from a separate beam, a difficulty is liable to be caused in weaving. The design N in Fig. 97 shows a simple form of cord combined with plain weave, which is produced by working four ends together in one split of the reed. The four ends group together, as represented in the drawing given at O, and if they

are in the same colour as the weft solid narrow lines of colour are formed in the cloth. A wide cord is obtained by denting a number of ends in two or more splits of the reed, and interweaving the weft on the underside, as shown at P (the marks indicate warp up). The picks interweave in nearly plain order on the underside, as represented in the diagram Q, so that the cord is kept out to the full width.

The designs R and S in Fig. 97 illustrate the combination of weft cords with other weaves than plain; 2-and-2 twill and 5-thread sateen respectively being shown in the examples. If the cords are required to show very clearly, they should be stitched at each side with a plain end, as shown in R and S. The design T also shows a weft cord combined with 2-and-2 twill, but in this case the stitch ends at the sides are arranged to interweave with the same degree of firmness as the ground ends. The cords, however, are not so clearly defined as when the stitching ends at the sides work in plain order. The designs U and V in Fig. 97 show how weft cords may be constructed to cut with a given warp-face ground weave; the marks in this case indicating weft up.

CORKSCREW WEAVES

Weaves of the corkscrew type, which are really twilled ribs, are used either alone or in combination with other weaves for a variety of purposes. In their simplest form they produce either a warp or a weft surface; and they are most regular in construction when the repeat contains an odd number of threads. A warp corkscrew stripe fabric is represented in Fig. 227, which, if turned one-quarter round, also illustrates the appearance of a weft corkscrew texture.

Warp Corkscrew Weaves.—Ordinary weaves of this class are constructed on a sateen base counting 2 outwards, as shown at A, B, and C in Fig. 98, which repeat on 7, 9, and 11 threads respectively. If the marks of the designs indicate warp up, as many marks are added vertically to each sateen base mark as will make each vertical space contain one mark more than it contains blank squares. Thus, in the 7-thread warp corkscrew, shown at D in Fig. 98, each vertical space contains four marks and three blanks; in the 9-thread weave E, five marks and four blanks; and in the 11-thread design F, six marks and five blanks. From an examination of the drawing given at G, which represents how the threads 1 and 2 of the design F interlace, it will be seen that the face and back of the cloth are nearly alike, the warp preponderating on both sides.

Sometimes, in order to make the weaves firmer, the floats on the back are stitched in the method indicated at H in Fig. 98, which shows the design F modified. The threads then interlace, as represented at I, the floats on the face not being interfered with, whereas on the back the threads form nearly plain weave.

In constructing warp corkscrew weaves that repeat on an even number of threads, it is necessary to employ a modification of the foregoing method. As shown at J and K in Fig. 98, which represent the bases of the 8- and 10-shaft warp corkscrew weaves respectively, the repeat is upon twice as many ends as picks. A base line of marks, as shown by the crosses, is inserted on the odd vertical spaces, counting 2; then a second line—indicated by dots—is run in on the even vertical spaces, as centrally as possible. The design is completed by arranging each vertical space with two more marks than blanks, as shown at L, or with the marks and blanks equal, as represented at M. In the latter case, however, the weft shows slightly on the surface of the cloth.

The standard 13-shaft warp corkscrew, which has been extensively used for fine worsted coatings, is based on a 13-thread sateen, counting 4 outwards, as shown at N in Fig. 98. Marks are added to the base marks in the order of 4, 2, 4, and 2, as indicated at O, and very flat twill lines are formed in the cloth, as represented by the different marks in the design.

Weft Corkscrew Weaves.—These are exactly the opposite of the warp corkscrews, and when the repeat contains an odd number of threads, are constructed

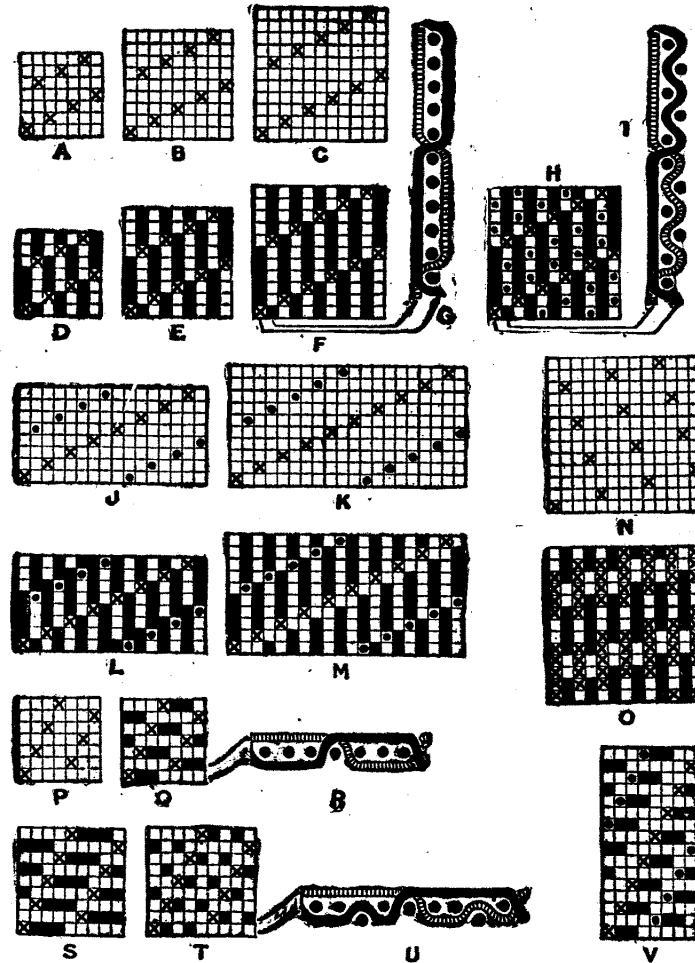


Fig. 98.

on a sateen base, counting 2 upwards. Marks are then added horizontally to the base marks, and if warp float is indicated, the number of marks on each horizontal space should be one less than the number of blanks. Thus, P in Fig. 98 shows the basis of the 7-thread weft corkscrew, and Q the complete design; while R represents how the picks 1 and 2 interlace with the ends, a weft surface being formed on both sides. The 9-thread weft corkscrew is given at S, and the same weave with the

weft stitched on the under side at T. The drawing U represents the interlacing of the picks 1 and 2 of T, and shows how the cloth is made firmer on the under side without the face floats being affected. The design V illustrates the method of constructing an 8-thread weft corkscrew. The systems of applying colour to corkscrew weaves, and special modifications of the structures are described and illustrated in Chapter XIII.

Modified Rib and Cord Weaves.—Very neat and effective designs are constructed by commencing a rib weave in a different position in succeeding sections. Thus,

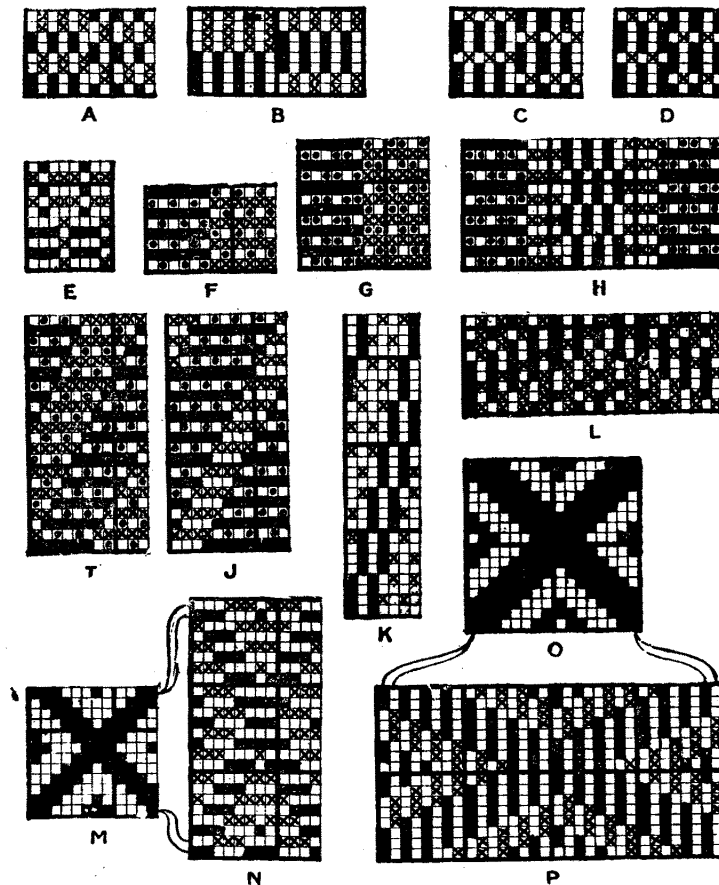


Fig. 99.

in Fig. 99 A shows a 2-and-2 warp rib arranged in sections of 6×6 , and B a 4-and-4 warp rib in sections of 8×8 ; while at C and D a 3-and-1 warp rib is indicated in sections of 6×6 , and 5×5 respectively, the latter forming more of a warp surface than the former. The designs A to D are effectively developed by colouring the ends in the order indicated by the different marks. E in Fig. 99 shows a weft rib arranged on the same principle as D.

Longitudinal Warp Cords.—The designs F and G in Fig 99 are cord weaves

which produce longitudinal cut lines at intervals of six ends. In F the first six ends interweave in plain order on the odd picks, and are raised on the even picks, while the second six ends are raised on the odd picks and interweave plain on the even picks. The change in the interlacing of the weft from plain weave to float at the back, and *vice versa*, causes a fine line or cut to be made every six ends. The design G is similar to F except that the plain weave is replaced by 2-and-1 warp twill, which brings the warp more prominently to the surface, while the direction of the twill is reversed in succeeding sections so as to develop the cut line more clearly. The design H shows the weave given at G combined with ordinary warp and weft rib weaves.

Diagonal and Waved Ribs.—Different methods of constructing ribbed diagonals are illustrated at T, J, and K in Fig. 99. In the design T the two weaves, indicated at F, are arranged in diagonal form, while in J a weft rib is combined diagonally with one of the weaves given at F. The design K shows a very steep diagonal in which 4-and-4 warp and weft ribs are combined.

The design L in Fig. 99 shows a waved rib structure which is constructed on the basis of the soleil weaves given at J and K in Fig. 95.

Diamond Ribs.—A method of constructing elaborate weft rib designs, to suit a pick-and-pick order of wefting, is illustrated by the examples M and N in Fig. 99. The marks of M are indicated on the odd picks of the design N, as shown by the solid marks, then marks are inserted on the even picks, as shown by the crosses, to correspond with the blanks of M. By introducing about twice as many picks as ends per inch, the design N will produce an effect similar to M, but with a weft surface on both sides of the cloth; and if two colours of weft are employed in 1-and-1 order the same design is formed on both sides except that one colour replaces the other.

The examples O and P in Fig. 99 similarly illustrate the construction of fancy warp rib designs, the marks of O being indicated on the odd vertical spaces of P, as shown by the full squares; while marks are inserted on the even vertical spaces, as shown by the crosses, to correspond with the blanks of O. In this case about twice as many ends as picks are required, and by arranging the ends in two colours, 1-and-1, a reversible warp-faced design in two colours is formed. The colouring of cord weaves is described in Chapter XIII.

BEDFORD CORDS

Plain-Face Bedford Cords.—The Bedford cord class of weave produces longitudinal warp lines in the cloth with fine sunken lines between, as shown in the fabric represented in Fig. 100. The method of constructing the *ordinary* type of Bedford cord weave is illustrated in stages by the examples A to I in Fig. 101. At intervals pairs of ends work in perfectly plain order with the picks, therefore these lifts are first indicated, as shown at A, D, and G; the number of ends between the pairs of plain ends being varied according to the width of cord required. The next stage consists of inserting marks (which indicate warp float) on the first and second picks of alternate cords, and on the third and fourth picks of the other cords, as shown at B, E, and H. The object of arranging the marks of the cord ends in alternate order is chiefly to equalise the lifts of the ends. The designs are then completed, as shown at C, F, and I, by inserting plain weave on the cord ends, which joins with the plain working of the pairs of ends. The cord ends float over three picks and under

one, while the picks float in pairs on the back of one cord and interweave in plain order in the next cord, as shown in the drawing given at J, which corresponds with the design F. In the design C each cord is six ends wide, and in F eight ends wide; but I produces cords which vary in width in the order of 10, 8, 6, and 8 ends. Other widths and variations can be readily schemed.

The usual order of drafting is indicated at K in Fig 101, the plain ends being drawn on the healds at the front. The weaving plan is a combination of plain and 3-and-1 twill shedding, as shown at L. In order to fully develop the sunken lines, the plain ends should be separated by the splits of the reed, as shown in the denting plan given at M; in some cases, however, the pairs of plain ends are dented together as indicated at N. Two, three, or more ends are passed through each split according to the fineness of the cloth (two ends per split are indicated in M and N); and some times the plain ends are woven two per split, and the cord ends three or four per split. The number of ends in the width of a cord has some influence upon the order of denting.

Wadded Bedford Cords. —

These structures contain thick wadding or padding ends which lie between the rib face cloth and the weft floats on the underside; the object of the arrangement being to give greater prominence to the cords. The method of introducing wadding ends in to the designs C, F, and I is illustrated by the examples O to T in Fig. 101; the arrows indicating the positions where these ends are introduced. The wadding ends, which are represented in O, Q, and S by the shaded squares, are additional to the ordinary

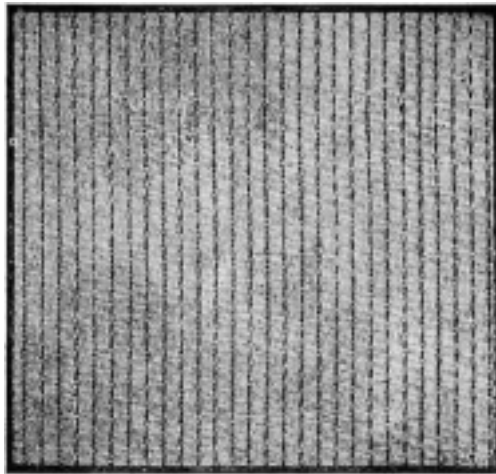


Fig. 100.

ends. In the complete designs given at P, R, and T they are raised where the picks float at the back, as shown by the crosses, and are left down where the picks interweave in plain order. The order in which the picks interlace with the ends is illustrated by the diagram given at U, which corresponds with the design R. The draft for the design P is indicated at V, and the pegging-plan at W; while X shows a method of denting which is based upon two ends per split, the wadding ends being dented extra. The number of wadding ends to each cord may be varied according to requirements.

The designs may be arranged with an odd number of ends (not including the wadding ends) to each cord, but it is then necessary to reverse the marks of alternate pairs of the plain ends, in order that the plain weave will join correctly. An example, without wadding ends, is given at Y in Fig. 101, which contains seven ends in each cord stripe. Suitable weaving particulars of a Bedford cord are:—Face warp, 30's cotton, 108 ends per inch; wadding warp, 2/20's cotton; weft, 36's cotton, 84 picks per inch.

Crepon Bedford Cords.—In both worsted and cotton cloths, hard-twisted (crimp) weft is sometimes used, the excessive shrinking of which causes the cords to stand up very prominently. The design Z in Fig. 101 is specially arranged to suit an order of wefting in which two picks of hard-twisted weft alternate with two picks of ordinary weft; the former floating on the underside of the cords. Each section of the design, which is enclosed by brackets, should be repeated about four times; it will be noted that the plain ends in one section are mid-way between those in the other section. In the process of finishing the hard-twisted weft floats on the

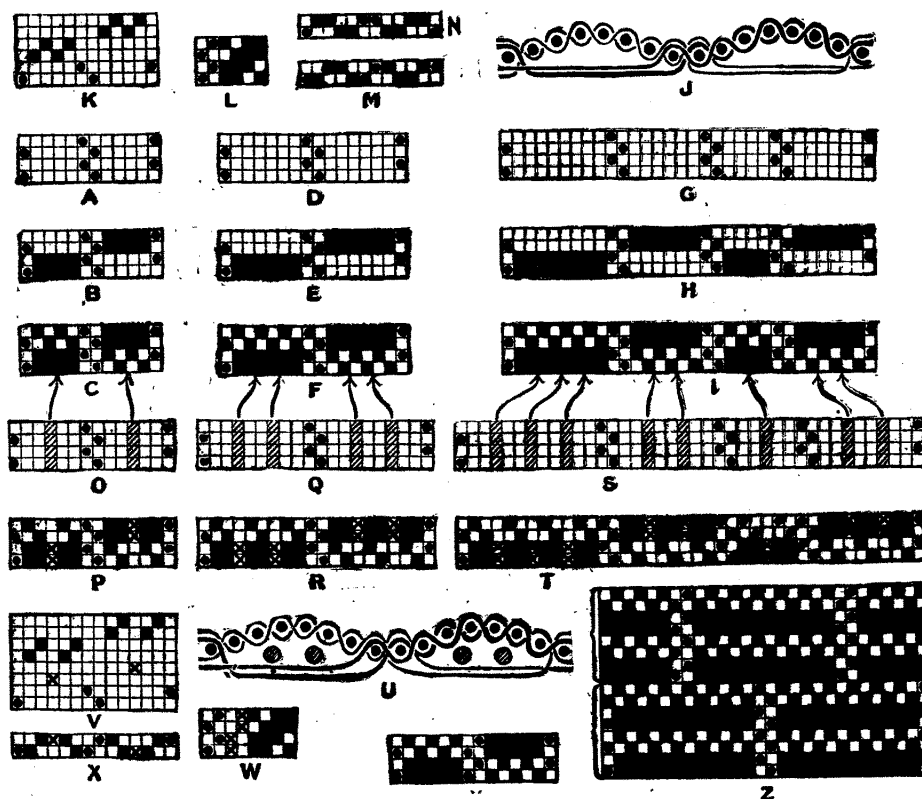


Fig. 101.

under side shrink extremely, and an irregular or "crepon" surface is imparted to the cloth.

Bedford Cords, arranged with Alternate Picks.—Bedford cords are also made with alternate picks floating at the back, in which case the pairs of plain ends require to be indicated in reverse order. An example, in which each cord is ten ends wide on the surface, is shown worked out in stages, at A to E in Fig. 102. The marks of the pairs of plain ends are indicated, as shown at A; then marks, which cut with the plain marks, are inserted on alternate horizontal spaces, as represented at B. Afterwards, plain weave is inserted on the blank horizontal spaces of the cords, as indicated at C, but in this case the plain does not join perfectly with the plain marks of

the pairs of ends. If wadding ends are introduced in the positions indicated by the arrows, the complete arrangement of the ends will be as shown at D, in which the

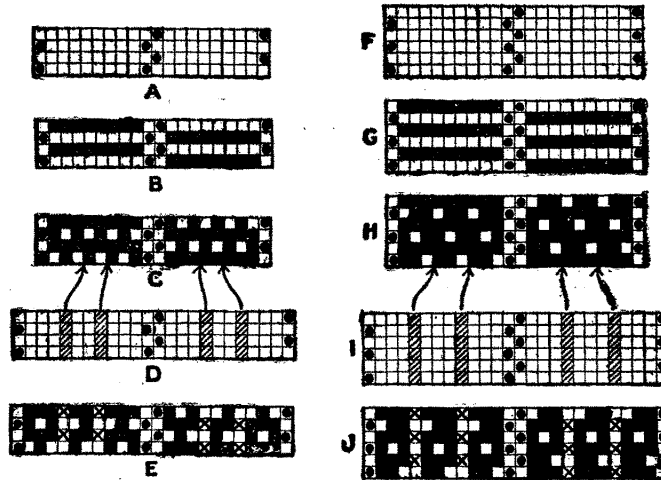


Fig. 102.

shaded marks represent the wadding ends. The complete design is given at E, in which the wadding ends are shown raised over the picks which float at the back.

Twill-Face Bedford Cords.—Another modification of the Bedford cord structure consists of using a warp twill instead of plain weave for the picks which interweave on the face of the cord stripes, the warp being thus brought more prominently to the surface. The examples F to J in Fig. 102 illustrate the different stages in designing a cord eleven ends wide on the face, in which 2-and-1 twill is employed for the face picks. H shows the complete design without wadding ends, while J shows H modified so as to include wadding ends, which are introduced in the positions indicated by the arrows below H. It will be seen by comparison that C and E in Fig. 102 are modifications of the design given at F in Fig. 99, and in the same manner H and J in Fig. 102 are modifications of G in Fig. 99.

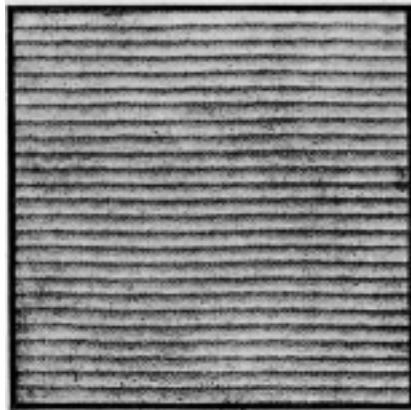


Fig. 103.

WELTS AND PIQUES

A typical pique structure consists of a perfectly plain face fabric composed of one series of warp and one series of weft threads, and a series of back or stitching warp threads. The stitching ends are placed on a separate beam which is very

heavily weighted, whereas the face ends are kept at moderate tension. At intervals the tight stitching ends are interwoven into the plain face texture, with the result that the latter is pulled down and an indentation is formed on the surface. In order to increase the prominence of the unstitched portions of the cloth, it is customary to insert wadding picks between the tight back stitching ends and the slack face fabric.

Ordinary Welt Structures.—The term “welt” is applied to the pique structure when the indentations form continuous sunken lines or cuts which run horizontally

in the cloth, as shown in the fabric represented in Fig. 103. The number of face picks in the width of a cord is varied according to requirements, but usually the number of consecutive picks that are unstitched should not exceed about twelve. The construction of the designs is illustrated in stages in Fig. 104, in which A, E, I, and M represent the first stage of weaves repeating on 6, 8, 10, and 18 picks respectively; the plain weave of the face fabric is indicated by the dots, while the positions of the stitching ends is shown by the shaded squares. The ends are arranged in the order of 1 face, 1 stitching, and 1 face, in each split of the reed, or in the proportion of 2 face to 1 stitching end. The complete designs (without wadding picks), to correspond with A, E, I, and M, are given respectively at B, F, J, and N in Fig. 104, the solid marks indicating the lifts of the tight stitching ends into the plain face texture on two consecutive picks. In the design B there are four picks between the indentations or cuts, in F six picks, and in J eight picks; but in the design N, which produces two sizes of cords in the cloth, there are ten and four picks alternately between the cuts.

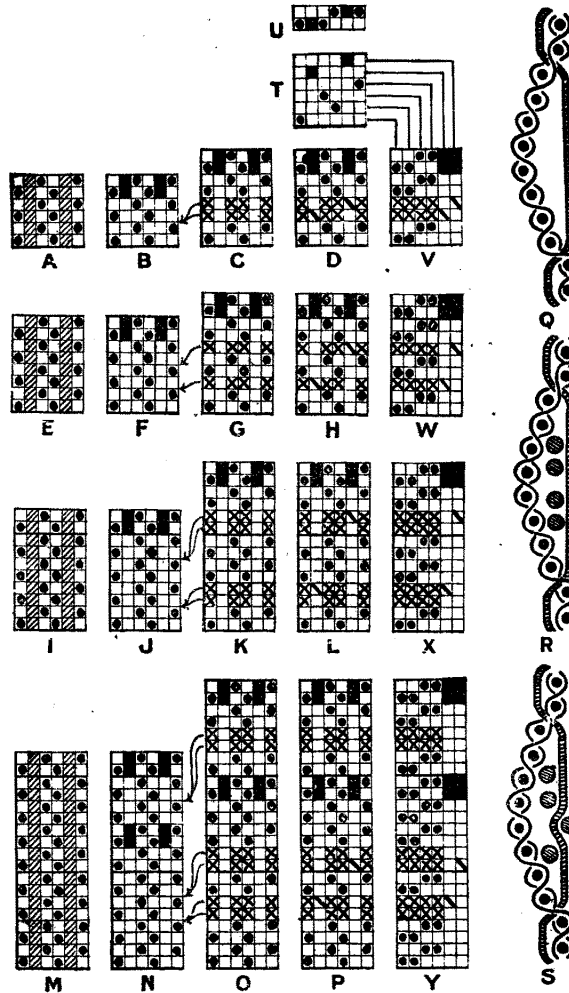


Fig. 104.

Weft Wadded Welts.—The designs C, G, K, and O in Fig. 104 illustrate the method of inserting wadding picks (the positions of which are indicated by the crosses) into the respective designs B, F, J and N; the object being to increase the prominence of the horizontal cords, and to make the cloth heavier and more substantial. Usually the wadding weft is thicker than the ground weft, and is inserted two picks at a place, as shown in C, K, and O; the looms being provided with changing shuttle boxes at one side only. Sometimes, however, the same kind of weft is used for both the face and the wadding, looms with a single box at each side being employed; and, in such a case, one wadding pick at a place may be inserted, as shown in the design G. Again, in some cloths thick wadding picks which are inserted in pairs, are supplemented by single wadding picks of the face weft. All

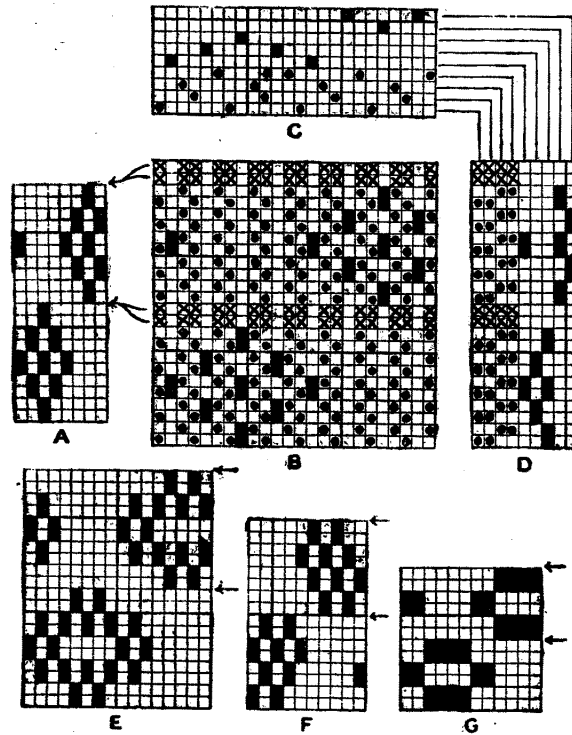


Fig. 105.

the face ends are raised when the wadding picks are inserted, as indicated by the crosses in the designs, while the stitching ends are left down.

Fast-Back Welts.—In each of the foregoing designs, the stitching ends are only lifted to form the indentations, the term "loose-back" being applied to this type of structure. The term "fast-back" is applied to cloths in which all, or a portion of the wadding picks are interwoven in plain order with the stitching ends. The designs D, H, L, and P in Fig. 104 show the respective designs C, G, K, and O made fast back, the diagonal strokes indicating where the stitching threads are raised over the wadding picks. In the designs D

and H all the wadding picks are thus interwoven, but in the design L only one of each pair, and in P only the two wadding picks in the centre of the broad cord, are woven plain.

The drawings Q, R, and S, in Fig. 104, which respectively correspond with the designs J, K, and L, show how the threads interlace with the picks in the three types of structures, viz., loose-back without wadding picks; loose-back wadded; and fast-back wadded.

The order of drafting is indicated at T in Fig. 104 and the denting plan at U, each split containing a stitching end between two face ends. The pegging plans for the designs D, H, L, and P, are given respectively at V, W, X, and Y.

Waved Piques.—A waved pique is a simple modification of the welt structure in which the indentations are not in a horizontal line but are arranged in alternate groups, as shown at A in Fig. 105, the marks in which indicate the lifts of the stitching ends on the face picks. The groups of marks do not overlap horizontally, as one commences on a face pick immediately following that on which the other has finished. Between succeeding groups two wadding picks are inserted, as indicated by the arrows at the side of A in Fig. 105. The complete design to correspond with A is given at B, in which the ends are arranged in the same order as in a welt, while there are ten face picks to two wadding picks. The lifts of the tight stitching ends force the wadding picks first in one direction and then in the other, so that waved

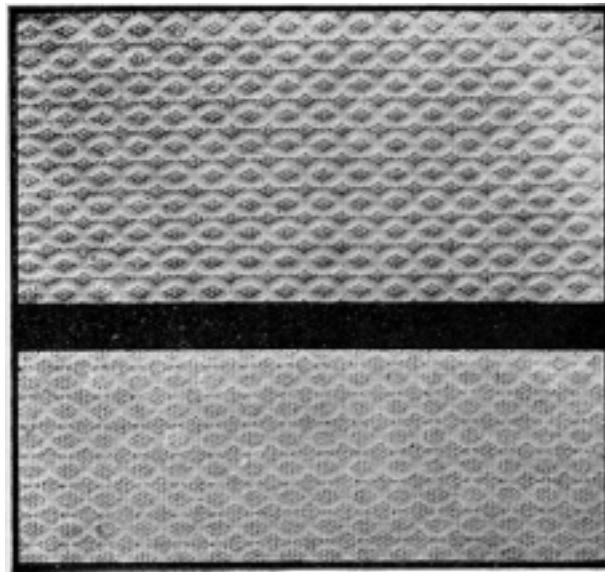


Fig. 106.

lines are formed across the cloth. This is shown in Fig. 106, which represents in the upper and lower portions respectively, the face and underside of a cloth that corresponds with the design B in Fig. 105. The draft of the design is given at C, and the pegging plan at D in Fig. 105. Other motive designs for waved piques are given at E, F, and G in Fig. 105, which are respectively arranged, as indicated by the arrows, to suit the introduction of 10, 8, and 6 face picks between the wadding picks. Suitable weaving particulars of a pique cloth are:—Face warp, 40's cotton, stitching warp, 28's cotton, 72 face and 36 stitching ends per inch; face weft, 50's cotton, 96 picks per inch, wadding weft, 20's cotton.

CHAPTER VIII

STRIPE AND CHECK WEAVE COMBINATIONS

Forms of Stripes and Checks—Selection of Weaves—Joining of Weaves—Relative Firmness of the Weaves. Classification of Stripe and Check Designs—Effects produced in one Weave turned in opposite directions—Combinations of Weaves derived from the same Base Weave—Combinations of Warp and Weft-Face Weaves—Arrangement of Weaves in Dice Check Designs—Method of Over-Checking Warp Sateen Weaves—Rib and Cord Stripes and Checks—Combination of different Weaves. Construction of Designs upon Motive Weave Bases.

STRIPE and check designs result from the combination, in equal or unequal spaces, of two, three, or more weaves or weave variations. Weaves that are suitable for combining in stripe form can very frequently be combined also in check form, while each transverse section of a check design, can generally be used alone in forming a stripe pattern. For these reasons, and in order to avoid repetition, the two classes of designs are described and illustrated together. The introduction of differently coloured threads may modify the appearance of both stripe and check weave combinations to a considerable extent, as shown in Chapter XII, but here only weave structure is considered.

Forms of Stripes and Checks.—Weave combinations are employed in nearly all kinds of fabrics and in every class of material; the kind of cloth to be woven, and its purpose, largely influence the form or style of the design, and the selection of the weaves that are combined. As a rule, very diverse form is more suitable for stripes than for checks, because in the latter the surface of the cloth is more broken up by the weave changes than in the former. In both styles the form should be originated, not haphazardly, but orderly; the degree of contrast of space and of weave between the several sections being kept clearly in mind.

The examples given in Fig. 143, in which the different markings may be taken to represent different weaves, illustrate a method of designing a range of stripe patterns by "modification," a commencement being made with a simple equal stripe. Greater diversity can be obtained than is shown in the examples by combining three or more different weaves. Fig. 107 illustrates the various forms of weave checks that are in general use, and in this case also it will be understood that different weaves may be introduced in a more varied manner than is indicated by the different markings. Thus, the form shown at A, in which the sections are equal in size, permits of the combination of two, three, or four weaves, although two only are employed most frequently. The pattern indicated at B, in which the spaces vary in size, is particularly suitable for the combination of three weaves, the large and small squares being in different weaves, and the oblong spaces both in a third. C and D are modifications of A, while E shows a further development than B of the combination of spaces of different sizes. The "set" form of check, indicated at F, is too stiff for ordinary purposes, but the introduction of an overcheck, as shown at G, greatly improves the effect, particularly if the overchecking lines are emphasised. Such arrangements as those given at H and I are especially useful when it is desired to show an expensive material prominently on the surface.

Selection of Weaves.—In selecting weaves for combination it is necessary to take into account the nature of the cloth as to: (a) the class of material; (b) the thickness of the threads and the number of threads per unit space; and (c) the kind of finish that is applied. Either simple or elaborate weaves may be employed when the threads are smooth and even—*e.g.*, silk, cotton, linen, and worsted yarns—and if the finishing process removes the loose fibre from the surface of the cloth; because the smooth thread structure that is formed renders the weaves clearly

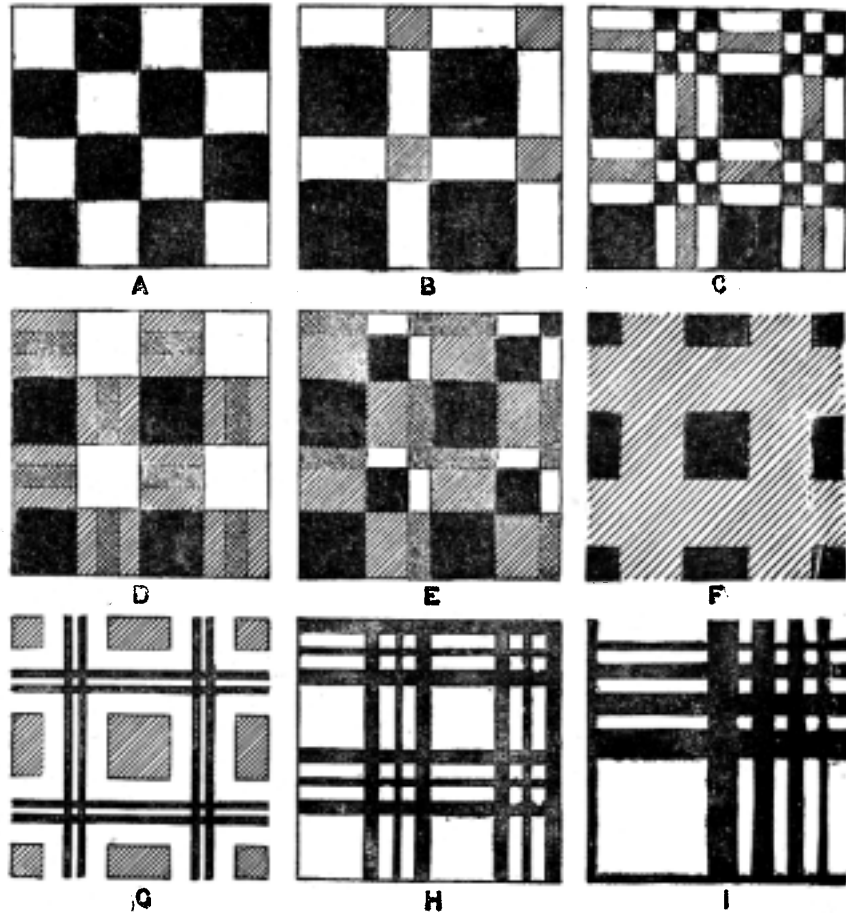


Fig. 107.

apparent. Woollen cloths vary considerably according to the class of yarn that is used and the finish that is employed, but as the threads, in any case, are somewhat rough and uneven, weaves of a fancy character are usually unsuitable. The finest woollen cloths, which are finished with a clear face, however, admit of the combination of such weaves as twills, sateens, whipcords, ribs and corkscrews, but for similar cloths which have a raised or "dress" face, and for rough cheviots and tweeds, only the very simplest weaves are suitable. When different materials are used in

a cloth weaves should be employed which will bring the better and more expensive threads chiefly to the surface.

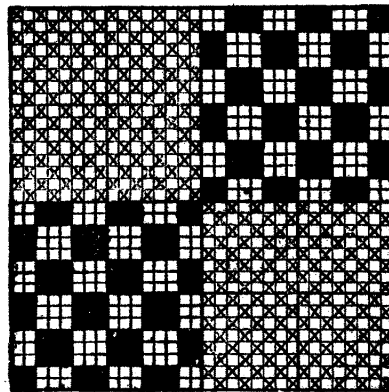
More elaborate weaves may be employed in fine yarns and fine setts than in thick yarns and coarse setts, because in producing a given length of float more threads are passed over in the former case, which enables more detail to be introduced in the weaves.

In any material, if a raised finish is applied, the weave structure is more or less concealed by the surface fibres, hence it is useless to employ elaborate weaves. A clear finish, on the other hand, develops the weaves so that a design is shown under the most favourable conditions.

Joining of Weaves.—It is very important to avoid the formation of long floats where the different sections of a design are in contact. Certain equal-sided twills, and weaves that are the reverse of each other, may be arranged to cut at the junctions—that is, with warp float against weft float. If the weaves will not cut they require to be carefully joined together, and, if possible, no longer float should be made at the junctions than there is in the weaves



A



B

Fig. 108.



Fig. 109.

that are combined. In joining the weaves vertically the prevention of long weft floats on the face side of the cloth is of most importance, whereas at horizontal junctions (in check designs) long surface warp floats have chiefly to be avoided. Long floats on the underside are of secondary importance, but they should be prevented as much as possible. Sometimes it is necessary to modify one or both weaves where they are in contact in order to make them join properly, and in some cases a weave with a minimum length of float—such as plain—is introduced between two weaves.

Relative Firmness of the Weaves.—In stripe designs, if the warp is brought from one beam, the weaves that are combined should be similar in firmness. If there is much difference in the relative number of intersections in the weaves, the ends should be brought from separate beams to correspond, in order that the take-up of each series may be properly regulated. For example, the plain ends of the stripe design given at A in Fig. 108 will take up much more rapidly than the ends that

form the 3-and-3 hopsack, hence if all the warp is brought from one beam the plain ends will become very tight, and the others slack. This will not only make it very difficult, if not impossible, to weave the cloth, but will result in the fabric having an uneven or "cockled" appearance. In check designs similarity in the firmness of the weaves is not of the same importance, because succeeding sections of the design compensate for one another, so that the average take-up of the ends is about equal. Thus, 3-and-3 hopsack weave and plain, when combined in check form, as shown at B in Fig. 108, will weave all right, except that in a heavily wefted cloth the picks tend to group together in the hopsack sections, and to spread out in the plain sections, and, therefore, are distorted in the cloth. This is illustrated in Fig. 109 in which a fabric is represented that is woven in a check combination of 3-and-3 hopsack and plain weave similar to the design B in Fig. 108.

CLASSIFICATION OF STRIPE AND CHECK DESIGNS

Stripe and check weave combinations may be conveniently classified as follows:—

- (1) Designs in which the same weave—usually a twill—is used throughout, but turned in opposite directions.
- (2) Designs in which the sections are in different weaves that are derived from the same base weave.
- (3) Combinations of warp and weft face weaves.
- (4) Combinations of different weaves.

Effects produced in one Weave turned in opposite directions.—A stripe weave of this class is shown in Fig. 110, which represents a fabric that is composed of 2-and-2 twill running to left and to right, as indicated in the corresponding design given at C in Fig. 111. The dots in the design C indicate positions where coloured ends are introduced in the cloth. The form of the stripe is similar to that shown at B in Fig. 143.

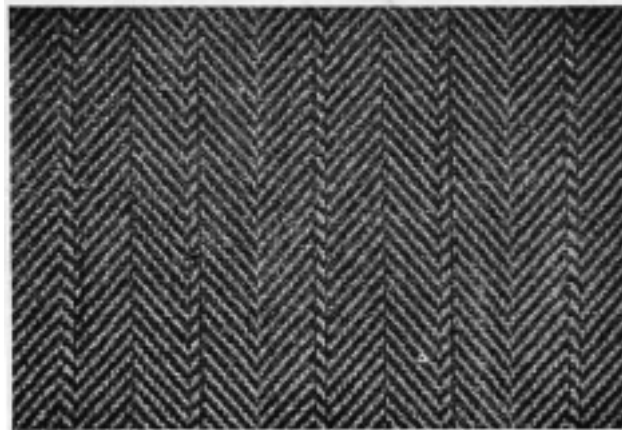


Fig. 110.

Examples of check designs are given at D and G in Fig. 111, the former of which is constructed in the form represented at B in Fig. 107, and the latter in the form shown at A. In the design D each section consists of 3-and-3 twill, and in G of a 3-and-3 twill derivative, both designs being capable of being drafted on to six healds, as shown at E and H respectively. Each draft is in two sections, and by using reversed 3-and-3 twill pegging plans, as indicated at F and I, the check designs are formed; whereas if an ordinary 3-and-3 twill weaving plan is employed stripe

designs, consisting of the first six picks of D and G, will result. An example of a 2-and-2 twill check design is given at D in Fig. 206.

In fine warp-face cloths, such weaves as warp sateens, warp twills, whip-cords, and warp corkscrews—twilling in opposite directions—are suitable for stripe patterns when a strong contrast between the sections is not desired. Mostly, however, they are not fit for checks, because the preponderance of warp float makes it impossible, as a rule, to avoid the formation of long surface floats at the horizontal junctions. J in Fig. 111 shows a stripe design composed of a warp-faced 10-thread twill, while K shows a whip-cord weave arranged in stripe form.

In the foregoing designs the difference of effect, due to reversing the direction

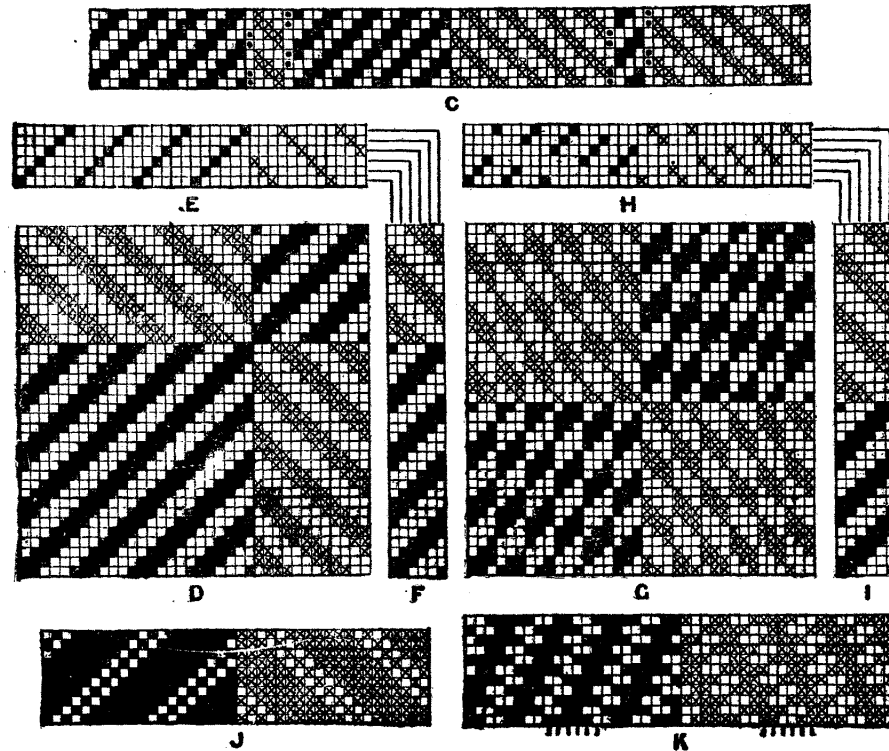


Fig. 111.

of the weave, is emphasised by the twist of the yarns alternately running with and opposing the direction of the twill. A useful method of varying the appearance of the designs, particularly of the stripe patterns, consists of employing both right and left-hand twist in the threads. Thus, each section of the design K in Fig. 111 might be arranged in the warp in the order of 8 ends right-hand twist, 6 ends left-hand twist, and 8 ends right-hand twist; the left-hand twist ends occupying the positions indicated by the marks below K.

Combinations of Weaves derived from the same Base Weave.—When the same base weave is used throughout a design, two or more different systems of drafting are employed; a stripe design resulting from a simple weaving plan, while a check design is formed by constructing the pegging-plan in sections upon bases which corres-

pond with the draft. For instance, the design given at L in Fig. 112, which is based upon an 8-thread twill weave, is produced by means of a combination of straight and sateen drafting, as indicated at M. If the straight twill given in the lower portion of the plan N is used for the weaving plan, a stripe design will be formed consisting of the first 8 picks of L; whereas the complete check design results from using the whole of the plan N for the pegging-plan. It will be seen that the shaded squares in N, which show the basis of the pegging plan, are arranged vertically

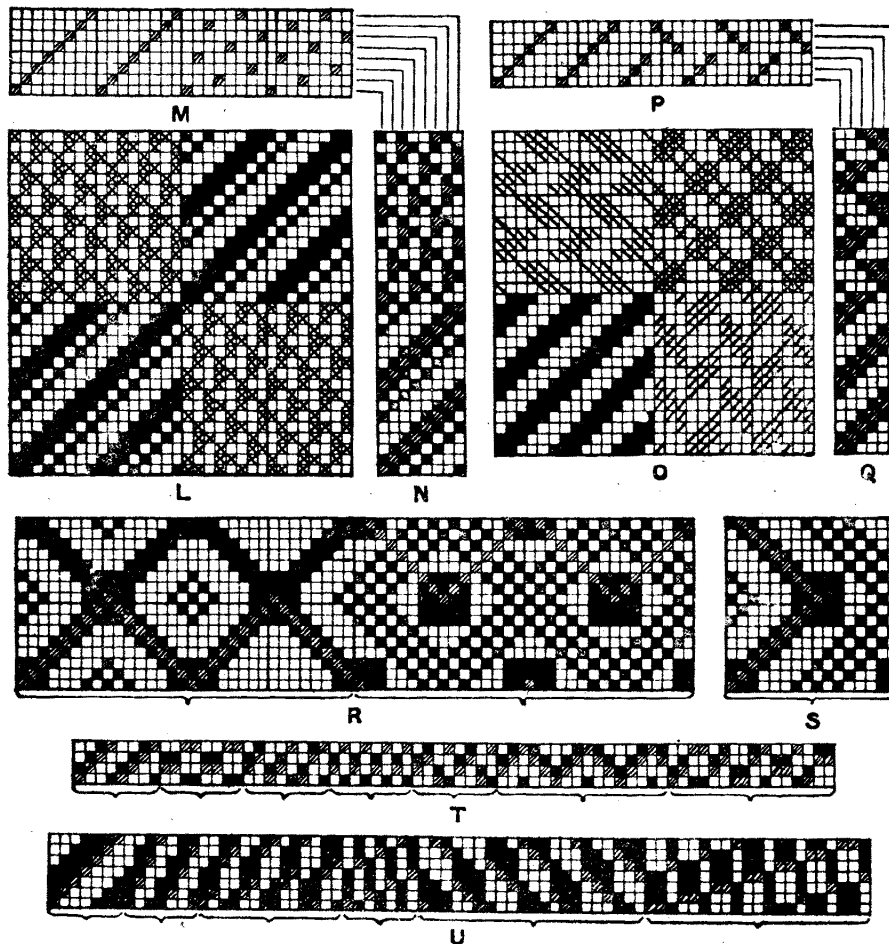


Fig. 112.

in the same order as the marks are indicated horizontally in the draft M. The twill weave shown in the upper right-hand section of L is produced by the combination of a sateen draft and a weaving plan that is based upon the sateen. It does not necessarily follow that such a result will be obtained in all cases, as sometimes the combination simply produces another sateen re-arrangement of the twill.

The design given at O in Fig. 112 illustrates the construction of a check design

by combining weaves that are based upon 3-and-3 twill. The draft, which is indicated at P, is in straight and broken order alternately, and corresponds with the basis of the pegging-plan given at Q. In this case the check design is composed of

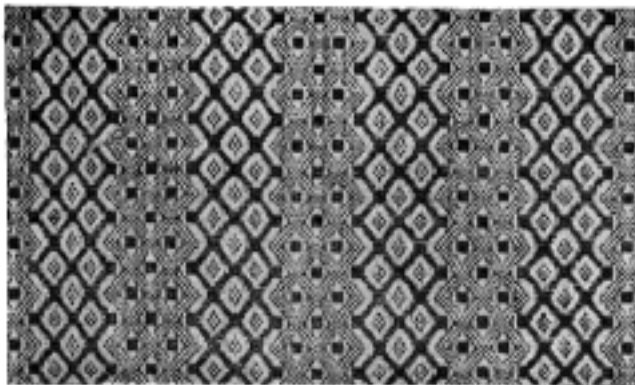


Fig. 113.

four different weave effects, which is due to the marks of the twill having been added horizontally to the base marks in the upper portion of the pegging-plan Q. Other bases may be combined on the same principle as in the foregoing examples, but if care is not taken in selecting a suitable base weave, and in arranging the different sections, bad floats at

the junctions of the weaves may readily occur, particularly in check designs.

A stripe fabric is represented in Fig. 113, for which the corresponding design is given at R in Fig. 112. The pattern results from the combination of a fancy pointed draft (which is indicated by the shaded squares in the design R) and the spotted zig-zag pegging-plan, shown at S. The draft is in two sections, as indicated by the brackets below R, in the first of which the threads are arranged

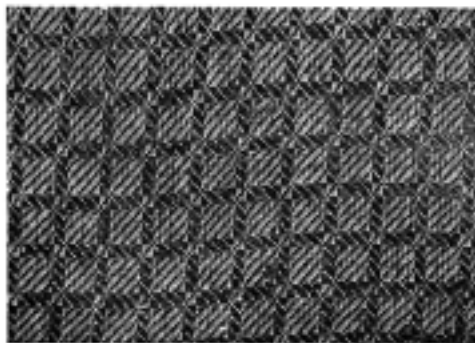


Fig. 114.

8 to right and 8 to left, and in the second 8 to left and 8 to right. The symmetry of the design is due to the pegging-plan S having been built up similarly on each side of a base line which runs vertically in the order of 8 to right and 8 to left.

Stripe designs which result from the combination of different orders of drafting are less liable than checks to contain bad floats at the junctions, and they, therefore, give greater scope than the latter in producing

variety of effect. The examples T and U in Fig. 112, in which the different sections are indicated by brackets, are given simply to show how different weaves may be constructed and combined. Two or more of the sections may be used together, and each section be repeated a number of times, according to the size of pattern required. In each design the shaded squares indicate the bases of the weaves, and also the draft, while the weave in the first section forms the weaving plan. The pattern represented in Fig. 19 (p. 19) shows a combination of 5-thread sateen and 5-thread twill which has been woven by drafting

on five healds. The chief advantage of this system, and also of that illustrated in Fig. 111, is that the designs can be produced in a comparatively few healds; and, further, if the base weave can be woven by ordinary tappets, the stripe designs can be obtained without any modification of the loom. Check designs, however,

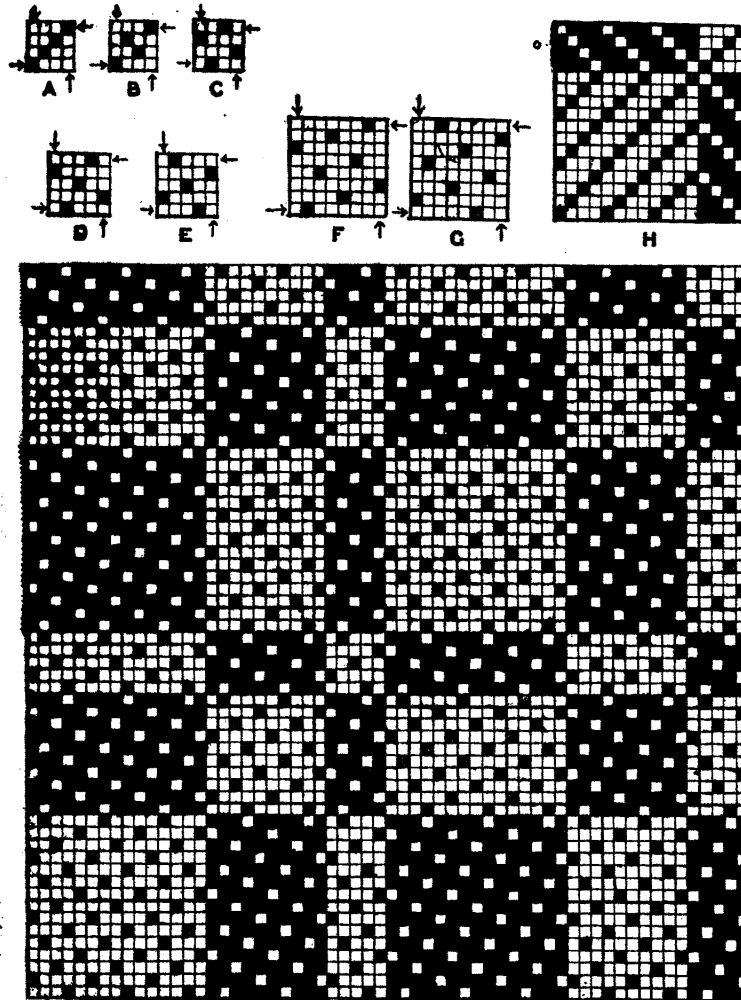


Fig. 115.

on account of the large number of picks in the repeat, require a dobby shedding motion even though the base weave repeats on a small number of threads.

Combination of Warp and Weft Face Weaves.—These produce the clearest effects in the cloth, particularly if there is a difference in colour between the warp and weft yarns. *Dice check* designs, a simple example of which is represented in Fig. 114, are produced on this principle by combining two opposite twill or sateen weaves. It is particularly necessary, in dice patterns, that the weaves cut at the

junctions both vertically and horizontally in order that the sections will be firmly bound at the edges; otherwise the outermost threads, which are floated, are liable to slip over the threads in the adjacent sections.

Arrangement of Weaves in Dice Check Design.—The principle of reversing, illustrated in Fig. 41 (p. 42), may be employed in the construction of dice checks, but the base weave requires to be constructed very precisely in order that a uniform design will result. The marks of the base weave should be arranged in such a manner that the first and last picks are alike, and also the first and last ends, when followed in opposite directions. The examples, given at A to G in Fig. 115, in which the arrows indicate the direction in which the threads should be followed, fulfil these conditions. For instance, in the plan F a mark is placed in the second square of the first pick, counting from the left, and in the second square of the last pick, counting from the right; and in the

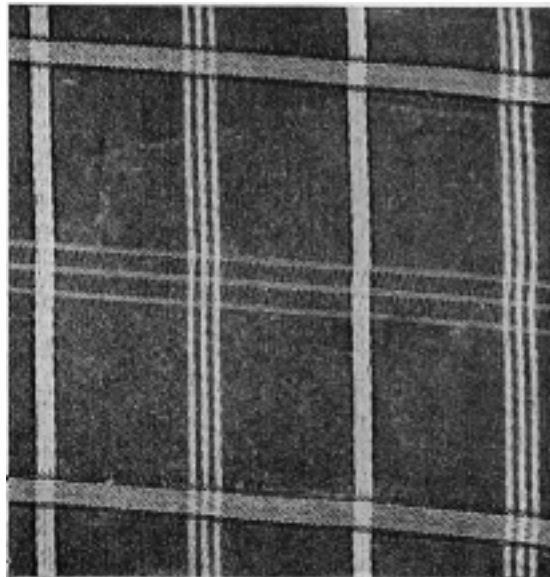


Fig. 116.

third square of the first end, counting from the top, and in the third square of the last end, counting from the bottom.

Twill base weaves are readily arranged by running a single line of marks through the centre, as shown at A in Fig. 115. The 4-thread sateen may be inserted in two positions, as indicated at B and C, while the 5-thread sateen may be arranged to twill in either direction, as shown at D and E. The 8-thread sateen, counting three to the right, may be indicated in two positions, as shown at F and G, and these plans, when turned one quarter round, show similar effects, counting three to the left.

The design H in Fig. 115, which corresponds with the fabric represented in Fig. 114, shows the combination of 4-thread warp and weft twill weaves. The large design in Fig. 115 shows the combination of 5-thread warp and weft sateen

weaves, and is arranged in the form illustrated at E in Fig. 107, nine different shapes of sections being formed in warp and weft.

Method of Over Checking Warp Sateen Weaves.—In producing a coloured over-check in a warp sateen cloth, it is necessary to employ a weft-face weave where the specially coloured picks are required to show distinctly on the surface. A representation of a sateen cloth, checked with colour, is given in Fig. 116, the weave of which is 5-thread warp sateen, except where the horizontal lines are formed. The plan J in Fig. 117 shows how the weaves are arranged, the 5-thread warp sateen being crossed by a 10-thread weft sateen (indicated in the upper portion of J) where the special picks are inserted. The cloth contains nearly twice as many ends as picks per unit space, therefore, a longer float is employed in the weft sateen weave than in the warp sateen, in order that the yarns will show about equally prominently on the surface. In

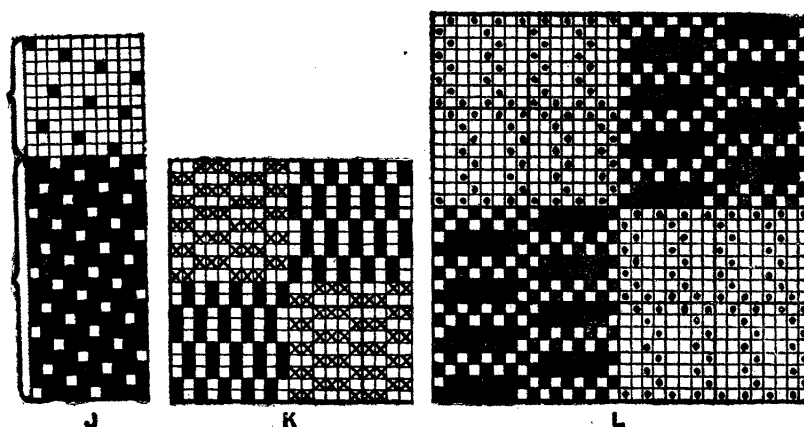


Fig. 117.

the example the weft sateen is carried across the corresponding colours in the warp, the arrangement enabling the design to be woven in a straight draft on ten healds. The warp weave might be carried through the corresponding weft colours, but this would complicate the draft and necessitate the use of more healds.

Rib and Cord Stripes and Checks.—Warp and weft face rib or cord, and corkscrew weaves are readily combined in stripe and check form. K in Fig. 117 shows a check design, which is composed of 3-and-3 warp and weft rib weaves, except that each section commences with a float of two in order that no longer float than three will be made where the weaves join. The design L in Fig. 117 illustrates the combination of warp and weft Bedford cord weaves, while an example of a check design that is composed of warp and weft corkscrew weaves, is given at H in Fig. 228.

Combinations of different Weaves.—In this class of stripe and check designs, there is practically no limitation to the variety of effect that can be obtained except what is imposed by the loom and the materials employed. For fabrics such as

suitings and coatings the patterns are not striking in appearance, and designs of the class shown at A, B, and C in Fig. 118 are employed, in each of which it will be noted that the weaves join well together. In the warp and weft rib sections of the design C, the threads should be more finely set than in the body of the check.

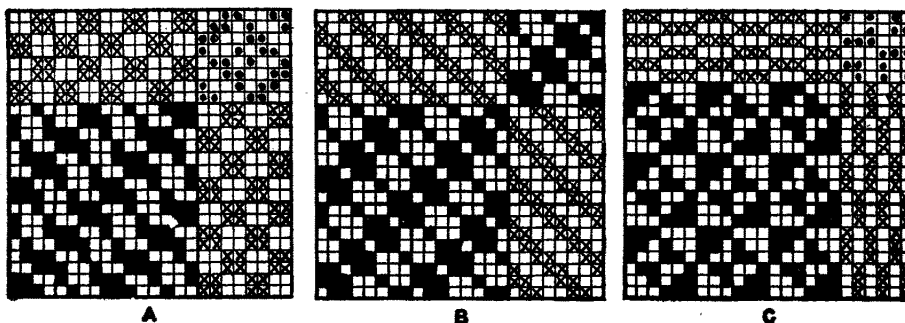


Fig. 118.

Combinations of different weaves in stripe form are illustrated in Figs. 189, 194, 199, 202, and 204; and in check form in Figs. 224 and 226, in Chapter XII.

CONSTRUCTION OF DESIGNS UPON MOTIVE WEAVE BASES

In this system, which is an extension of the combination of weaves in check form, a small motive weave is first constructed. Then each square of the motive is taken to represent a convenient number of ends and picks in a new design, in which different weaves are combined in an order that corresponds with the arrangement of the marks and blanks of the motive. For example, A in Fig. 119 shows a motive which repeats on 6×6 , and forms the basis of the fancy dice design given at B; each square of the motive represents 8 ends and 8 picks, and the blanks and marks respectively correspond to the 4-thread weft and warp sateens that are combined in the design. The full repeat is upon 48 ends and 48 picks, but an examination will show that the design can be drafted upon 16 healds.

C in Fig. 119 shows how a motive may be arranged so as to represent the combination of more than two weaves. Thus, in the design D, in which 8 ends and 8 picks correspond to one square in C, the twilled hopsack sections coincide with the solid marks, the 4-thread warp twill with the dots, the Mayo weave with the crosses, and the 4-thread weft twill with the blanks of C. It is necessary for the weaves to be as carefully joined together as in check weave combinations. The method of construction enables the sections of a large design to be readily arranged in advance, and there is also the advantage that if a well balanced motive weave is made, the design constructed from it will be correctly balanced.

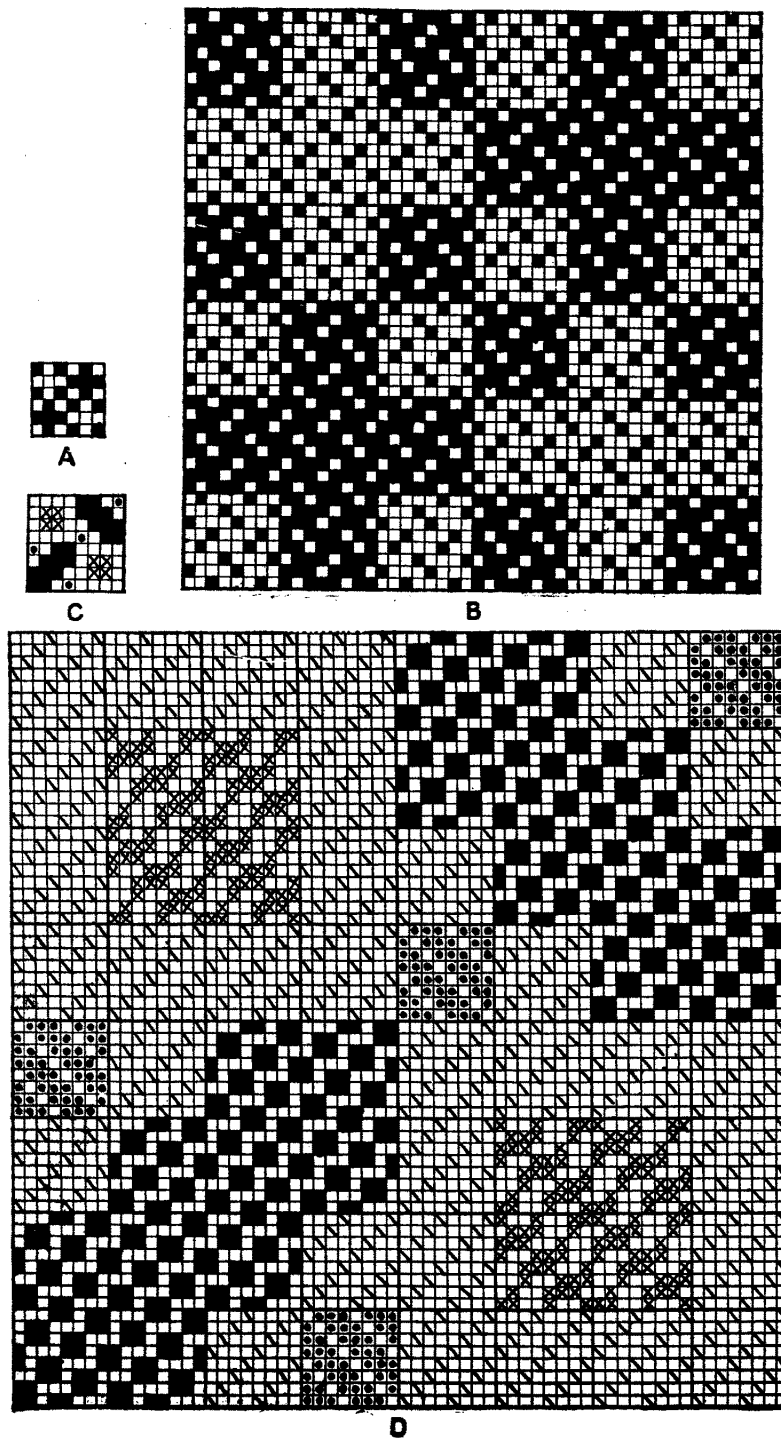


Fig. 119.

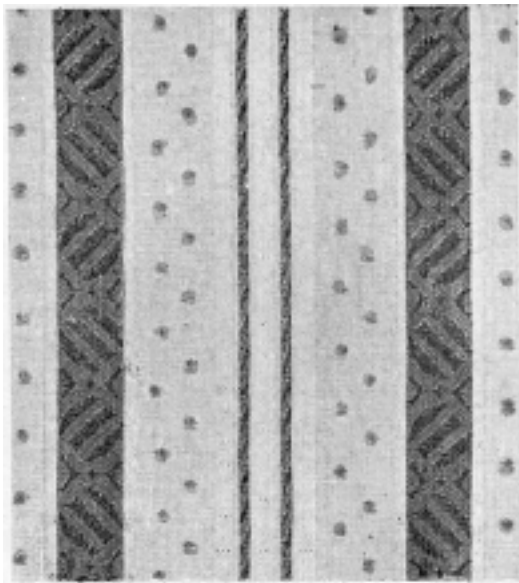
CHAPTER IX

SPECIAL CLASSES OF STRIPE AND CHECK FABRICS

Crammed Stripes and Checks—Fancy Weave Stripes upon Warp Sateen Grounds—Zephyr Stripes and Checks—Oxford Shirting Cloths—Harvard Shirtings—Wool and Union Shirtings—Combination of Bedford Cord and Pique Weaves. Construction of Heald Knitting Plans for Stripe Drafts. Comparison of Structures—Diameters of Yarns—Setting of Simple Structures—Cloths in which the Warp and Weft Threads are Different in Thickness—Comparative Setting of Weaves.

CRAMMED STRIPES AND CHECKS

THE weave combinations that are used in fancy vestings, shirtings, dress and blouse fabrics, and skirtings, are frequently in much greater contrast and more elaborate than the examples given in the preceding chapter, and colours are employed



more prominently in order to emphasise the form of the design. Further, the threads in certain sections of the designs are sometimes crammed—that is, there are more threads per unit space in one portion than in another portion. The objects of cramming certain threads in a cloth are: (a) To produce a pattern in one weave by varying the density of the cloth. (An example of this type of structure is given at F in Fig. 2, which shows a voile stripe dented one per split combined with a mercerised stripe dented two per split.) (b) To show a special material or colour prominently on the surface. (c) To secure firmness of structure in threads which are more loosely woven

than the ground threads. (d) To obtain a uniform ground texture when extra threads are introduced.

Fig. 120 represents a stripe blouse fabric in which a prominent warp figure and fine lines of a steep twill are produced in mercerised cotton yarn woven two ends per mail and four ends per split, while the ground ends are ordinary cotton woven one per mail and two per split. The arrangement of the stripe is indicated by the different marks in the corresponding design given in Fig. 121; each vertical space of the crammed weaves, which are represented by the solid marks, corresponding to two ends. Firmness of texture is secured in the broad figured stripe by the threads

interweaving in plain order between the figures ; while the narrow stripes are shown up very prominently by the threads interlacing in steep-twill order—a method which gives a rich and distinct appearance to a lustrous yarn when only a few ends are used at a place. Diagonal marks are indicated in Fig. 121 to show where crimped or “ crepon ” stripes have been formed by bringing a portion of the ground ends from a lightly tensioned separate beam ; these ends taking up about 35 per

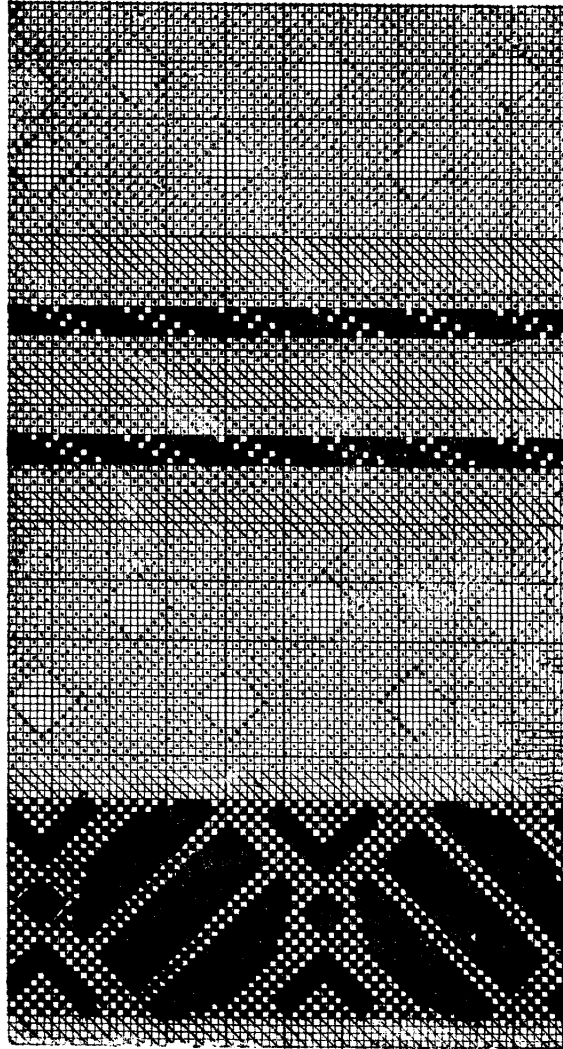


Fig. 121.

cent. more rapidly than the ground ends. The small spots in the ground stripe are due to floating the weft, which is composed of ordinary cotton.

A crammed stripe fabric is represented in Fig. 122, which is composed of cotton ground warp, crammed silk warp, and botany worsted weft, and illustrates a style that is suitable for either a dress, blouse, or shirt fabric. The corresponding design is given at A in Fig. 123, above which the order of denting is indicated. The ground

weave is plain and is dented 2 per split, while the crammed stripe consists of 5-and-1 warp twill woven 5 per split, and 3-and-3 warp rib woven 8 per split; and, in addition, lines of colour are formed in a 5-and-1 stitch weave.

Fig. 124 represents a crammed check fabric, the corresponding design for a portion of which is given at B in Fig. 123. In this case the ground ends are dented 2 per split, and the crammed ends 4 per split, as indicated above the design, while a similar weft cram is produced by making the take-up motion inoperative on alternate picks where the brackets are indicated at the side of the design. The ground weave is plain, and the crammed weaves 4-thread warp and weft sateens, except that the warp sateen weave is doubled vertically where the crammed weft sateen is intersected. This is in order that the surface floats will be of the same length throughout the design. The system of drafting is illustrated at C in Fig. 123, while D shows the corresponding pegging-plan.

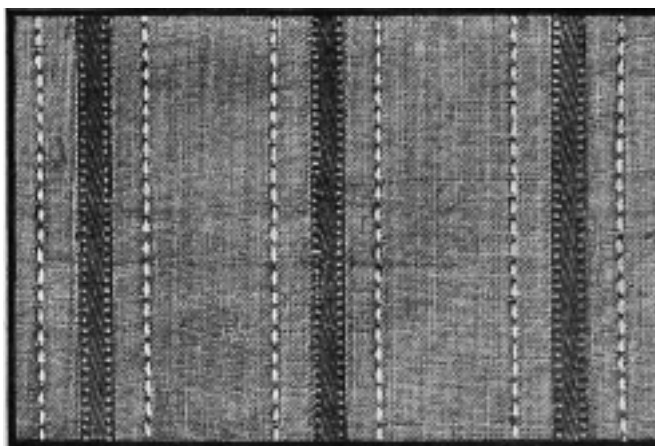


Fig. 122.

A crammed check fabric is represented in Fig. 125, in which the over-check is formed by interweaving specially coloured ends and picks in warp and weft rib order respectively. A portion of the corresponding design is given in Fig. 126, in which the marks indicate weft. In the crammed warp sections, 15 ends are arranged, 1 dark, 1 light, and dented in four splits; while in the crammed weft sections, 20 picks are arranged 2 dark, 2 light in order to fit a loom with changing boxes at one end only. In cramming the weft the up-take catch was raised by the shedding mechanism a sufficient number of times to compress the 20 picks into the same space as the four splits of the reed occupied by the crammed ends.

A checked dress fabric is represented in Fig. 127 for which the corresponding design is given at A in Fig. 128. The design is simply a stripe combination of plain weave and crêpe, but in order to show the latter weave more prominently in the cloth it is developed in double ends and woven 4 per split, whereas the plain weave is in single ends dented 2 per split. The two sections of the design are in different colours of warp, and the checked appearance of the cloth is due to the weft being arranged in two colours to correspond with the order of warping.

Fancy Weave Stripes upon Warp Sateen Grounds.—Certain features to be noted in forming a prominent fancy weave stripe upon a warp sateen ground, are illustrated by the example shown in Fig. 129, and the corresponding design given at B in Fig. 128.

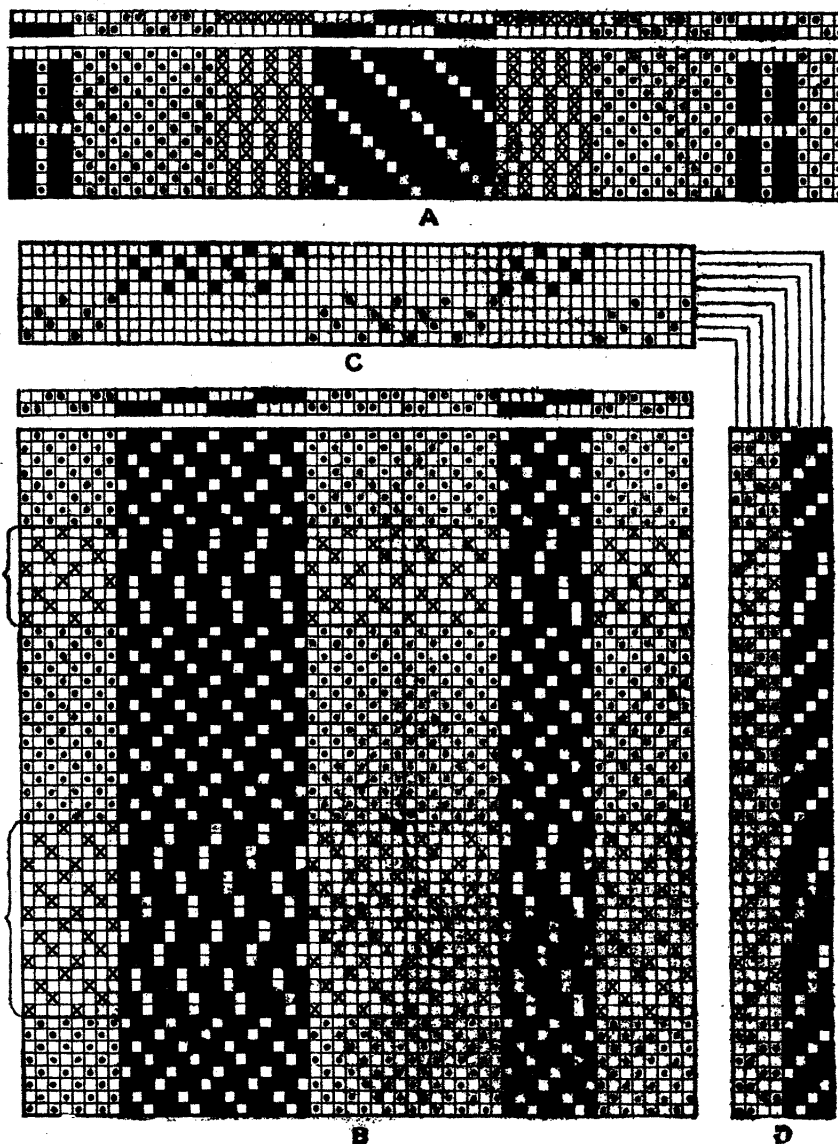


Fig. 123.

The cloth represented is a type of cotton texture that is used for skirtings, boys' suitings, and workmen's jackets, and very frequently these fabrics, although finely set in the warp, are for economical reasons woven with proportionately only a small

number of picks. It is, therefore, impossible to produce a prominent stripe effect by floating the weft, and, further, the weft should be in the same colour as the

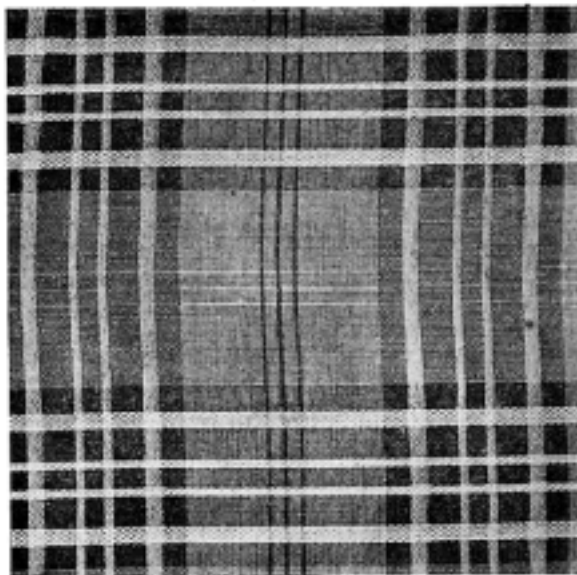


Fig. 124.

ends which form the warp sateen ground in order that the latter will be quite solid in appearance. However, by employing contrasting colours in the warp, and particularly if double ends are used for the special stripe, as indicated in B, Fig. 128,

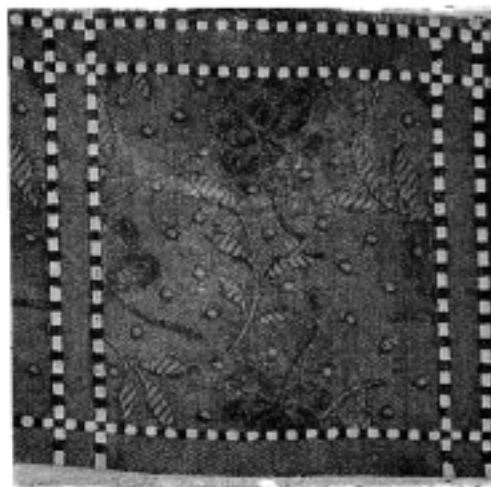


Fig. 125.

any required degree of prominence can be given to the fancy weave. Plain threads may be introduced to separate the different weaves, but this necessitates the use of

extra healds if none of the threads in the special weave interlace in plain order. If, however, the weaves are so arranged that the sateen floats do not obscure small figuring floats at the sides of the stripe, they may be placed directly in contact.

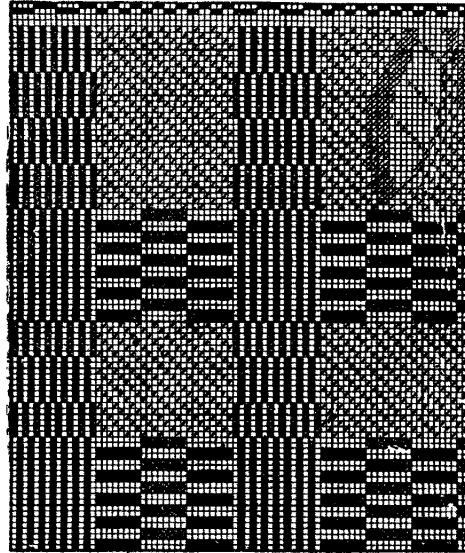


Fig. 126.

Zephyr Stripes and Checks.—In zephyr stripes and checks, which are used for dress, blouse, and shirt fabrics, the bulk of the cloth is generally in plain weave



Fig. 127.

and the pattern is very largely due to colour. Cord threads are frequently introduced (a representation of a plain corded zephyr is given at E in Fig. 2 (p. 3), and in

some cases certain threads are floated and brought prominently to the surface by cramming, as shown in the example given in Fig. 124; while plain and crêpe weaves are combined, as indicated in the fabric represented in Fig. 127. More or less elaborate figures frequently form part of the ornamentation, and a neat style of zephyr cloth is represented in Fig. 130, in which a small figured effect is formed on a corded stripe. The corresponding design is given in Fig. 131, in which the crossés

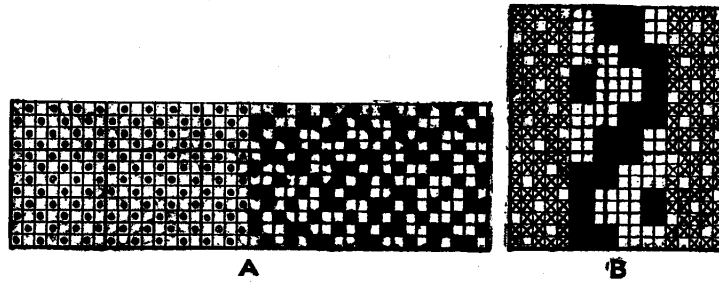


Fig. 128.

indicate the cord stripes (each of which is produced by placing two thick white ends in one mail and one split of the reed), the solid marks the weft figure, and the dots the plain ground.

In stripe zephyrs, the weft is most frequently white, the colour being obtained in the warp, and a distinct feature is that finer weft than warp should be employed,

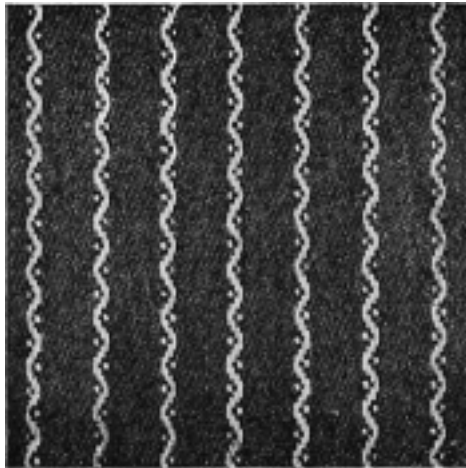


Fig. 129.

or the cloth is liable to appear irregular or "shady." A fine quality may be woven in 2/120's cotton warp, 100 ends per inch, and 80's bleached cotton weft, 104 picks per inch; and a medium quality in 50's cotton warp, 84 ends per inch, and 60's or 70's weft, 80 picks per inch. 2/20's to 2/30's cotton is suitable for the cord stripes. In the best cloths silk weft is used instead of cotton weft, and coloured weft, both silk and cotton, is employed in the production of "shot" zephyrs.

Oxford Shirting Cloths.—Stripe designs are largely employed in Oxford shirting fabrics, and a typical example is represented in Fig. 132, for which the corresponding design is given at A in Fig. 133. The best qualities of these textures are full, soft,

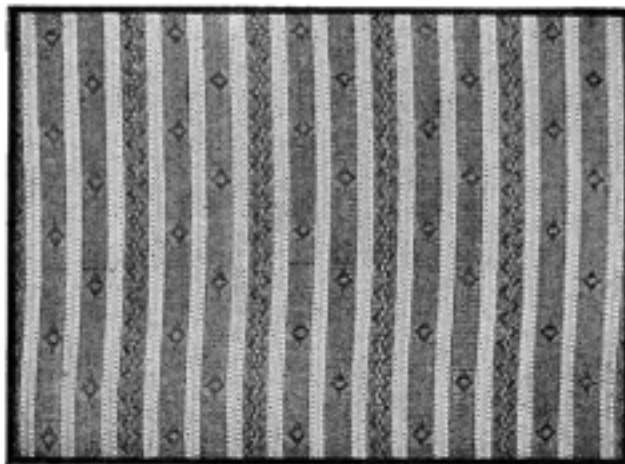


Fig. 130.

and somewhat lustrous, and thick weft—spun with little twist from long stapled cotton—is employed, while the warp yarn is also made from a good grade of cotton. Standard cloths are woven with two ends per mail (tapes), with the bulk of the weave

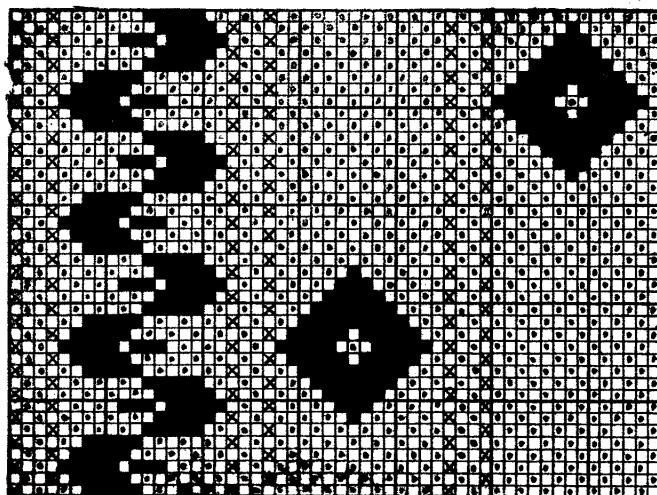


Fig. 131.

plain, but they are also made in hopsack weaves (termed matting Oxfords), in fancy mat weaves, such as that shown at B in Fig. 133, and in plain weave with the warp composed of single ends (termed single warp Oxfords). The double-end arrangement

in the warp causes the cloth to be chiefly weft surface, so that the warp colours are subdued, whereas in single-warp Oxfords the warp colours show more prominently while the cloth is harder in the handle. The textures are not heavily coloured, but are particularly neat and clean in appearance, a white foundation being most

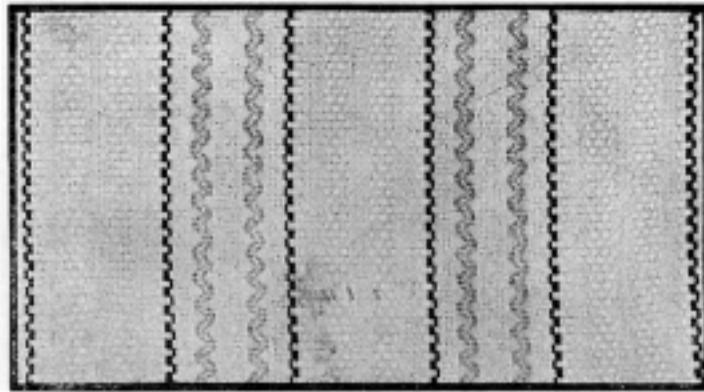


Fig. 132.

frequently made upon which fine lines of colour, in the form of stitch threads and small fancy weaves, are developed. In some cases, however, a coloured warp is used for the ground, but the weft is almost invariably white. In order to make a colour show clearly on a white double end foundation in the plain weave, three

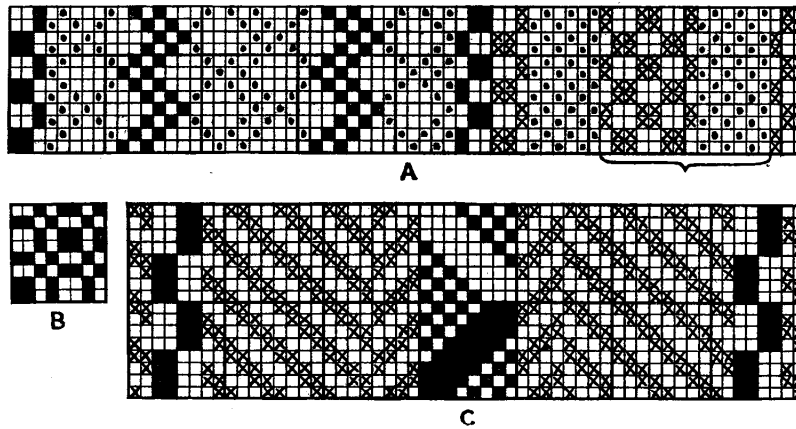


Fig. 133.

ends of the colour may be placed in each mail instead of two, while to get fine solid lines of colour the coloured ends may be drawn one per mail and dented four per split. The single ends in the latter arrangement take up more rapidly than the double ends, and it is, therefore, usually necessary to place them on a separate beam in order to ensure good weaving. A good quality of Oxford cloth may contain 56 double ends per inch of 36's cotton, and 52 picks per inch of 14's cotton; and

a coarser cloth, 40 double ends per inch of 40's cotton, and 40 picks per inch of 10's cotton. In the design given at A in Fig. 133, each vertical space represents two ends in the cloth, and the solid marks indicate the weave formed by the coloured threads; the bracketed portion, which consists of plain and 2-and-2 hopsack, is repeated.

Harvard Shirtings.—The stripe fabric, represented in Fig. 134, is a Harvard shirting, the corresponding design for which is shown at C in Fig. 133. This cloth is made in single ends, and the ground weave is generally 2-and-2 twill; and, compared with an Oxford fabric, darker colours and rather cheaper yarns are employed, the cloth being stiffer and harder, while the ornamentation is more pronounced. Sometimes, however, the Harvard cloth is made in imitation of an Oxford, as regards quality, design, and colouring, but the 2-and-2 twill ground is retained. The weft is all white, except in checked Harvards, in which a few picks of coloured weft are introduced. The weave ornamentation consists largely of variations of the 2-and-2 twill, and of mat and rib weaves working in 2-and-2, and 4-and-4 orders, by which small spot and chain effects in strong colours are formed. A 4-and-4 order of working is obtained in a 2-and-2 twill tappet loom by coupling to the ordinary tappets a "scroll" tappet which moves a heald in one direction at one complete revolution, and in the other direction at the next revolution.

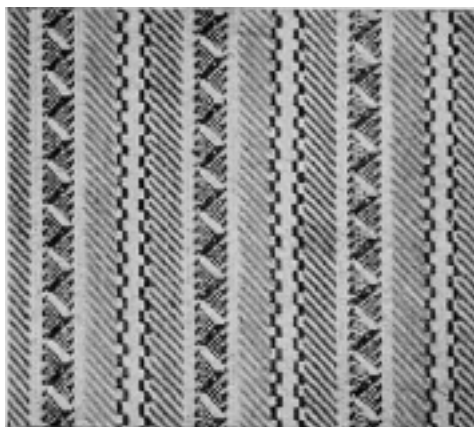


Fig. 134.

Harvard cloths that are woven in dobbies are ornamented by fancy weaves and small figures along with which plain weave is generally introduced, as shown in C, Fig. 133, in order that the figuring threads will be about equal in firmness to the threads which form the 2-and-2 twill ground. Very frequently the 2-and-2 twill makes a bad junction with the fancy weave, rather long white weft floats being formed, which, however, are made almost invisible by placing white ends at each side of the coloured stripe upon which the fancy weave is brought up. The 2-and-2 twill ground weave is modified on the principle illustrated at P in Fig. 62 (p. 61), so as to produce considerable variety of effect on a small number of healds.

Wool and Union Shirtings.—All-wool and union shirting and pyjama cloths, which are milled and raised in the finishing process, are not suitable for the combination of fancy weaves in the ordinary manner, but very elaborate colouring may be employed in the warp, as the formation of the nap on the surface greatly subdues the strength of the colours in the cloth. All wool shirtings (taffetas) may be composed in the warp of from 2/60's to 2/80's botany, and in the weft of from 40's to 70's botany with from 60 to 80 ends, and from 50 to 70 picks per inch. In a union cloth one series of threads may be composed of cotton, or wool, while the other series is a "union," "llama," or "angola" yarn, which consists of a mixture of cotton and

wool fibres (sometimes a mixture of wool and silk, or cotton and silk is employed), or both series of yarns may be union. A llama shirting is composed of union warp and weft—as for instance, 18's warp and 16's weft (worsted count) which contain 70 per cent. wool, and 30 per cent. cotton (stated as 70/30) with 38 ends and 44 picks per inch. A Ceylon shirting is made with cotton warp, and the cloths may be woven with from 64 to 68 ends per inch of from 36's to 40's cotton warp, and 56 picks per inch of 22's (worsted count) weft which contains from 70 to 85 per cent. of wool. The colours require to be specially fast dyed on the cotton warp in order that they

will stand the milling process, and as the dyeing is liable to somewhat weaken the yarn, it is necessary for a good quality of warp to be used. As regards the weave ornamentation of these cloths, the raised surface does not prevent the development of fancy weaves in lustrous threads which are crammed in the reed, in the manner illustrated by the example given in Fig. 122.

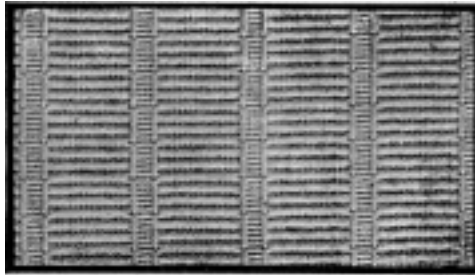


Fig. 135.

Combination of Bedford Cord and Pique Weaves.—

Bedford cords, piques, honey-combs, and other special weaves are combined in very diverse ways in blouse fabrics, skirtings, vestings and shirtings, with and without coloured threads. If coloured threads are introduced they should be dyed fast to bleaching, as the ground yarns are generally woven grey and bleached in the piece. Fig. 135 represents a cloth in which a Bedford cord weave is combined in stripe form with two sizes of pique cords. The corresponding design is given in Fig. 136, in which the diagonal strokes indicate the plain face weave that is formed by two-thirds of the ends. The remaining third serves as wadding ends—as indicated

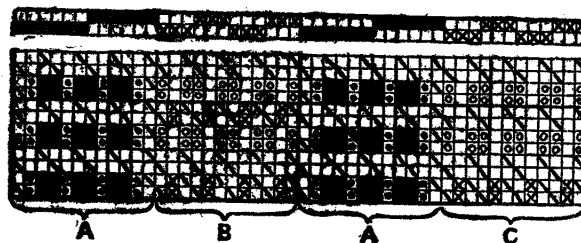


Fig. 136.

by the dots—in the Bedford cord sections, which are lettered A, and as tight stitching ends—as shown by the crosses—in the pique cords, the smaller of which is lettered B, and the larger C. The picks 5, 6, 9 and 10 which float on the back of the Bedford

cord stripes, form the wadding picks of the pique stripes, as indicated by the circles.

CONSTRUCTION OF HEALD KNITTING PLANS FOR STRIPE DRAFTS

In weaving stripe drafts in knitted healds it is necessary—particularly if the stripes are broad—for the healds to be knitted to coincide with the pattern in order to ensure smooth working. There should be the required number of mails on each shaft, and each mail should be in the correct place on the shaft in relation to the

position in the reed of the end which passes through it. The order of knitting the healds is decided by three factors: (a) the draft; (b) the order of denting; (c) the number of splits of the reed per unit space. A heald-knitting plan can be conveniently indicated upon design paper, after the draft and denting order have been made out, in the manner illustrated in Fig. 137, in which A shows a stripe draft upon twelve healds, and B the order of denting. The stripe is arranged as follows:—

16 ends on healds 1 and 2 — 2 ends per split = 8 splits.

24 ends on healds 3 to 8 — 3 ends per split = 8 splits.

16 ends on healds 1 and 2 — 2 ends per split = 8 splits.

16 ends on healds 9 to 12 — 4 ends per split = 4 splits.

28 splits.

The heald-knitting plan to coincide with the draft A and denting plan B is given at C in Fig. 137, and it will be seen that C contains as many horizontal spaces as there are healds—viz., 12—and as many vertical spaces as there are splits in the repeat—viz., 28. In constructing C the ends are taken in groups according to the

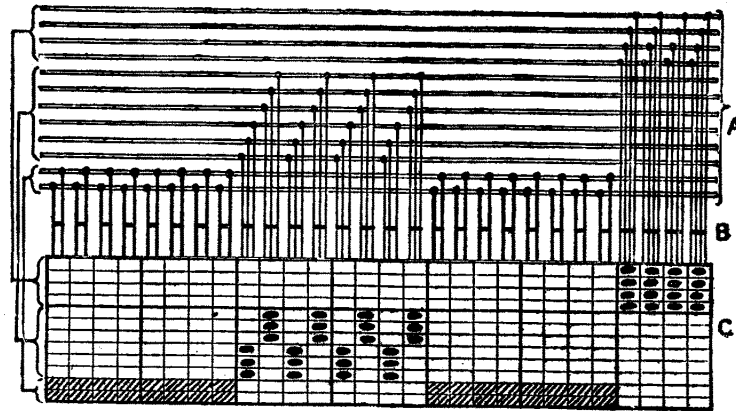


Fig. 137.

order of denting, and marks are indicated on the spaces to correspond with the healds on which the ends are drawn. Thus, commencing with the first split, there are eight splits in each of which two ends are drawn on the healds 1 and 2, and corresponding marks are placed on the first and second horizontal spaces of C. In the ninth split there are three ends which are drawn on the healds 3, 4, and 5, and marks are indicated where the ninth vertical space of C intersects the horizontal spaces 3, 4 and 5, and so on. It will be seen that as many marks are indicated upon each vertical space of C as there are ends passed through the corresponding split, and as many marks upon each horizontal space as there are ends drawn on the corresponding heald.

A knitting machine can be arranged to knit and miss the leashes in any desired order, and at any required rate per unit space. If, in the example, the rate of knitting is the same as the splits per unit space of the reed, the order of knitting and missing will be found by reading along the spaces of C in Fig. 137 horizontally.

For economical reasons, however, it is advisable to employ as low a rate of knitting as possible, and in the following list a method is shown of adapting the order of knitting to suit a lower sett than the reed sett. In the centre column the order of knitting and missing is given which corresponds exactly with the plan C, the rate of knitting being taken as the sett of the reed; while in the third column the order is given for the healds 3 to 12 taking the rate to be equal to half the reed sett:—

Position of Heald.	Rate of knitting = splits per inch of reed.	Rate of knitting = $\frac{1}{2}$ splits per inch of reed.
Healds 1 and 2	knit 8 8 miss 8 4	
Healds 3, 4, and 5	knit 1 1 1 1 miss 8 1 1 1 13	knit 4 miss 4 6
Healds 6, 7, and 8	knit 1 1 1 1 miss 9 1 1 1 12	knit 4 miss 4 6
Healds 9 to 12	knit 4 miss 24	knit 4 miss 10

In the second column the numbers knitted and missed total 28 to correspond with the 28 splits in the repeat of the stripe, but in the third column the total is half that number—viz., 14, which coincides with the reduction in the rate of knitting by one half. All the healds 3 to 12 may be knitted alike in the order of 4 knitted, 10 missed; the leashes being afterwards placed on the shafts in correct relative position. It is impossible to reduce the rate of knitting the healds 1 and 2 to one-half the sett of the reed, but it might be reduced to three-fourths the sett, in which case the order would be knit 8, miss 3, knit 8, miss 2—a total of 21. In giving the knitting instructions either the width of the healds or the number of repeats of the pattern may be specified along with the rate and order of knitting.

A more elaborate draft than the preceding example is shown on design paper at A in Fig. 138, whilst B illustrates the corresponding heald knitting plan. The healds are numbered at the side of A, No. 1 representing a doup and front crossing heald. Arrows are indicated below the draft to show where splits of the reed are left empty, while above the order of denting is given. Lines connect each group of ends with the corresponding vertical space in B. The ends in the first split are drawn on the healds numbered 2 and 3, therefore, marks are indicated on the second and third squares of the first vertical space of B. In the second split three ends are drawn on the healds 2, 3, and 4, and in the third split, four ends on the healds 2, 3, 5, and 6, and marks are indicated on the corresponding squares of the second and third vertical spaces of B.

As before, the plan B shows the exact relative positions that the heald leashes should occupy, and gives the order of knitting and missing if the rate is the same as the splits per unit space of the reed. The number of splits in the repeat is 40, and assuming that the rate is taken as one-half the reed sett, the healds numbered 1, 13, and 14 might be knitted in the order of 8 missed and 12 knitted—giving a total of 20. The rate of the healds 4 to 12 might be taken as one-fourth the reed sett, in which case the order would be: knit 2, miss 8—giving a total of 10.

COMPARISONS OF STRUCTURES

The designs and cloths which have been described and illustrated clearly show that different settings are required, not only for distinct classes of fabrics, but also for different weaves in similar structures, and for the same weave in different structures. The setting of cloths has in the past been almost entirely based upon experience and experiment, and, therefore, has offered considerable difficulties to those

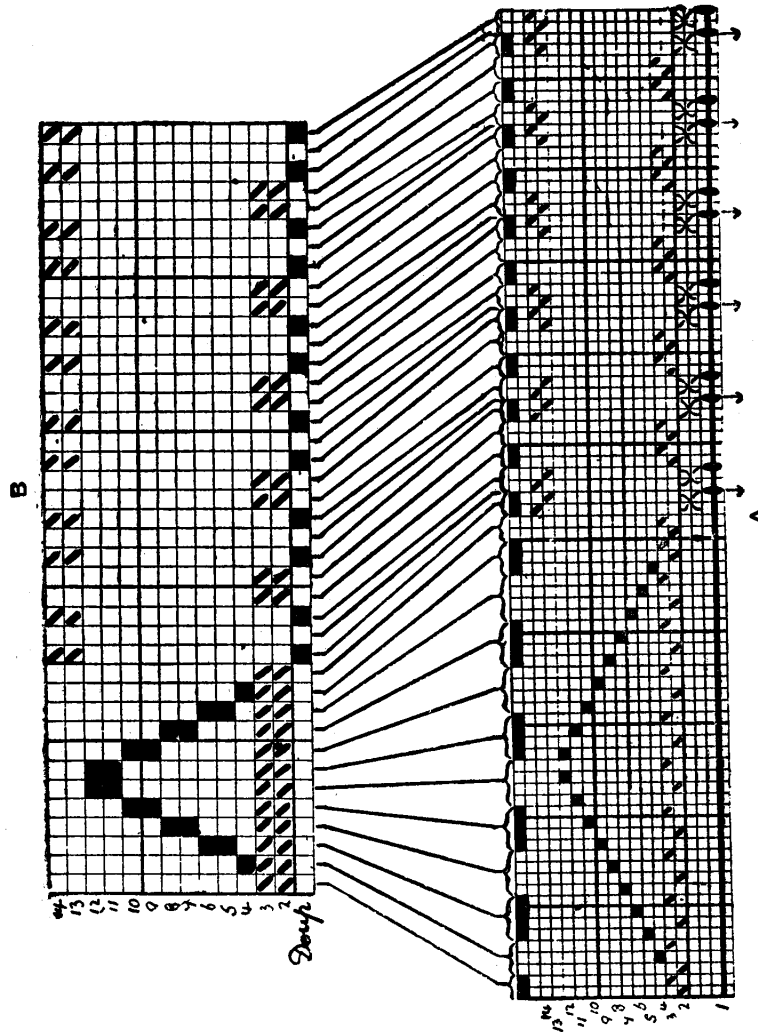


Fig. 138.

with limited experience, or with limited facilities for carrying out experiments. In the following a basis is given that will enable the counts of the yarns and the threads per unit space, which are suitable for a given structure of cloth in a certain weave, to be reasoned out. Also the method may enable useless experiments in building cloths to be avoided, while by it weaves and structures can be readily compared and the effects produced in the woven fabric be more clearly realised.

A complete treatise on the setting of cloths would be out of place here, and the calculations and allowances to be made are therefore given in a simple form (the angle of curvature of the threads is not taken into account). The results will be found none the less valuable, however, for practical purposes. The diameters of the yarns, the number of threads per unit space, the relative number of intersections in the weave, and the type of structure to be made (which includes the class of raw material of which the warp and weft are composed, and the kind of finish that is applied), are the leading factors in the calculations; but in building a cloth, the price at which it can be sold has, of course, to be taken largely into account.

Diameters of Yarns.—The approximate diameter of a given count of yarn may be ascertained by finding the square root of the yards per lb. and deducting 8 per cent. for silk, cotton, and linen yarns, 10 per cent. for worsted yarns, and 15 per cent. for woollen yarns.

$$(1) \text{ The diameter of a } 1/40\text{'s cotton yarn} = \sqrt{40 \times 840} - 8 \text{ per cent.} = \frac{1}{168}''.$$

$$(2) \text{ The diameter of a } 2/60\text{'s worsted yarn} = \sqrt{30 \times 560} - 10 \text{ per cent.} = \frac{1}{116}''.$$

It is obvious that if a 1/40's cotton yarn is $\frac{1}{168}$ of an inch diameter, 168 of such threads can be placed side by side just touching each other in one inch; and, in the same manner, 116 threads of 2/60's worsted. It is convenient to express the diameter of a yarn, not as a fraction of an inch, but as so many diameters per inch (the reciprocal of the diameter). Thus, the diameter of a 1/40's cotton yarn may be expressed as 168 diameters per inch, and of a 2/60's worsted yarn as 116 diameters per inch.

Setting of Simple Structures.—Simple fabrics may be divided broadly into three distinct classes, as follows:—

(1) Ordinary structures, in which the warp and weft threads bend about equally.

(2) Warp rib structures, in which the weft threads lie straight and only the warp threads bend.

(3) Weft rib structures, in which the warp threads lie straight and only the weft threads bend.

In the ordinary structures the warp threads are separated from each other by the intersections of the weft threads, and the weft threads by the intersections of the warp threads. In the warp and weft rib structures the threads of the straight series are separated by the intersections of the threads which bend, but the latter are not separated by the intersections of the straight threads.

The approximate maximum setting in the loom of "square" ordinary cloths is found by the formula:—

$$\frac{\text{Diameters per inch of the yarn} \times \text{number of threads in one repeat of the weave}}{\text{Number of threads} + \text{number of intersections in one repeat of the weave}}$$

(3) The number of ends and picks per inch in a square plain cloth woven in 40's cotton yarn (see the first calculation) =

$$\frac{168 \text{ diameters} \times 2 \text{ threads}}{2 \text{ threads} + 2 \text{ intersections}} = 84.$$

(4) In a square 2-and-2 twill cloth in 2/60's worsted yarn (see the second calculation) the number of ends and picks per inch =

$$\frac{116 \text{ diameters} \times 4 \text{ threads}}{4 \text{ threads} + 2 \text{ intersections}} = 77.$$

In a rib structure the maximum number of threads per inch of the series which bend may be taken as equal to the number of diameters per inch, while the number per inch of the straight series will be found by the preceding formula. Thus, for a warp rib cloth woven in 40's cotton warp and weft in plain weave, as in the third calculation, the number of ends = 168, and the number of picks = 84. For a weft rib cloth woven in 2/60's worsted warp and weft in 2-and-2 twill, as in the fourth calculation, the number of ends = 77, and the number of picks = 116.

The particulars ascertained in the foregoing methods will produce very firm and sound cloths, which, however, may be too hard for certain purposes, and also too costly. Fewer threads per inch than the calculated number may be employed within limits (usually from 10 to 15 per cent. less) and a good saleable structure will yet result. Thus the ends and picks per inch given in the third calculation may be reduced, for price reasons, from 84 to 76, or the cloth might be modified to 80 ends and 72 picks per inch, and still yield a reasonably good structure. Similarly the 2-and-2 twill cloth in the fourth calculation might be reduced to 70 ends and picks, or 72 ends and 68 picks per inch.

Cloths that are shrunk by milling and felting in the process of finishing should be set lower than an unfelted cloth, at least in the proportion of the greater degree of shrinkage. Further, the operation of felting imparts additional firmness to a cloth so that if it is desired an even greater reduction in the sett can be allowed.

(5) Assuming that a 2-and-2 twill ordinary cloth is woven in 20 skeins woollen yarn—

$$\text{The diameter of the yarn} = \sqrt{20 \times 256} - 15 \text{ per cent.} = \frac{1}{84}''$$

$$\frac{64 \text{ diameters} \times 4 \text{ threads}}{4 \text{ threads} + 2 \text{ intersections}} - 10 \text{ per cent. for extra shrinkage} = 38 \text{ threads per inch.}$$

Cloths in which the Warp and Weft Threads are different in Thickness.— If the counts of the warp and weft are different, but not very much different, the ends and picks per inch for an ordinary cloth may be judged from the average of the diameters.

(6) In an ordinary plain cotton cloth woven in 40's warp (168 diameters) and 50's weft (188 diameters): the intersection theory gives respectively 84 and 94 ends and picks, which may be used as a basis of the setting. 88 ends and 88 picks per inch may be taken as about the maximum, but according to whether the ends or picks are required to predominate the cloth may be reduced to the neighbourhood of, say, 88 ends and 80 picks per inch, or 80 ends and 88 picks per inch.

Warp face cloths are usually woven with more ends than picks per inch and finer warp than weft, while in weft face cloths the conditions are the reverse. A 3-warp and 1-weft twill is just as firm as a 2-and-2 twill, and the particulars given in the fourth calculation will produce a similarly sound cloth in either weave. For the warp face twill, however, it is much more appropriate to increase the calculation number of ends from 77 to 84 per inch or more, and to reduce the number of picks to about 68 per inch; while if thicker weft than warp—say 20's worsted (95 diameters)

is used, the picks may be reduced to 56 or 60 per inch (63 is the calculation number for 95 diameters in 3-and-1 twill). The increase in the number of ends per inch and in the thickness of the weft changes the structure of the cloth towards that of a warp rib. The particulars of a 3-and-1 weft face twill will be the same as the preceding if weft be substituted for warp.

In warp and weft rib structures the straight threads are mostly thicker than the threads which bend, and only a comparatively few straight threads per inch are employed.

(7) In a warp rib cloth woven in plain weave with 2/80's cotton warp (168 diameters) and 3/30's cotton weft (84 diameters); the maximum number of ends per inch = 168.

A suitable number of picks per inch =

$$\frac{84 \text{ weft diameters} \times 2 \text{ picks in weave}}{2 \text{ picks} + 2 \text{ intersections in weave}} = 42.$$

A reasonably good cloth, and one with a softer feel, will result by changing the particulars to 144 ends and 36 picks per inch.

(8) Assuming that the yarns given in the seventh calculation are required in a 2-and-2 warp rib weave, the ends per inch will be as before—viz., 168.

A suitable number of picks per inch will be found on the intersection theory as follows:—

$$\frac{84 \text{ weft diameters} \times 4 \text{ picks in weave}}{4 \text{ picks} + 2 \text{ intersections in weave}} = 56.$$

The bending series of threads in loosely woven rib weaves, such as the 3-and-3 and 4-and-4 effects, may be set from 5 to 10 per cent. finer than the number of diameters per inch, although this is not necessary in order to produce a good cloth. The setting of corkscrew weaves is similar to that of the looser woven rib weaves.

In sateen weaves the intersections do not support each other, and the cloths may be set up to the diameters per inch of the threads which form the face and nearly up to the diameters per inch of the threads on the back.

(9) In an 8-thread warp sateen cloth woven in 30's worsted warp (116 diameters) and 20's worsted weft (95 diameters), the number of ends per inch will be 116.

A suitable number of picks per inch will be:—

$$\frac{95 \text{ weft diameters} \times 8 \text{ picks in weave}}{8 \text{ picks} + 2 \text{ intersections in weave}} = 76.$$

More picks than 76 could be inserted while retaining the maximum number of ends, but in a warp sateen the face of the cloth is of chief importance so that it is advisable to cheapen the cloth in the weft. A reasonably good cloth will result, with from 104 to 108 ends per inch instead of 116. In an 8-thread weft sateen the setting will be opposite to that of the warp sateen.

While an 8-thread sateen weave may very well be set up to the diameters per inch of the face yarns, a 5-sateen weave, on account of its greater firmness, will handle rather hard if set so fine.

(10) In a 5-thread weft sateen cloth woven in 30's cotton weft (143 diameters), and 20's cotton warp (118 diameters), the picks per inch may range from 140 to about 120.

A suitable number of ends per inch =

$$\frac{118 \text{ warp diameters} \times 5 \text{ threads in weave}}{5 \text{ threads} + 2 \text{ intersections in weave}} = 84.$$

Comparative Setting of Weaves.—It is a very good method in reasoning out the setting of weaves to which the intersection theory cannot be applied to find the diameters of the yarns that are considered suitable, and also the threads per inch based on the intersection theory. A comparison of the figures will then usually enable the setting to be decided upon which is suitable for the method of interlacing, and the effect that is desired in the cloth. A twill weave that is re-arranged in sateen order usually requires to be set firmer than the original twill, but how much firmer varies according to the degree in which the intersections in the re-arranged weave support each other. A comparison of the designs K, L, M, N, and O in Fig. 28 (p. 31) will make this clear.

(11) Assuming that the designs K, L, M, N, and O are required to be woven in 20's cotton yarns (116 diameters)—

For the design K the number of ends per inch by the intersection theory =

$$\frac{118 \text{ diameters} \times 11 \text{ threads}}{11 \text{ threads} + 6 \text{ intersections}} = 77.$$

The number of ends and picks per inch may, if desired, be reduced from 77 to the neighbourhood of 70.

The designs L, M, N, and O are looser in structure than the design K; O being firmer than the others, while L is firmer than M and N. It is necessary, however, to consider the effects that the weaves will produce in the cloths. The design L produces a flat twill and the weft should therefore predominate over the warp. The warp may be set with 77 ends per inch, as found in the eleventh calculation, while the picks may be increased to about half-way between 77 and the 118 diameters per inch, viz., about 98 picks.

The designs M and N are very loose and may be set almost up to the diameters per inch, but half-way between 77 and the 118 diameters—viz., 98 ends and 98 picks—may be taken as reasonable setting.

The design O produces a steep twill, and it is therefore advisable to allow the warp to predominate over the weft. The weave is nearly as firm as the design K, and taking 77 ends and picks as the maximum setting of the latter design, an increase in the number of ends to about 88, and a decrease in the number of picks to about 68 may be taken as suitable for the design O. A looser woven steep twill would require to be set finer, and very loose weaves, such as those shown at H and L in Fig. 33 (p. 35) might be set in the warp about up to the diameters per inch. Thicker weft than warp also should be employed.

A consideration of honeycomb weaves will show that the warp and weft should be similar, and in reasoning out the setting of the cloths a comparison may be made between the threads per inch of a plain ordinary cloth, and the diameters per inch of the yarns.

(12) Assuming that 20's cotton yarns (118 diameters) is employed for a honeycomb weave: The intersection theory gives 59 ends and picks per inch as maximum setting for plain cloth. About half-way between 59 and 118 (diameters)—viz., 88 ends and picks per inch will be suitable for an ordinary honeycomb. A large loosely woven honeycomb weave may be set finer.

A Bedford cord weave has a warp surface and the warp should therefore be finely set. The surface is really plain weave, but only half the picks are on the face in the cord stripes. The setting therefore requires to be finer than plain weave in both warp and weft. In 30's cotton warp and weft (146 diameters) a number half-way between the threads per inch for plain cloth (73) and 146 diameters—viz., 110—will give a reasonable basis of the setting. The warp may be set rather finer or rather coarser, according to price, while the picks may be reduced, if desired, to about 84.

The face of a pique structure is an ordinary plain fabric, and plain weave may therefore form the basis of the setting. If 40's cotton (168 diameters) is used for the face warp and weft, 84 face ends and picks is the maximum setting for plain weave. In the pique cloth, however, stitching ends are woven into the face fabric and impart firmness to it, and it is therefore quite appropriate to reduce the setting from 84 to an average of about 72 face threads per inch. The stitching ends require to be thicker than the face ends, while thick weft is generally used for the wadding picks.

An open imitation gauze weave is quite different from an ordinary cloth, but the warp and weft should be similar. By basing the setting upon plain weave, and placing each group of ends in one split with a split missed between the groups, a reasonably good result will be obtained. Thus if the 4 × 4 imitation gauze weave is required in 30's cotton yarns (146 diameters) a reed with 37 splits per inch may be employed dented 4 ends per split, 1 split missed.

The foregoing methods of arriving at the weaving particulars of cloths can be compared with the particulars of structures that have been previously given. No hard and fast rules are laid down, as the correct setting of cloths is very largely a matter of good judgment, but theory can be made a very useful adjunct to practice. It will be found serviceable to compare the known particulars of good cloths with the results ascertained by the diameter and intersection theory.

CHAPTER X

COLOUR THEORIES AND PHENOMENA

Purpose of Colour. *Light Theory of Colour*—Wave Theory of Light—Cause of Colour—How Colours are affected—Mixtures of Coloured Lights. Complementary Colours—Effect of Fatigue of Colour Nerves—The Chromatic Circle. *Pigment Theory of Colour*—Comparison with Light Theory—Mixtures of Coloured Pigments—Colour Constants—Qualities or Attributes of the Primary and Secondary Colours—Modification of Colours—Coloured Greys—Contrast and Analogy. *Colours in Combination*—Kinds of Contrast—Effect of Contrast—Simultaneous Contrast—Contrast of Hue—Contrast of Tone. *Harmony in Colour Combinations*—Harmony of Analogy—Harmony of Contrast—Basis of Colour Harmony—Relative Spaces occupied by Colours—Divisional Colours. How Colours are modified in Textile Fabrics.

Purpose of Colour.—In certain classes of textiles, which range from simple structures to elaborately figured damasks and gauzes, and compound fabrics such as fancy toilets and quilts, colour is not employed; the ornamentation being due to the method in which the threads are interwoven, and to the variation in the reflec-

tion of the light from the different parts of the cloth. On the other hand, there are fabrics in which colour forms the predominant decorative feature—the weave simply serving as the structural element of the texture. For instance, cloths which are finished with a raised surface may have the weave pattern completely concealed, the ornamentation then being entirely due to the introduction of colour; while in many kinds of rugs, tapestries, and carpets, the form produced by the weave is solely for the purpose of displaying colour. In other classes of cloths, as for example, ordinary figured textures and extra warp and extra weft figured styles, colour is used as a supplementary agent to the effect produced by the system of interlacing, its purpose then being to improve the design by giving greater precision to the form. There are also styles in which the design is due to the combination of a particular scheme of interlacing with a certain order of arranging coloured threads. When colours are employed it is with the definite object of brightening and beautifying the fabric, and it is therefore very important that harmonious colour combinations be obtained. Frequently colour is of more consequence than form, since it is possible for a good scheme of colouring to redeem an otherwise uninteresting design, whereas a displeasing colour combination will render worthless a good form.

There are two theories of colour, viz., the “Light” theory and the “Pigment” theory. These are based upon entirely different principles, and unless this is remembered, confusion is liable to arise between them. In mixing differently coloured lights the colours are added, whereas mixing coloured pigments, as in dyeing, is a process of subtraction, since one colour absorbs or counteracts the other.

Light Theory of Colour.—

The simple experiment of Sir Isaac Newton's, illustrated in Fig. 139, enables the composition

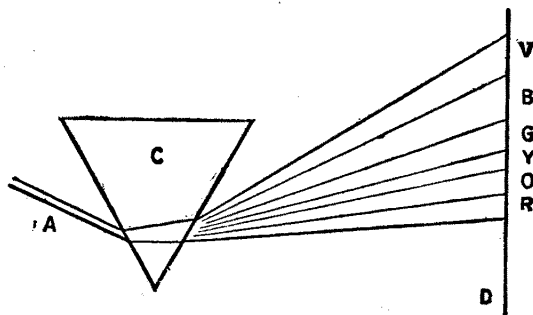


Fig. 139.

of white light to be determined, and demonstrates that light is the source of colour. A beam of sunlight, A, entering a small hole and passing across a dark room, is intercepted by a glass prism, C. In its passage through the prism the beam is refracted, and is split up into its constituent elements, with the result that it forms a band, not of white light, but of different colours which may be displayed upon a screen as represented at D. The band of coloured light thus obtained is called the solar or prismatic spectrum, and the colours—which are arranged in the same order as the colours in a rainbow, are known as spectral or spectrum colours. For convenience, the colours are classified in six divisions—viz., Red, Orange, Yellow, Green, Blue, and Violet; but every gradation of colour is shown in the spectrum, the change from one to another being imperceptible. Thus, red changes through different degrees of reddish-orange to orange; orange through orange-yellows to yellow; yellow through yellowish-greens to green; green through greenish-blues to blue; and blue through bluish-reds to violet. The preponderating colours in the spectrum are blue and colours containing blue, and it is customary to describe these as the cold sombre colours, and red, orange,

and yellow as the warm luminous colours. The refraction of the light rays increases from the red to the violet, and in addition to the visible rays ultra-red or dark heat rays and ultra-violet or chemical rays are found which lie outside the red and violet rays respectively. These are only known by their chemical action.

Wave Theory of Light.—Bodies such as the sun, a gas flame, etc., are self-luminous and are rendered visible by the light that they emit. The majority of bodies are non-luminous and become visible only by reflecting the light that reaches them from luminous bodies. Non-luminous bodies owe their *colour* to the reflection of the light that falls upon them, no colour being visible when there is no light; and colours are simply sensations due to the action of decomposed light upon the retina of the eye. It is a generally accepted theory that the transmission of light is due to wave motion of the ether (with which it is presumed space is filled and all bodies are permeated), the undulations in which are set up by the rapid vibrations of the molecules of which the source of the light is composed. The waves of light from a self-luminous body, on striking an object, are in part re-transmitted, and ultimately, if the object is within view, they fall upon the retina of the eye, and by means of the optic nerve communicate the sensation of vision, or light and colour, to the brain. White light is composed of innumerable rays which vary as to their undulatory speed—that is, their wave length (distance from crest to crest), and to this variation the difference of colour is due. Thus, the waves of red light are the longest or least rapid, and of violet the shortest or most rapid, the intermediate colours becoming shorter as to their wave length, or more rapid, in order from red to violet.

Cause of Colour.—The colour of an object is not inherent in the matter itself, but all bodies have the property of selective absorption, *i.e.*, the power to break up the light that falls upon them, and to absorb or reflect the different waves or colour rays of which the light is composed. *The colour of a body is determined by the character and intensity of the light rays that it reflects.* For instance, assuming that a cloth is composed of black, white, and red stripes, it may be stated—in a general way—that the black portion absorbs all the waves of light that touch it and reflects none; the white portion reflects all the waves of light and absorbs none; while the red portion reflects most of the red waves of light, and absorbs all, or nearly all, the others. In the same manner a blue object reflects nearly all the blue waves, and a green object nearly all the green waves, the other waves in each case being mostly absorbed and the colours extinguished. The “Absorption Spectra” of objects show what colours are reflected, and it is found that a black object reflects some light, and a coloured object a greater or less proportion of the rays other than those which determine its colour.

How Colours are Affected.—Since it is by the modification of light that colour is produced the colour of a body is affected, first, by the nature of the light—a change of light frequently causing a change of colour, this being especially the case with dyed fabrics; and, second, by the properties of the material upon which the light falls, the brightness and precision of the same colour varying, for instance, according to whether it is applied to silk, wool, or cotton. Also, the perceptive powers of the eye in different individuals is an influencing factor, as some people are “colour-blind,” or insensitive to a particular colour, and cannot distinguish, for example, red from green.

Mixtures of Coloured Lights.—Although, in the light theory, the colours are

classed in six divisions, there are really only three pure or "primary" colours—viz., red, green, and blue (ultramarine), since by combining the lights of these colours in pairs in different proportions (Rood's experiments) all the other colours of the spectrum can be produced. The following results are obtained from the combination of coloured lights :—Yellow from red and green ; bluish green from blue and green ; purple from blue and red ; orange from red and yellow ; yellowish green from green and yellow, etc., the resultant colour being intermediate in the spectrum between the colours that are mixed. By mixing the three primary light colours white is produced, while white (or a very light grey) also results from mixing a primary light colour with the colour that results from mixing the other two primary colours. Thus, a mixture of blue and yellow, green and purple, and red and bluish-green lights produces white light.

Complementary Colours.—The light colours, which, by admixture in pairs, produce white light, are considered to be complementary to each other. Thus, blue and yellow, green and purple, and red and bluish green are complementary. There are many other complementary pairs, every colour of the spectrum having its complement in another part, as, for instance, orange and blue-green, violet and yellow-green, etc. *Complementary colours are in the greatest possible contrast to one another.*

Effect of Fatigue of Colour Nerves.—The complement of a colour may be determined by placing a disc of the colour upon a sheet of white paper, looking at it intently for a time, and then transferring the gaze to another white surface. The complementary colour will appear in the form of the disc of the original colour, the image being termed the negative or after-image, while the first impression is called the positive image. In explanation of this it is supposed (the Young-Helmoltz theory) that in the retina there are three groups of nerve fibres, one group of which is sensitive to the red waves of light, the second to the green waves, and the third to the blue waves. When a colour is looked at the corresponding nerves are excited, and if the gaze be continued for a considerable time, become fatigued, while the other nerves are resting. When the eye is transferred to another surface the rested nerves produce sympathetically an after-image which is complementary in colour to the first colour. Thus, by looking at red the nerves that are sensitive to red become fatigued while the green and blue groups of nerves are resting. If a white surface (which excites the red, green, and blue groups equally) be then looked upon, the red nerves are too exhausted to respond, whereas the green and blue groups act together, so that a bluish-green after-image appears. By looking at yellow both the red and the green nerves are fatigued, and a blue after-image results, and so on.

The exhaustion of the colour nerves causes a colour, when looked at for some time, to appear duller, and in examining dyed cloths, in order to avoid this defect, it is necessary to pass from one colour to another, as for instance from red to green or olive, or to transfer the gaze at intervals to a colour which is complementary to the colour of the cloths. Further, the fatigue of the nerves has an effect upon the appearance of a colour which is viewed immediately after another colour has been looked at, and in the following list examples are given of the changes that take place :—

If red has previously been looked at—blue appears greener ; yellow appears greener ; orange appears yellower, and green appears bluer. If blue has previously been looked at red appears more orange ; yellow appears more intense ; orange

appears yellower ; and green appears yellower. If green has previously been looked at red appears more violet ; yellow appears more orange ; blue appears more violet ; and orange appears redder. The term "successive contrast of colour" is applied to the effect produced by viewing colours one after the other.

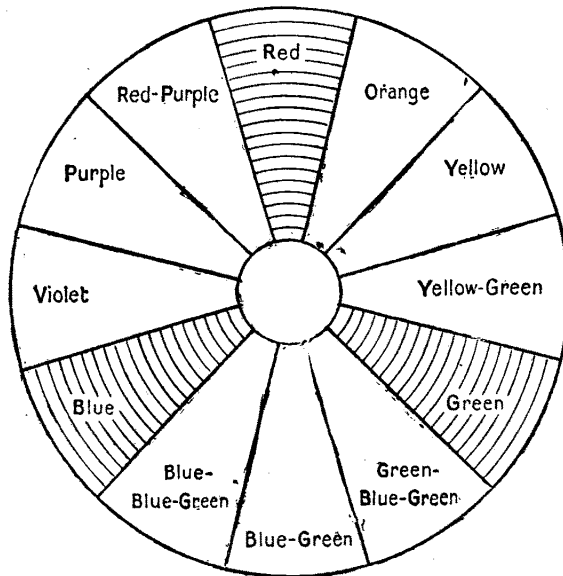


Fig. 140.

the green to the blue through greenish-blue to bluish-green; and from the blue to the red through violet, purple, and reddish purple. Opposite colours in the circle are complementary and in extreme contrast to one another.

The Chromatic Circle.

—Any two complementary colours are in the greatest possible contrast to one another, and Fig. 140 illustrates how a chromatic circle may be made which enables the colours that are complementary to be readily seen. The circle is divided into a convenient number of equal parts, in this case twelve, and at equal distances from each other the primary light colours — red, green, and blue (ultramarine)—are painted in. From the red to the green the colours are then changed through orange, yellow, and yellow-green;

PIGMENT THEORY OF COLOUR

Comparison with Light Theory.—The effects obtained by mixing dyes or coloured pigments together are different from those resulting from the mixing of coloured lights. Thus, the combination of red and green lights produces yellow, and of yellow and blue lights white ; whereas red and green pigments yield a dull brown, and yellow and blue pigments green. It has been previously stated that in mixing differently coloured pigments one colour tends to absorb or counteract the other. A third colour is produced because colouring matters reflect colour rays other than those of the predominating colour. The *absorption spectra* of coloured bodies give the colours that are reflected by them, and it is found that both yellow and blue pigments reflect green light, so that when they are mixed the combined action of the two causes practically all the light to be absorbed except the green rays. That is, the blue absorbs the red, orange, and yellow rays of light, and the yellow the violet and blue rays, so that the reflected rays of the mixture are green. It is the reflected light rays, which are common to the pigments, that govern the colour that is produced by their mixture, and the more the reflected rays of the pigments overlap the brighter is the resulting colour, while the fewer reflected rays there are in common the duller is

the colour. Both red and yellow pigments reflect orange light, red also reflects a little yellow, and yellow a little red, and the luminous orange results from their mixture. The reflected rays of red and green overlap in yellow, orange, and red light, but the quantity of each is only small, hence in this case a dull brown hue results from the mixture.

Mixtures of Coloured Pigments.—The effects produced by mixing coloured pigments is very well explained by the Brewster theory, which is adopted in the practical application of colours in dyeing. In this theory red, yellow, and blue are taken as *simple*, or *primary* colours, because they cannot be obtained by mixing other pigment colours, whereas by their admixture in different proportions, and with the addition of black and white pigments, practically all other colours can be produced. When two of the simple colours, or the three, are mixed the resultant colour is termed a *compound* colour. By mixing the primary colours in pairs *secondary* colours are formed, while the mixing of the secondary colours in pairs produces *tertiary* colours, as indicated in the following list :—

CLASSIFICATION OF COLOURS.

Primary.	Secondary.	Tertiary.
Red Yellow Blue	Green (Yellow and Blue) Purple (Red and Blue) Orange (Red and Yellow)	Russet (Purple and Orange) Citron (Green and Orange) Olive (Green and Purple)

In forming the secondary colours yellow and blue produce green, red and blue produce purple, and red and yellow produce orange; while the tertiary colours—russet, citron, and olive—respectively result from the mixing of purple and orange, green and orange, and green and purple. The tertiary colours thus result from the mixture of the three primary colours, but in each case one of the three is in excess of the other colours. Compared with the primary and secondary colours the tertiary colours are grey and dull, the colour being due to the predominating colour. Thus, red is the predominating element in russet, yellow in citron, and blue in olive. The relation of the primary, secondary, and tertiary colours to each other is shown diagrammatically in Fig. 141, and it will be found useful to the beginner to paint out such a diagram with the colours indicated, using—say—carmine or crimson lake, Indian yellow, and Prussian blue, as the three primaries.

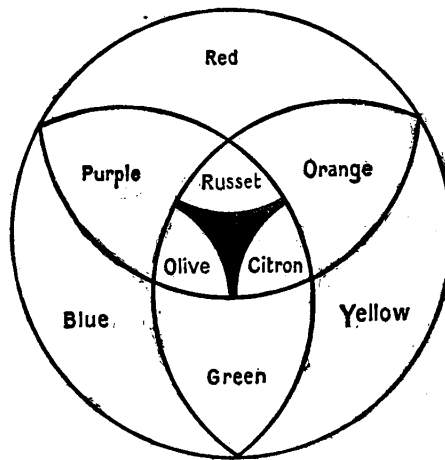


Fig. 141.

A useful diagram is also given in Fig. 142, which shows the arrangement of the primary, secondary, and intermediate colours in the Brewster theory. The circle is divided into eighteen parts, and the primary colours, red, yellow, and blue are,

placed equidistant from each other, with the secondary colours between them. Between each primary and secondary colour two intermediate colours are indicated in which the primary is in excess of the secondary in different proportions.

The term "complementary" is used in a different sense in the light and pigment theories of colouring, as in the latter theory each primary colour and the secondary colour that results from the mixing of the *other two* primaries are considered to be complementary to each other. Thus, red and green, yellow and purple, and blue and orange form complementary pairs. In the same manner each secondary colour, and the tertiary colour which results from the mixing of the other two secondaries, are taken to be complementary; green and russet, purple and citron, and orange and olive, forming complementary pairs. In Figs. 141 and 142 complementary pairs

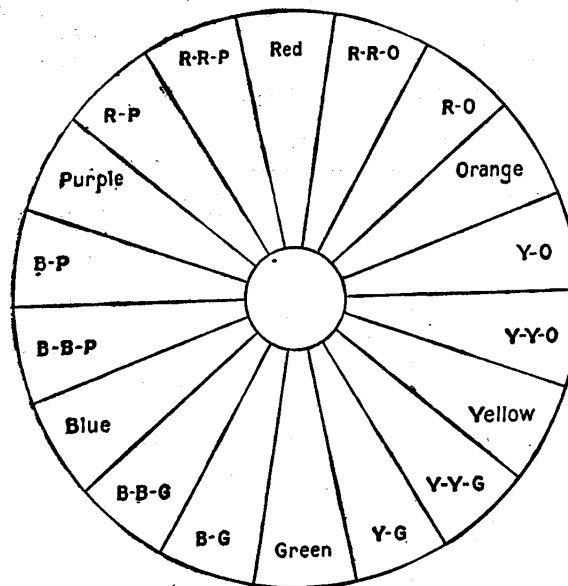


Fig. 142.

are shown opposite to each other, and it will be found useful to compare these diagrams with Fig. 140, which illustrates the *true* complementary pairs.

Colour Constants. —

Colours differ from each other in "hue," in "luminosity or brightness," and in "purity," which are termed the three constants of colour. The colours of the spectrum, which are pure colours, are accepted as the normal colours, and they are generally taken as the standard for comparisons.

The constant *hue* varies according to the wave-length of the light

rays. A difference in hue means a difference in colour, the terms blue, red, yellow, violet, etc., being employed to distinguish different colour sensations or hues from each other. A blue and a green may be exactly alike as regards luminosity and purity, but they are different in hue because the wave lengths of the blue and green light rays are different. The hue of a colour is always the predominating colour in it; thus, if an orange colour contains more red than yellow it is an orange with a red hue, whereas if yellow predominates over the red it is an orange with a yellow hue.

The constant *luminosity* varies according to the degree of light that a colour reflects, no colour being as luminous—that is, as bright or intense—as white. Yellow is the most luminous colour, then orange, and then red, while violet is the least luminous. Two reds, or two greens might be alike as to hue and yet appear different on account of one being more luminous than the other.

The constant *purity* signifies the degree in which a colour is free from white light. All pigment colours are mixed more or less with white light, and when

compared with the corresponding spectral colours appear paler. When a colour fades it loses in purity, but at the same time it may also change in hue, and in such a case there is a change in both hue and purity. A colour that is very pure is said to be saturated.

Qualities or "Attributes" of the Primary and Secondary Colours.—Different effects are produced on the mind by different colours, the impression of brightness, warmth, and nearness being conveyed by some, and of coldness and distance by others. Red is a brilliant and cheerful colour, and gives the impression of warmth. It is a very powerful colour and appears to advance slightly towards the observer. Yellow is a very luminous and vivid colour and conveys the idea of purity. It is not so warm looking as red, but appears more distinctly to advance to the eye. Blue is a cold colour and appears to recede from the eye. The qualities of the secondary colours are somewhat intermediate between the primary colours of which they are composed. Thus orange is a very strong colour and possesses warmth and brightness, but it is not so intense as yellow. Green is a retiring and rather cold colour, but appears cheerful and fresh. Purple is a beautiful rich and deep colour, and for bloom and softness is unsurpassed. The primary and secondary colours are too strong and assertive to be used in large quantities in their pure form except for very special purposes. They are chiefly employed in comparatively small spaces for the purpose of imparting brightness and freshness to fabrics; their strength being usually much reduced by mixing with black or white when they are used in large quantities as ground shades.

Modification of Colours.—Pigment colours may be modified in the following three ways:—(1) By mixing with another colour. (2) By mixing with black. (3) By mixing with white. A scale or range of colours may be obtained by each method, or by the methods in combination. Mixing a colour with another colour produces a change in hue; thus, crimson results from adding to red a small quantity of blue, and scarlet from adding to red a small quantity of yellow. The degree of the change of hue is determined by the proportionate quantities of the colours mixed. For instance, if the yellow predominates in a mixture of yellow and blue the hue is a yellowish green, but if the blue predominates a bluish green is produced. A scale of seven hues of green, running from a very yellow green at A to a very blue green at G, results from mixing yellow and blue in the proportions indicated in the following list:—

	A	B	C	D	E	F	G
Yellow	4	3	2	1	1	1	1
Blue	1	1	1	1	2	3	4

In the same manner, but with a change in the relative proportions of the colours mixed, a scale of seven hues of orange can be obtained by mixing red and yellow, as shown in the following:—

Red	1	2	3	4	5	6	7
Yellow	7	6	5	4	3	2	1

When a colour is mixed with white or black a change of *tone* results. By mixing a colour with white in different proportions *tints* of the colour are produced;

while by mixing with varying proportions of black, *shades* of the colour result. A tint is therefore a tone which is lighter, and a shade a tone which is darker, than the normal colour; and a scale of tones of a colour may be obtained running from the lightest tint to the darkest shade. The relative proportions of the colour and the white or the black may be arranged on the principles illustrated in the foregoing examples, or as shown in the following:—

White or Black Colour	7 1	6 1	5 1	4 1	3 1	2 1	1 1
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Another method of arrangement is as follows:—

White or Black Colour	7 1	5 1	3 1	1 1	1 3	1 5	1 7
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The following list gives some of the tones of the primary and secondary colours:—

The shades of red	form browns,	and the tints	rose colours and pinks.
„ „ yellow	„ olive and drab,	„ „	straw, lemon, and primrose colours.
„ „ blue	„ slates and indigos,	„ „	lavenders and pale blues.
„ „ green	„ greenish olives,	„ „	pea-green, and light greens.
„ „ orange	„ olive browns,	„ „	salmons and creams.
„ „ purple	„ maroons and puce,	„ „	lilacs and heliotropes.

Coloured Greys.—Certain neutral or broken colours—termed coloured greys—result from mixing a normal colour with both black and white in varying proportions. Thus, a scale of red greys, running from dark to light results from mixing white, black, and red in the proportions given in the following list:—

White	1	2	3	4	5	6	7
Black	7	6	5	4	3	2	1
Red	1	1	1	1	1	1	1

The white and black alone would produce a scale of seven pure greys running from dark to light, but to each of these is added the same proportion of red—viz., one part of red to eight parts of grey. The scale thus varies as to light and shade, but is equal as to colour. In the next list a different arrangement of the proportions is given, an increasing quantity of colour being added to an equal amount of pure grey; the seven blue greys which result thus varying as to colour, but being equal as to light and shade except for the influence of the colour.

White	4	4	4	4	4	4	4
Black	4	4	4	4	4	4	4
Blue	1	1½	2	2½	3	3½	4

A “mode” shade is a broken colour in which a certain hue predominates over a pure grey.

Contrast and Analogy.—These terms are used in reference to the hue and tone of colours. Colours which are very dissimilar, such as green and red, blue and yellow, blue and red, etc., are said to be in colour contrast; while colours which are alike, or contain a common element, such as red and reddish-orange, green and

bluish-green, etc., are said to be analogous in colour. In the same manner there is contrast of tone, as in dark blue and light blue, or light green and dark red; and analogy of tone as in light blue and light yellow, and mid blue and mid green, etc. Two colours may be in contrast in both colour and tone, or in analogy in both, or in contrast in one and in analogy in the other.

COLOURS IN COMBINATION

Kinds of Contrast.—There are two heads under which colour combinations are classed—viz., **mono chromatic contrasts**, and **poly-chromatic contrasts**. Mono-chromatic contrasts are those in which different tones of the same colour are combined; as, for instance, two shades of red, or three tints of blue, etc. Softly graded contrasts result which are specially suitable for such fabrics as overcoatings, suitings, and costumes. Poly-chromatic contrasts include all combinations of two or more different colours which may be alike or different in tone—e.g., light green and light blue, and light green and dark red. A style partakes of both classes of contrast when a ground pattern, consisting of different tones of the same colour, has bright threads of another colour introduced upon it at intervals for the purpose of improving the effect.

Effect of Contrast.—Two kinds of contrast may be formed by colours that are in combination—viz., “successive contrast” and “simultaneous contrast.” In successive contrast (which is referred to on page 134) the colours are such a distance apart that one is perceived after the other. In simultaneous contrast the colours are placed in juxtaposition, or side by side, so that both are seen at the same time. The same law governs both classes of contrast, and in each case the colours have the property of changing each other's qualities; but the change is greater when the colours are in actual contact than when they are seen separately.

Simultaneous Contrast.—Colours that are in juxtaposition are subject to two kinds of contrast—viz., “contrast of hue” and “contrast of tone.”

Contrast of Hue.—In contrast of hue each colour influences its neighbour, since each appears to be tinged with the complementary hue of its neighbour. Thus, in a cloth consisting of red and blue stripes the red appears tinged with yellow—the complementary of the blue, and the blue with bluish-green the complementary of the red. As a further illustration, it may be assumed that in a stripe fabric, the colours are arranged in the order of red, blue, red, green, blue, and green, a blue stripe being formed between two red stripes and then between two green stripes. The blue stripes, although dyed exactly the same, would appear different, because in one case the blue is tinged with bluish-green—the complement of red, and in the other case with purple—the complement of green. One stripe of blue would thus appear greener, and the other more violet than is actually the case.

The change in colours due to simultaneous contrast can be readily judged by an examination of the chromatic diagram given in Fig. 140. The effect is to make the colours that are in contact appear further apart in the circle; thus in a combination of blue and red the blue inclines towards blue-green, and the red towards orange; while in a combination of purple and yellow the purple becomes more violet and the yellow rather greener. It will be seen that simultaneous contrast makes the colours more unlike, and when colours that are opposite in the circle are combined

the contrast between them is intensified, and if suitably proportioned both colours are enriched.

Contrast of Tone.—This comes into play when two tones of the same colour are in juxtaposition—*e.g.*, dark blue, and light blue—and when dark and light colours are placed together—*e.g.*, dark blue and light green. The dark colour, by contrast, makes the light colour appear lighter than it actually is, while similarly, the light colour makes the dark colour appear darker than it is. On a white ground colours appear deeper and darker; on a grey ground they appear about normal; whereas on a black ground they look brighter and lighter.

HARMONY IN COLOUR COMBINATIONS

Harmony of colour is not governed by fixed principles, and any combination of hues that is pleasing and gives full satisfaction to the observer may be said to constitute harmony. The colour sense in different persons, however, varies—being more highly developed in some than in others—and what may appear harmonious to one may be more or less inharmonious to others. In combining colours the influence that one colour has upon another should be carefully thought out, so that they may be arranged in such a manner that they will enhance and enrich, rather than impoverish each other. Harmony is obtained when the proper hues are so associated that every particle of colour is helpful to the complete colour scheme. It is usual to distinguish between two kinds of harmony—*viz.*, harmony of analogy and harmony of contrast.

Harmony of Analogy.—There are two ways of producing a harmony of analogy—(1) By the combination of tones of the same colour that do not differ widely from each other. (2) By the combination of hues which are closely related and are equal or nearly equal in depth of tone. Different tints of blue, or shades of green when combined, yield a “harmony of analogy of tone” if the difference between them is not too marked. Tone-shaded effects are produced by combining a series or scale of tones of a colour which are so graded and arranged as to run insensibly one into another. In a combination of yellowish-green and bluish-green, yellow and blue are differentiating colours; but there is a common element in green, and if the two hues are nearly equal in depth of tone, and are harmonious when united, they form a “harmony of analogy of hue.” Harmonies of analogy are of chief value in producing quiet effects.

Harmony of Contrast.—There are two ways of producing a harmony of contrast—(1) By the combination of widely different tones of the same colour. (2) By the combination of unlike colours. Thus, a pleasing combination of two tones of blue, the interval between which is marked, forms a “harmony of contrast of tone,” while the union of red and green, red and blue, or blue and yellow, if harmonious, forms in each case a “harmony of contrast of hue.” Harmonies of contrast are useful when clear smart effects are required. As previously stated (p. 139) there may be analogy in tone and contrast in hue, or contrast in tone and analogy in hue in a combination.

There is also “harmony of succession—or gradation—of hue” (which partakes somewhat of both kinds of harmony) in which there is a succession of hues that pass insensibly one into the other—the spectrum being a typical example. Red and yellow, when combined, are in colour contrast; but by introducing between them

a series or scale of hues of orange—running from reddish-orange to yellowish-orange—the two colours may be so blended one into the other that there is no sharp contrast, and an effect closely related to harmony of analogy is produced. Similarly, yellow may be passed imperceptibly into blue through a series of hues of green, and blue into red through hues of violet and purple.

Basis of Colour Harmony.—Complementary hues are harmonious, but in their pure state they yield contrasts that are too strong. The colours still form similar complementary pairs when reduced by means of black, or white, or both black and white, and in this condition they form most harmonious combinations. A study of the complementary hues, and their shades, tints, and broken colours, is therefore of great value as an introduction to the combining of colours, and as a basis of colour harmony. The painting out of colour circles, such as those shown in Figs. 140, 141, and 142, is a useful means of acquiring a knowledge of hues that harmonise, as colours that are opposite in the circles go well together except when they are too strong.

It is not necessary, however, to only select colours that are complementary in order to produce harmony, and it is generally considered that it is better to combine hues which are from 20 to 30 degrees on one side or the other of their complements, as these are not so strongly in contrast. It will be noted that in Fig. 142 (Brewster's theory of arrangement) opposite colours are not so strongly in contrast as in Fig. 140, in which the colours are arranged according to the Young-Helmholz theory. The effect of contrast, when complementary or near complementary colours are in contrast, is to enrich the colours.

In producing a harmony of contrast it is a good rule to select colours that are separated by at least 90 degrees on the chromatic circle, shown in Fig. 140. Related colours, which are from about 30 to 90 degrees apart on the circle, such as blue and purple, yellow and green, etc., are in most cases inharmonious. Colours that are very near together in the chromatic circle can be combined in producing a harmony of analogy of hue. When a large number of hues are employed in a design colours that are similar usually preponderate. For example, in a green scheme of colouring—greenish-blues, bluish-greens, and blue can be employed on the one side, and greenish-yellow, yellowish-greens, and yellow on the other side; and in this way all the colours can be run through—in this case, of course, with greens predominating. In any combination of colours, one hue should predominate somewhat over any other hue, either in area or intensity, in order that the design will possess character. If the colours are united so as to be about equally prominent, the design will appear monotonous, however well the hues harmonise; this being especially the case if the colours are bright.

Dark grounds are more suitable for the application of bright colours, such as red, orange, and yellow, than light grounds, as their qualities of brightness and intensity are improved on the former, and diminished on the latter. On the other hand sombre colours, such as violet and purple, are deepened and enriched on light grounds and suffer on dark grounds.

Relative Spaces occupied by Colours.—While allowing for a predominating hue it is usual to arrange the spaces occupied by the several colours in a design in accordance with the relative intensity of the hues. Too great an excess of a colour is injurious to an effect, and it is necessary to employ a strong colour more sparingly than a less intense colour. Thus, a combination of a shade of blue with intense

yellow might be harmonious if the space occupied by the blue largely predominated; whereas with the yellow predominating, the effect would be displeasing on account of the blue being overpowered by the greater luminosity of the yellow. In the same manner a few threads of bright red on a toned green foundation might prove pleasing where a large number of threads of red would appear crude.

In combining threads which are in strong contrast, the space occupied by each hue or tone should be small, but if the contrast is subdued, the space allotted to each may be large. This is illustrated in a general way by the following lists in which the contrast is represented relatively by the terms black, grey, and white; the black and white producing a strong contrast, and the black, or white with grey more subdued effects, as the grey more nearly approaches the black or the white.

- | | | | | | | | |
|-----|----|---------|-------|-----|----|---------|-------------|
| (a) | 2 | threads | black | and | 2 | threads | white. |
| (b) | 4 | „ | „ | „ | 4 | „ | light grey. |
| (c) | 8 | „ | „ | „ | 8 | „ | mid grey. |
| (d) | 16 | „ | „ | „ | 16 | „ | dark grey. |
| | | | | | | | or |
| (e) | 2 | threads | white | and | 2 | threads | black. |
| (f) | 4 | „ | „ | „ | 4 | „ | dark grey. |
| (g) | 8 | „ | „ | „ | 8 | „ | mid grey. |
| (h) | 16 | „ | „ | „ | 16 | „ | light grey. |

Divisional Colours.—In many combinations the contrast has the effect of making the colours appear blurred and confused at their joining. In such a case, and when the colours are too strong in contrast, hues of a neutral character, or black, grey, or white may be employed to separate the colours. The strength of the contrast is thereby reduced, and the colours are made to appear clear and precise. When a colour is used to form the divisional line its qualities should be about intermediate between those of the two colours, or a paler tone of either colour may be suitable. Black can always be successfully used to separate two bright colours, while white and grey are useful in separating a bright and a sombre colour, or two sombre colours, grey being used instead of white when the latter forms too strong a contrast.

Although black is not so useful in separating a bright and a sombre colour as two bright colours, it can be successfully employed in combination with the sombre colours, such as blue and violet, and the darker shades of the luminous colours, in forming a harmony of analogy.

HOW COLOURS ARE MODIFIED IN TEXTILE FABRICS

The following factors tend to modify colours in their application to textile fabrics:—(a) The physical structure of the raw material; (b) The mechanical construction of the yarn. (c) The structure of the cloth. (d) The finish applied to the cloth after weaving. The presence or absence of lustre in a fabric to which colour is applied has a great influence upon the appearance of the colour, and in very many cases lustre is imparted to cloths in the process of finishing for the purpose of enhancing the brightness of the colour. On the other hand, cloths are finished with a rough fibrous surface in order that the colours will appear deep and full.

(a) The different raw materials vary extremely as to lustre. The silk fibre is perfectly smooth, is somewhat transparent, and has the greatest lustre; hence

colours upon silk are most brilliant and rich. The fibre has such a high-reflecting power that low-toned colours appear well upon it which may readily show dull and poor when applied to other materials. In wool the lustre varies according to the class of the material. The fibres of long wool (and mohair and alpaca) have comparatively large and flat outer scales, and being smoother this class of wool takes a brighter colour than short wools, the outer scales of which are small and have free protruding edges which disperse the light. The special quality of the colour upon long wools is its brightness, and upon short wools fulness and softness. The cotton fibre has a downy surface, and in its natural condition possesses very little lustre, hence in dyed cotton the colour is lacking in brightness as well as softness. In mercerised cotton the colour has a much brighter appearance owing to the material being made smoother and more transparent. Flax, hemp, and jute also take a dull tone of colour; but China grass, which is more lustrous, ranks next to long wool and mercerised cotton in giving brightness of hue when dyed.

(b) The tone of a colour is influenced to a considerable extent by the way the fibres are arranged in the thread, as the straighter and more parallel the fibres are laid the more lustrous is the thread. Thus worsted yarns, in which the fibres are arranged as straight as possible, take a bright tone of colour, while in woollen yarns, in which the fibres are intermingled and crossed with each other, the tone of the colour is soft and mellow. In the same manner a combed and gassed cotton thread takes a brighter tone of colour than the rougher carded cotton thread.

(c) The manner in which the warp and weft threads intersect each other, and the frequency of the intersections influence the brightness of the colour, as they affect the smoothness of the surface of the cloth. Other things being equal, the more frequent the intersections are the more subdued is the tone of the colour; but the way in which the intersections are arranged has a considerable effect upon the brightness. Thus a warp twill weave produces a rougher surface and appears duller than a warp sateen weave on the same number of threads; the latter type of weave yielding the smoothest surface it is possible to construct, and therefore giving the brightest tone to the colour.

(d) Two distinct types of finish are applied to cloths—a clear finish and a raised finish. In the clear finish all the loose fibre is removed from the face of the cloth, and the operations tend to promote smoothness and lustre of surface and to increase its reflecting power, hence the brightness and precision of the colour are enhanced. In the raised finish the fibres are drawn on to the surface of the cloth, which is covered with a soft even nap into which the light penetrates and becomes saturated with the colour before being reflected. The colour appears soft and subdued; but it is brighter in tone when the surface fibres are laid smoothly in one direction than when they are made to stand vertically from the foundation. In the latter case the light is dispersed and the colours acquire greater fulness and depth of tone.

CHAPTER XI

APPLICATION OF COLOUR—COLOUR AND WEAVE EFFECTS

Mixed Colour Effects—Methods of Production—Fibre Mixture Yarns—Twist Yarn Mixtures. *Combinations of Differently Coloured Threads*—Colour Stripes and Checks—Simple Regular Patterns—Simple Irregular Patterns—Compound Orders of Colouring—Counter-Change Patterns—Graduated Patterns—Modification of Stripe and Check Patterns—Balance of Contrast in Pattern Range Designing—Colour Combinations in Relation to Weave. *Colour and Weave Effects*—Representation of Colour and Weave Effects upon Design Paper—Methods of producing Variety of Effect in the same Weave and Colouring—Classification of Colour and Weave Effects—Simple Colour and Weave Effects—Continuous Line Effects—Shepherds' Check Patterns—Bird's Eye and Spot Effects—Hairlines—Step Patterns—All-Over Effects.

COLOURS may be dyed upon textile materials at various stages of manufacture—*e.g.*, in the loose fibre state, in the sliver or top condition, and in the form of the spun thread or the woven cloth. The object in each case may be to produce a solid colour effect in the woven cloth by employing only one colour. On the other hand, different colours may be combined at one or other process of manufacture with the object of producing either a mixed or intermingled colour effect, or an effect in which each hue appears distinctly as a solid colour.

MIXED COLOUR EFFECTS

Methods of Production.—The following methods of producing mixed colour effects are employed :—

(1) By blending differently coloured fibres which have been dyed in the raw or the sliver condition, producing "mixture yarns." A somewhat similar mixed colour effect is obtained in "melange" yarns, which are produced by printing the slivers in bands of different colours that the subsequent drawing operations cause to be more or less thoroughly intermingled in the spun thread.

(2) By introducing small patches of dyed fibres into the slivers at the later stages of the processes preceding spinning; a thread spotted with the colour being produced.

(3) By spinning from differently coloured rovings, producing "marl" yarns, in which the colours are blended only to a limited extent; the resultant thread, in some cases, having almost the appearance of being composed of two differently coloured threads twisted together.

(4) By printing the spun thread in bands of different colours.

(5) By twisting together differently coloured threads producing various kinds of fancy twist yarns.

(6) By combining (either as a fibre mixture or a twist) two materials in the undyed state which have different affinities for colouring matters—*e.g.*, wool and cotton, and submitting the woven cloth to two dyeing operations (cross-dyeing).

(7) By employing differently dyed threads, arranged one, or at most two, threads at a place, and using weaves of a crêpe or broken character.

Fibre Mixture Yarns.—In mixtures of differently dyed fibres the degree in which the colours are intermingled varies according to the number and character of the processes which follow the blending. The mixing may be done in the later stages prior to spinning with the object of producing a colour mixture in which each colour retains its purity. On the other hand, by blending in the early stages, colour effects are produced which are quite unlike those obtained by mixing colours in any other way. The differently dyed fibres are so thoroughly intermingled that a new colour results, in which, however, the separate colours can be distinguished by close examination. For instance, an intimate mixture of yellow and blue fibres produces a hue of green which is quite different from any green that can be obtained by mixing yellow and blue pigments, because in the fibre mixture each colour retains, in some degree, its individuality, whereas in the pigment mixture the original colours are effaced.

Various classes of fibre mixtures are included in the following list :—

- (1) Mixtures of white and black producing greys.
- (2) Mixtures of one colour with white or black producing tones of the colour.
- (3) Mixtures of different tones of the same colour.
- (4) Mixtures of two or more colours.
- (5) Mixtures of two or more colours with white or black.
- (6) Mixtures of black and white (grey) with one or more colours producing coloured greys.

In producing a scale of hues, tones, or greys, the quantities of the different constituents may be arranged on the principle illustrated in the examples of mixing pigments (pp. 137 and 138). The best arrangements, as a rule, are those in which the sum of the proportions is the same in each hue or tone, as in the following example :—

Colours	A	B	C	D	E
Dark Olive	5	5	5	5	5
Black	1	2	3	4	5
White	2½	2	1½	1	½
Lavender	2½	2	1½	1	½
Orange	1	1	1	1	1

The most suitable materials for fibre mixtures are the fairly strong and lustrous medium wools, such as are used in the manufacture of mixture serges and tweeds.

In selecting the colours to be mixed the following rules are of general application :—(a) In a mixture of two tones of the same colour there should be a distinct difference between the two. (b) The colours should harmonise when laid side by side before mixing. (c) The proportionate quantities should be in accordance with the relative intensities of the hues, subdued colours, and black and white being chiefly employed, while bright colours are introduced in small quantities for the purpose of imparting brightness.

Twist Yarn Mixtures.—In yarns composed of differently coloured threads twisted together there is no intimate intermingling of the fibres, so that each colour is seen separately, the twisting of the threads simply breaking the continuity of the colours.

The prominence of an intense colour can be reduced without its purity being affected, and the yarns are, therefore, specially useful in cases in which the introduction of a self-coloured thread would cause the hue to show too strong.

The various classes of fancy twist threads include the following :—

Grandrelle yarns are composed of two or more differently coloured threads twisted together. These yarns sometimes predominate in a cloth, as for instance in covert-coatings, and analogous colours are then used, such as two tones of olive or brown, etc. When, however, the threads are only used in small quantities in a cloth one of the colours should be strong; thus scarlet, orange, bright blue, or light green may be twisted with black. A class of grandrelle shirting is woven in which cotton twist threads predominate, and in these yarns white and a rather strong colour, such as blue or red, are largely used in combination.

Spiral yarns are composed of two threads twisted tightly together (which may be alike or in different colours) round which a soft spun thread is twisted spirally.

Gimp yarns, which mostly handle somewhat harsh, consist of a central hard twisted thread, and a soft spun thread, which is given in more rapidly than the centre thread.

Diamond yarns consist of a thick centre thread, round which two fine threads are twisted in opposite directions, thus producing a diamond effect.

Curl or *Loop* yarns consist of a fine foundation thread, a soft-spun thick thread, which is given in rapidly so that it forms loops at intervals, and a fine binder thread.

Knop yarns are composed of one or two foundation threads which are twisted with a third thread, but the latter, at intervals, is wrapped round and round the former so as to produce lumps or knops.

Cloud, *Slub*, or *Flake* yarns are composed of two foundation threads, with which pieces of short-fibred twistless slivers are twisted at intervals.

Different hues, and also different materials, can be combined in various ways in the yarns. In the grandrelle, spiral, gimp, and diamond yarns the colours appear regularly, whereas in the curl, knop, and cloud threads a special colour can be shown prominently at intervals. In the same thread combinations of two or more of the effects can be produced in diverse ways.

COMBINATIONS OF DIFFERENTLY COLOURED THREADS

Effects are produced by combining differently coloured threads as follows :—

(a) With the warp in one colour and the weft in another colour, forming a "shot" effect. (b) With the warp in different colours and the weft in one colour, producing a stripe. (c) With the warp in one colour and the weft in different colours, producing a cross-over effect. (d) With both the warp and the weft in different colours, producing a check style. In addition, in the production of special stripe, spotted, and figured designs, different colours may be introduced by employing one or more series of extra weft, extra warp, or both extra weft and extra warp threads.

Colour Stripes and Checks.—An arrangement of weft threads in a cloth can also be employed for the warp threads, and *vice versa*; therefore, stripe and check colour combinations are considered together in the following. The patterns result from the combination, in equal or unequal spaces, of two, three, or more colours, and in their construction it is necessary to have the following in mind :—

(a) Colours which harmonise, and tones that will assist harmony should be selected.

(b) Each colour or tone should be allotted a suitable extent of surface.

(c) The appearance of a colour is influenced by the weave, as different weaves break up the colours on the surface of a fabric in a varying degree; the effect, for instance, of a 2-and-2 twill being quite different from that of a 1-and-3 warp twill or sateen. A continuous warp face weave, although suitable for a stripe, is quite inapplicable to a check. To produce a *perfect* check, weaves with equal warp and weft float should be employed and the weft threads should be similar to the warp threads as regards number, thickness, material, and colour arrangement.

Stripe and check effects may be conveniently classified into: patterns in two colours, and patterns in three or more colours; both of which may be subdivided broadly into regular and irregular orders of colouring. Arrangements of coloured threads are also classified into—simple orders, and compound orders.

Simple Regular Patterns.—Examples of regular patterns in two colours are—4 threads dark and 4 threads light, or 16 threads dark and 16 threads light; and a three-colour style—8 threads dark, 8 threads medium, and 8 threads light. A four-colour regular pattern may be arranged—6 threads first colour, 6 threads second colour, 6 threads first colour, 6 threads third colour, 6 threads first colour and 6 threads fourth colour; in which the second, third and fourth colours are separated from each other by the first colour. The regular arrangements do not, as a rule, yield interesting styles, but small patterns are more effective than large patterns. In some cases, however, the combination of the weave with the colour scheme modifies the stiffness of the form and makes it more pleasing. A regular order is very often employed as a ground effect in a special stripe or check design; while sometimes a slight change in a pattern is made at intervals in order to render it more interesting. For instance, a 6×6 order of colouring might be arranged—6 threads first colour, and 6 threads second colour for five times; then 6 threads first colour, 2 threads second colour, 2 threads third colour, and 2 threads second colour. In check patterns a two-colour scheme gives three; the third hue being produced where the two colours cross each other. In the same manner six colour effects are produced in a three-colour scheme—viz., colours 1, 2, and 3 separately, 1 and 2 together, 1 and 3 together, and 2 and 3 together.

Simple Irregular Patterns.—The irregular colour arrangements permit much more detail and diversity to be introduced than the regular styles. Examples in two colours are 6 threads dark and 2 threads light, or 16 threads dark and 8 threads light; while a three-colour irregular pattern is—12 threads dark, 8 threads medium, and 4 threads light. The last example, if produced in check form, gives a variety of shapes—viz., 12×12 , 8×8 , 4×4 , 12×8 , 12×4 , and 8×4 .

Compound Orders of Colouring.—A compound order of colouring is a combination of two or more simple orders, each of which is repeated a number of times. A variety of arrangements is given in the following list (p. 148).

Example 1 is a combination of three regular simple orders in two colours; example 2, of two regular orders in three colours; example 3, of two irregular orders in two colours; example 4, of three irregular orders in three colours; while example 5 illustrates the arrangement of regular and irregular orders in two colours, and example 6, in three colours.

EXAMPLES OF COMPOUND ORDERS OF COLOURING.

<p>1</p> <p>1 dark } 8 times 1 light } 2 dark } 4 times 2 light } 1 dark } 8 times 1 light } 4 dark } 4 times 4 light }</p> <p>2</p> <p>2 dark } 6 times 2 medium } 2 light } 4 dark } 3 times 4 medium } 4 light }</p>	<p>3</p> <p>2 dark } 8 times 1 light } 4 dark } 6 times 2 light }</p> <p>4</p> <p>3 dark } 6 times 2 medium } 1 light } 1 dark } 6 times 2 medium } 3 light } 1 dark } 3 times 4 medium } 1 light }</p>	<p>5</p> <p>2 dark } 8 times 2 light } 3 dark } 4 times 1 light } 2 dark } 2 times 2 light } 1 dark } 4 times 3 light }</p> <p>6</p> <p>3 dark } 4 times 3 medium } 3 light } 4 dark } 4 times 3 medium } 2 light }</p>
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Counter-change Patterns.—The term counter-change is applied to styles in which the colours change positions; one colour being allowed to predominate in one section of the pattern, and another colour in the next section in exactly the same proportion. An illustration in two colours is—8 threads dark, 2 threads light, 8 threads dark, then 8 threads light, 2 threads dark, and 8 threads light. Three colours may be introduced on this principle, as for example—12 threads dark, 4 threads medium, 12 threads dark; then 12 threads medium, 4 threads light, and 12 threads medium.

Graduated Patterns.—In these styles the spaces occupied by the colours are gradually increased or decreased in size, as shown in the following examples :—

EXAMPLES OF GRADUATED PATTERNS.

1.	First Colour	1	3	5	7	9	11	
	Second Colour	2	4	6	8	10	12	
2.	First Colour	2	6	10	14	10	6	
	Second Colour	4	8	12	12	8	4	
3.	First Colour	2	4	8	16	8	4	
	Second Colour	4	8	16	8	4	2	
4.	First Colour	2	1	6	8	10	12	
	Second Colour	12	10	8	6	4	2	
5.	First Colour	2	4	6	8	6	4	
	Second Colour	3	3	3	3	3	3	
6.	First Colour	1	3	5	7	7	5	3
	Second Colour	2	6	6	6	6	2	
	Third Colour		4		8		4	

Example 1 illustrates "single-shading," in which the threads are graduated in one direction only, whereas examples 2 and 3 show "double-shading" the number

of threads of each colour being gradually increased and then decreased. Example 4 illustrates inverse shading; the number of threads of one colour increasing, while those of the other are decreasing. In example 5 the first colour is double-shaded, whereas the second colour is stationary; and example 6 is illustrative of shading in three colours.

Modification of Stripe and Check Patterns.—One of the principal features in the designing of colour stripes and checks is the production of a great variety of effects by repeatedly introducing slight changes in the arrangement of the threads. The modifications may be made in the warp at intervals, either while the threads are being run on the weaver's beam, or in the loom; the changes in the weft pattern to correspond offering no difficulty. The examples given in Fig. 143 illustrate, in a general way, the system of working as applied to the modification of a stripe. Two colours only are mostly represented, but the method holds good when more colours are used. Commencing with the regular stripe, indicated at A, the first modification consists of bisecting each stripe, as shown at B, and the second by introducing two stripes in the centre, as represented at C. The stiffness of a symmetrical pattern may be reduced by introducing a line in a different colour, in the manner indicated by the differently shaded line in C. This line, in a check style, will produce an over check. Example D in Fig. 143 shows a modification which is symmetrical in form; while in each example E and F one half of the pattern is symmetrical and the other half non-symmetrical. A compound arrangement of the threads is illustrated at G and a graduated pattern at H.

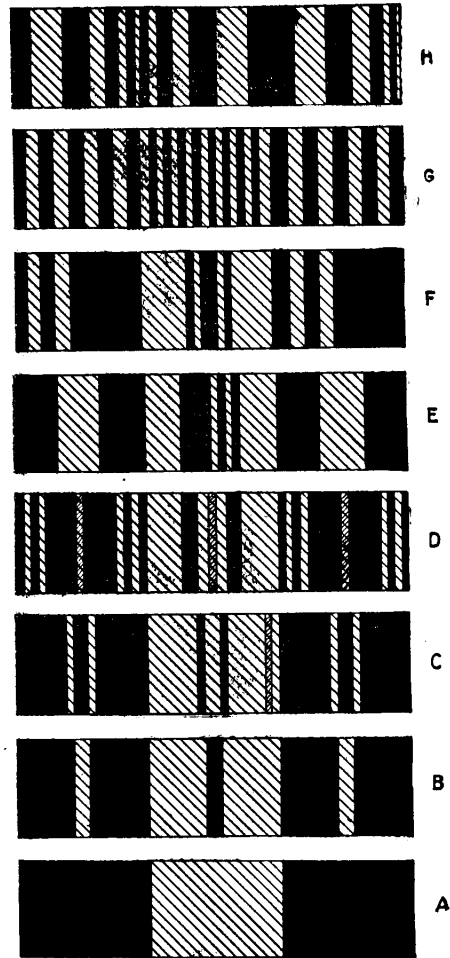


Fig. 143.

In painting out coloured stripe patterns the form of the design may be first lightly indicated in pencil; then in order that the stripes will be clearly defined lines of colour should be ruled at the edges by means of a ruling pen. The liquid colour can be readily inserted in the pen with the brush that has been employed in mixing the pigment, and the brush can be used in washing in the colour between the ruled lines. In some cases it is convenient to paint the ground shade entirely over the surface of the design before the specially coloured stripes are painted in;

or, in place of this method, suitably coloured paper may be used for the ground shade upon which the special stripes are painted.

Balance of Contrast in Pattern Range Designing.—The examples given in Fig. 143 are all different in form, and each therefore constitutes a distinct style. In pattern designing, however, it is frequently necessary to produce a range of effects which will form only one style. In the latter case the arrangement of the threads requires to be exactly the same in each pattern in the range. The difference between the patterns is due to different colours being used; and it is necessary to obtain the same degree of contrast in colour and tone in each pattern. After the form of the style has been decided upon, the number of colours to be used, and their relative intensity in the different sections may be determined; the most intense colour, of course, being allotted to the smallest section. The colours of the first pattern may then be selected, and when found satisfactory, these are employed as the toning of every other pattern in the range. The system of working is illustrated by the following example of a range of stripes :—

Form of Stripe	A	B	C	X	Y
16 threads	Black	Black	Black	Black	Brown
4 threads	Dark Green	Dark Blue	Brown	Orange	Black
16 threads	Black	Black	Black	Black	Brown
2 threads	Red	Orange	Light Green	Dark Blue	Light Green

In each pattern A, B, and C the least intense colour or black is allotted to the largest section (16 threads), the medium colour to the next largest section (4 threads), and the brightest colour to the smallest section (2 threads). The dark green, dark

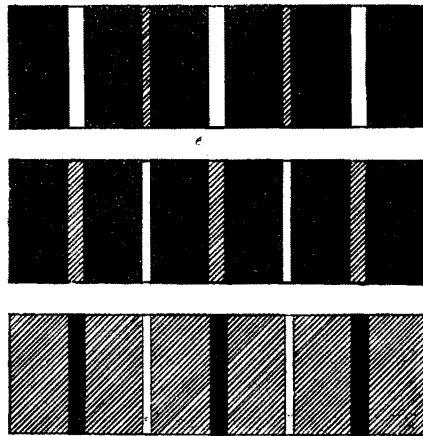


Fig. 144.

and with the first pattern. This is illustrated in Fig. 144, in which the relative intensities of the colours are represented diagrammatically. In each pattern A, B, and C, in the above list, the colours would appear relatively as shown at A in Fig. 144, only one style being formed; but in patterns X and Y the colours would be relatively as shown at X and Y in Fig. 144, each forming a distinct style on account of the difference in the contrast between the sections.

blue, and brown, in the medium-size section, should be equal in depth of tone, and there should be the same degree of contrast between the dark blue and the orange in pattern B, and between the brown and the light green in pattern C, as there is between the dark green and the red in the first pattern A.

Patterns X and Y in the list illustrate a wrong principle of arrangement. The same colours are employed as in the patterns B and C respectively, and the threads are arranged in the same order, but the position of the colours is changed, therefore the effects produced by X and Y would be out of balance with each other

Colour Combinations in Relation to Weave.—The weaves that are employed in conjunction with combinations of coloured threads may be broadly divided into the following three classes:—(1) Weaves which bring the warp and weft threads equally, or nearly equally, to the surface of the cloth, and enable the colours to be applied in both warp and weft. This type gives the greatest scope for colour effects. (2) Warp face weaves, in which the weft is almost entirely concealed, so that it is necessary to apply the colours chiefly in the warp. (3) Weft face weaves, in which the warp is nearly concealed, and in which it is seldom possible to apply the colour except in the weft. In some styles, however, notably hair-line effects, it is necessary to introduce the colours in both warp and weft, although one of the yarns is chiefly on the underside.

COLOUR AND WEAVE EFFECTS

A colour and weave effect is the form or pattern in two or more colours produced by colour and weave in combination. It is frequently quite different in appearance from either the order of colouring or the weave, because (a) the weave tends to break the continuity of the colours of warp and weft; and (b) a colour shows on the face of the fabric, whether it is brought up in warp float, or in weft float. This is illustrated in Fig. 145, where, in the 2-and-2 twill weave, A shows the effect produced by colouring 3 black, 3 white in the warp, with white weft; B, 3 black, 3 white in the weft, with white warp; and C, 3 black, 3 white in both warp and weft. Each effect consists of a small black form on a white ground; but while in A the floating of the black warp on the face produces the form, in B it is produced by the floating of the black weft, and in C by the combination of black warp float and black weft float on the surface.

Representation of Colour and Weave Effects upon Design Paper.—Colour and weave effects may be readily indicated upon point-paper, and for experimental purposes the method is useful, since it enables the designer to

see the effect any colour plan will produce with a given weave. Also, by viewing the point-paper sketch through a cloth-counting glass held at a suitable distance, the appearance of the pattern, when reduced approximately to the size it will be in the cloth, can be observed. Three things require to be known—viz., the order of warping, the order of wefting, and the weave. The examples D to I in Fig. 146 illustrate in stages the working out of an effect in which the threads are arranged 3 dark, 3 light in warp and weft, while the weave is

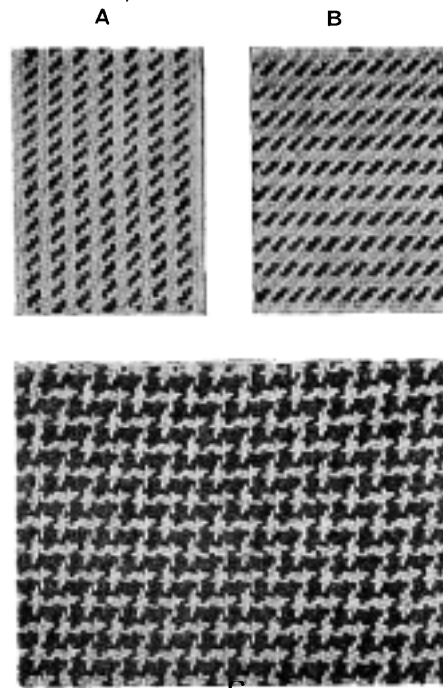


Fig. 145.

2-and-2 twill. The example corresponds and may therefore be compared with that shown in Fig. 145. The size of the repeat is obtained by finding the

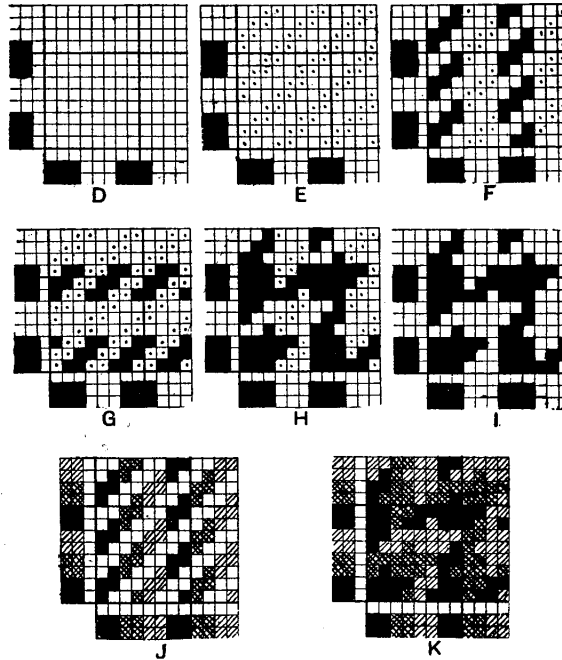


Fig. 146.

L.C.M. of the number of threads in one repeat of the colour plan, and in one repeat of the weave—in this case 12 ends by 12 picks. At D the arrangement

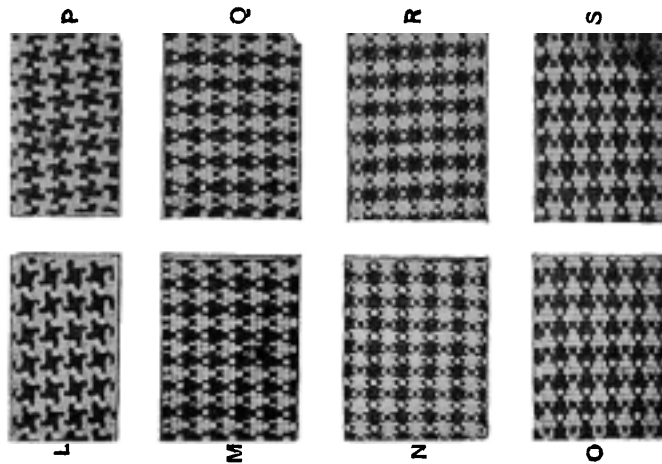


Fig. 147.

of the ends as to colour is indicated along the bottom, and of the picks up the side of the reserved space. At E, the weave is inserted lightly in pencil; the

weave marks indicating warp float. At F the dark ends are followed vertically in successive order, and where there are weave marks—that is, where the warp is floated on the surface—the squares are filled in solid. At G the dark picks are followed horizontally in successive order, and where there are blanks in the weave—that is, where the weft is floated on the surface—the squares are filled in solid. H shows the appearance of the sketch at this stage, while I represents the complete effect with the weave marks on light threads rubbed out.

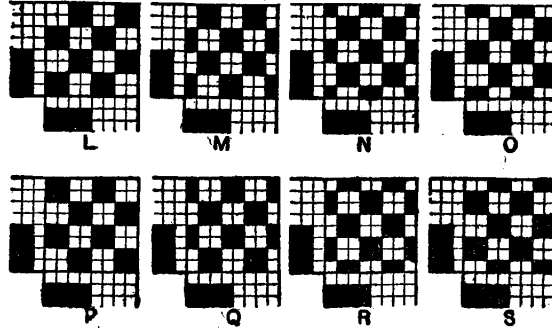


Fig. 148.

If the weave marks indicate weft, the blank spaces are filled in solid in following the dark ends, and the marked spaces in following the dark picks.

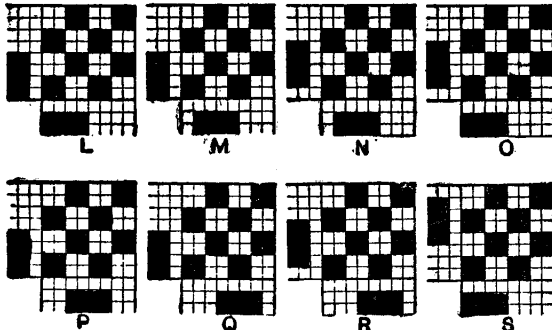


Fig. 149.

In the plan I in Fig. 146 the marks represent one colour and the paper the other colour. In working out an effect in colours, the ground may be indicated in the second colour after the first colour has been painted in in the manner described; or the lighter colour may be first painted entirely over the space, and the pattern in the darker colour be afterwards indicated over it.

The method of working is similar when more than two colours are employed, as shown at J and K in Fig. 146. The weave is 2-and-2 twill, and the warp and weft threads are arranged 2 dark, 2 medium, 2 light—the different colours being represented by different marks. The ends are followed first, each colour being dealt with in

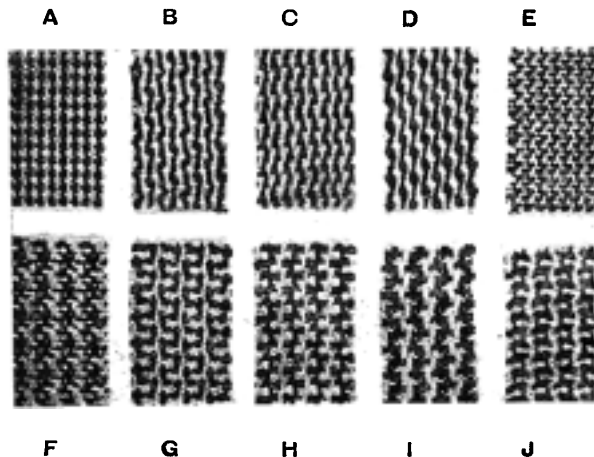


Fig. 150.

turn, and where there are weave marks the squares are filled in with the required colour, as shown at J. Afterwards the effect is completed by following the picks, and filling in the squares which are blank with the required colour, as shown at K. In small patterns it is usually better for the sketch to be extended over two or more repeats in each direction.

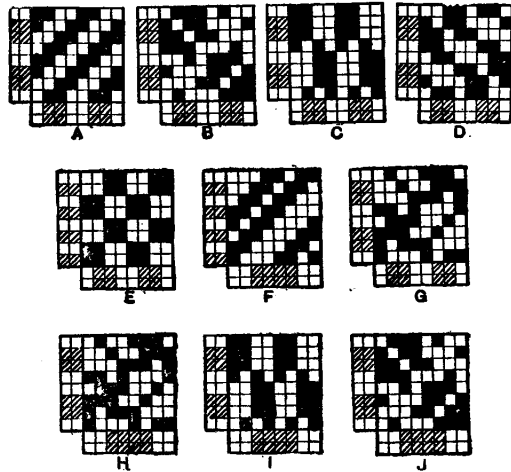


Fig. 151.

Methods of Producing Variety of Effect in the same Weave and Colouring.—An important factor to note in designing colour and weave effects is that different patterns can usually be obtained in one order of colouring and one weave by changing their relative positions. This is illustrated by the patterns represented in Fig. 147, and the corresponding plans, similarly lettered, given in Figs. 148 and 149. Each pattern, L to S in Fig. 147, is produced by the combination of a 4-and-4 order of warping and wefting, with a 2-and-2 hopsack weave. There are two ways in which the change

of effect may be brought about: (1) As shown at L to S in Fig. 148, the warp and weft threads may be arranged as to colour in the same manner throughout (viz., 4 dark, 4 light), but with the weave placed in a different position in each

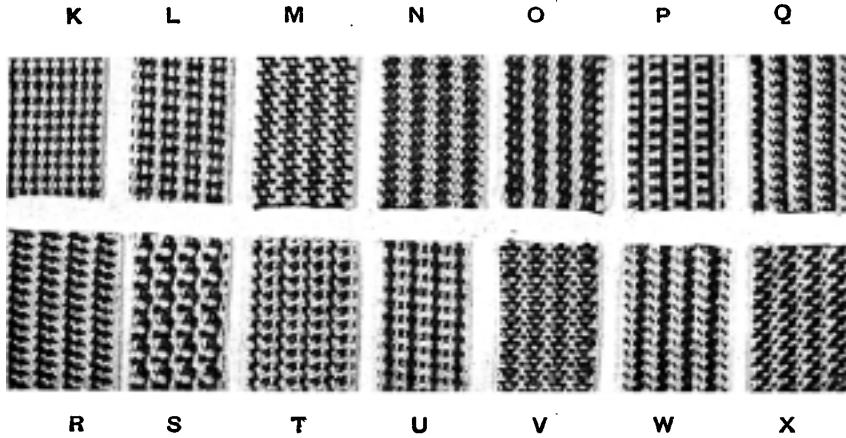


Fig. 152.

case. (2) As shown at L to S in Fig. 149, the weave may be placed in the same position throughout, but with the colour pattern commencing in a different manner in each case. In the latter method either the warp, or the weft, or both the warp and the weft colours may be changed in position. It will be noted in Fig. 147 that the

difference of effect in some cases is very slight, one-half of the patterns when turned over being simply duplicates of the other half. The example, however, is illustrative of the necessity in weaving of always retaining the same relation between the colouring and the weave throughout the length of the cloth. In subsequent examples it is shown that the change of effect thus produced can be made use of, not only in designing small patterns, but also in the economical production of stripe and check designs in very great variety.

Classification of Colour and Weave Effects.—A convenient classification of the orders of colouring the threads is as follows: (a) Simple warping and simple wefting; (b) compound warping and simple wefting; (c) simple warping and compound wefting; (d) compound warping and compound wefting. In (a) and (d) the order of warping may be the same, or different from the order of wefting. To each order of colouring, simple, stripe, and check weaves may be applied.

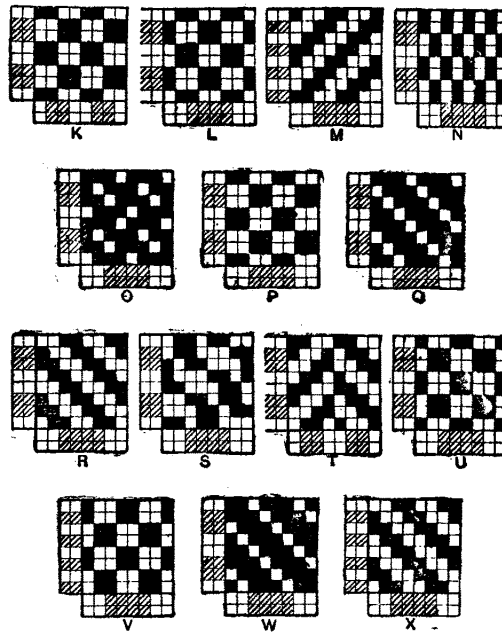


Fig. 153.

The style of pattern which is produced by the

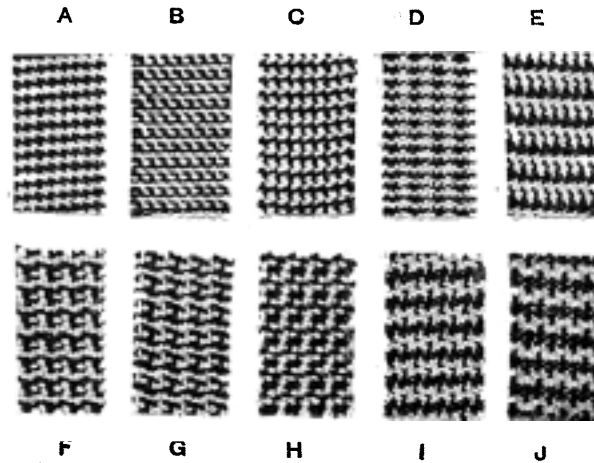


Fig. 154.

combination of each order of colouring with each type of weave, is given in the accompanying list.

Order of Colouring	Simple Weave	Stripe Weave	Check Weave
Simple Warping and Simple Wefting	Simple Pattern	Stripe Pattern	Check Pattern
Compound Warping and Simple Wefting	Stripe Pattern	Stripe Pattern	Check Pattern
Simple Warping and Compound Wefting	Cross-over Pattern	Check Pattern	Check Pattern
Compound Warping and Compound Wefting	Check Pattern	Check Pattern	Check Pattern

In addition to the foregoing styles, special orders of colouring and weaves are arranged to coincide with each other in such a manner as to produce special effects.

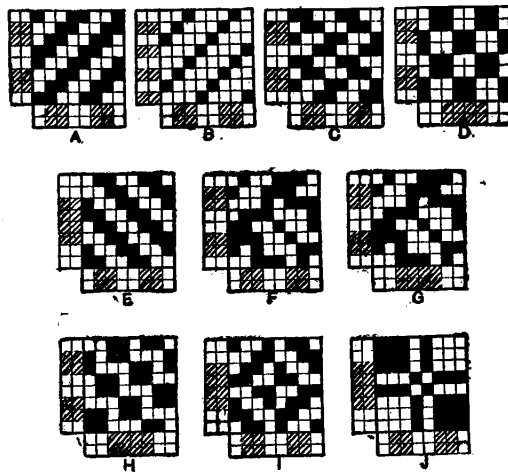


Fig. 155.

The effects produced by applying simple weaves to simple orders of colourings comprise continuous line effects, shepherd's-check patterns, bird's-eye and spot effects, step patterns, hairlines, and all-over patterns.

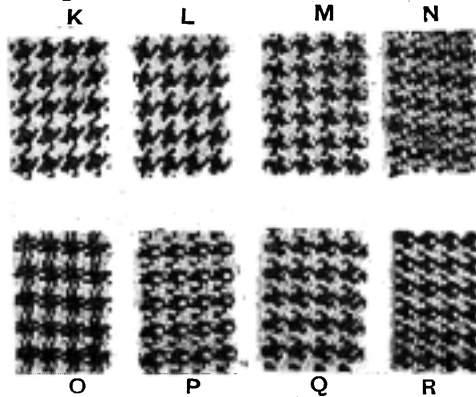


Fig. 156.

effects, and for the beginner it will be found good practice to sketch the patterns on point-paper in the manner previously described, and compare the sketches with the woven effects.

Simple Colour and Weave Effects.

— In these styles the arrangement of the threads as to colour may be regular (as for example, 4 dark, 4 light, or 3 dark, 3 medium, 3 light), or irregular (as, for example, 2 dark, 1 light, or 3 dark, 2 medium, 1 light). Many good effects are also obtained by arranging the weft in a different order from the warp (as, for example, 2-and-2 warping crossed with 1-and-1 wefting, or 4-and-4 warping crossed with 2-and-2 wefting).

Continuous Line Effects.

— Examples of continuous effects, in which the lines run lengthwise of the cloth, are given at A to X in Figs. 150 and 152. The corresponding weaves, lettered the same, are shown in Figs. 151 and 153, the weave marks indicating warp float. The exact position of the dark threads in relation to the weave is indicated by the shaded marks along the bottom and at the side of the plans. All the particulars are thus given for reproducing the

A in Fig. 150 shows the typical line effect produced by colouring the 2-and-2 twill in the order of 2 dark, 2 light; while in the effects shown at B to J the lines are more or less of a symmetrical zig-zag character. In K to O in Fig. 152 the lines are symmetrical and straight; in P to S they are serrated on one side, and in T to X small spots occur between the lines.

A to J in Fig. 154 show effects in which the lines run continuously across the piece, the corresponding weaves similarly lettered, being given in Fig. 155. As a general rule, patterns in which the horizontal lines show prominently are satisfactory only when used in combination with other effects.

Shepherd's-check Patterns.—Typical examples of shepherd's-check effects are shown at K and L in Fig. 156. In each the order of colouring is 4 dark, 4 light in warp and weft, and the weave 2-and-2 twill, the slight difference between the effects being due to the weave having been placed in different positions in relation to the colouring. M to R in Fig. 156 show useful variations of the shepherd's-check style. The weaves K to R in Fig. 157 correspond with, and are lettered the same as, the examples given in Fig. 156.

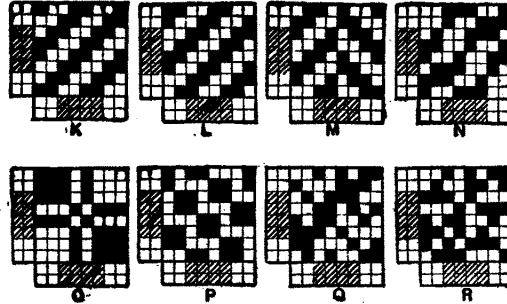


Fig. 157.

Bird's-eye and Spot Effects.—The term bird's-eye is applied to patterns in

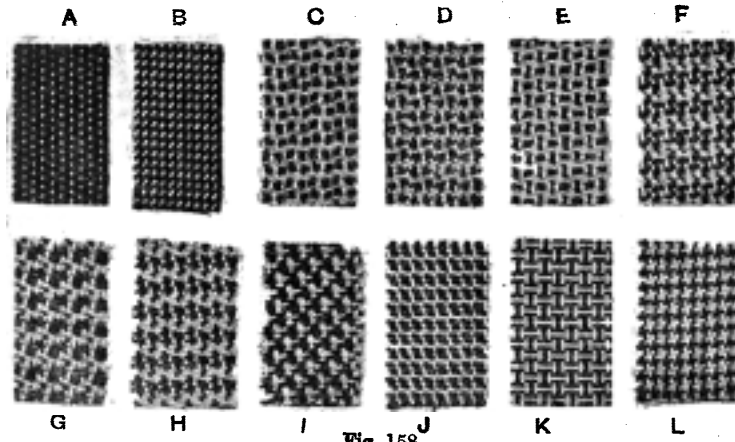


Fig. 158.

which the surface of the cloth is covered with small, distinct, detached spots of colour. Examples are given at A to L in Fig. 158, while the corresponding plans, lettered the same, are shown in Fig. 159. The weave marks in the plans indicate warp float, while the positions of the dark threads are shown by the shaded squares. The simplest style of bird's-eye pattern is obtained by introducing the spotting yarn in the warp, and using the same shade for the weft as the ground shade of warp, as shown at A and B.

Good spot patterns may be obtained in practically all the simple orders of warping and wefting, because where a warp colour is intersected by the same colour of weft, a spot formed of that colour appears on the surface of the cloth, whether the warp, or weft, or both are floated.

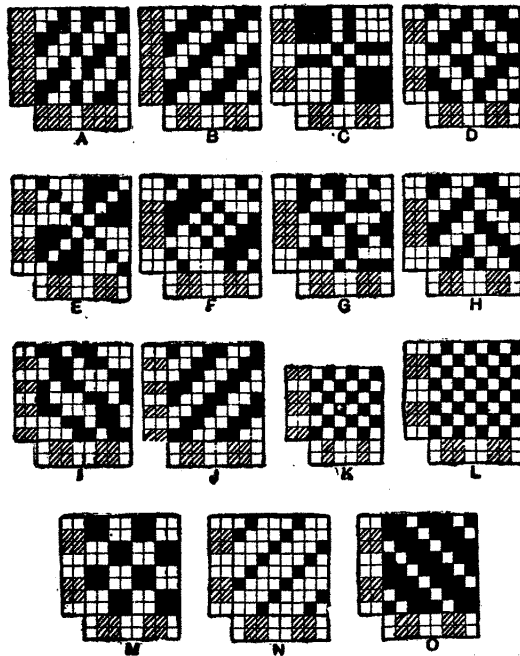


Fig. 159.

Therefore, by suitably arranging the floats where different colours intersect, a required form of pattern may be produced. Thus, the effect shown at L in Fig. 158 results from each of the arrangements given at L, M, N, and O in Fig. 159, a comparison of which will show that the weaves vary only where dark crosses dark, and light crosses light, the interlacing of the threads being exactly the same in all the plans where one colour crosses the other.

Larger spot effects are shown at P to Y in Fig. 160, for which the corresponding weaves are given in Fig. 161. With the exception of example T, it will be noted that the patterns are symmetrical, which is due in each case to the centre of the weave having been arranged to coincide with the centre either of the solid dark or the solid light space.

In the spotted effects represented in Fig. 162, the weft is arranged in a different

order from the warp, as indicated by the orders of colouring given along with the

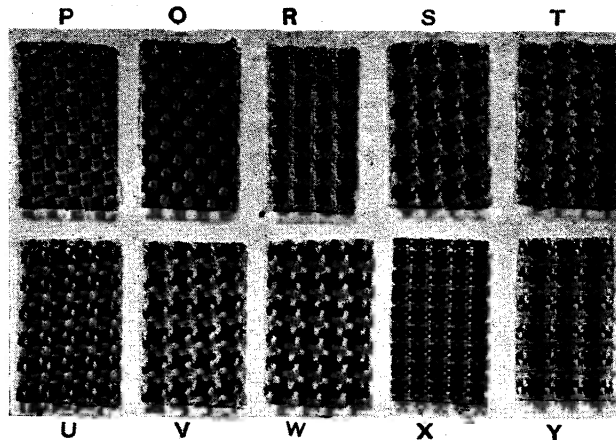


Fig. 160.

order from the warp, as indicated by the orders of colouring given along with the

corresponding plans in Fig. 163. A further series of patterns is illustrated in Fig. 164, and the corresponding plans in Fig. 165, in which the dark threads are grouped together in such a manner as to form enclosed spaces of the light colour. It will frequently be found that the grouping of the threads causes the woven effect to appear different from the point-paper sketch, the small details in some cases being entirely concealed in the cloth, and in others brought out prominently.

Hairlines. — These patterns consist of solid vertical or horizontal lines in 2, 3, 4, or more colours; the term hairline being specially used to distinguish effects in which each line of colour is equal to the width of one thread. By suitably arranging the weave and colouring, however, solid lines of colour may be produced which are equal in width to two or more threads.

Examples of vertical hairlines are given at C to H in Fig. 166, and the corresponding plans (with the orders of colouring indicated by different marks alongside and at the bottom) in Fig. 167, the weave marks representing warp float. C and D in Fig. 166 respectively show the single and double thread vertical hairline in two colours; the former being produced by colouring the plain weave 1 dark, 1 light in warp and weft, and the latter by colouring the 2-and-2 hopsack weave 2 dark, 2 light, as shown at A and B respectively in Fig. 167. The patterns C and D in Fig. 166 can also be produced in the 4-thread warp sateen weave, as shown at C and D in Fig. 167. This weave is preferred to the plain weave for the single-thread effect in some classes of fabrics, because the cloth is fuller and softer to handle, and can be made heavier, at the same time that it can be woven in looms with changing-boxes at one end only. Also when used for the double-thread effect, the 4-thread sateen D yields a smoother and softer texture than the 2-and-2 hopsack weave B, and in the latter weave

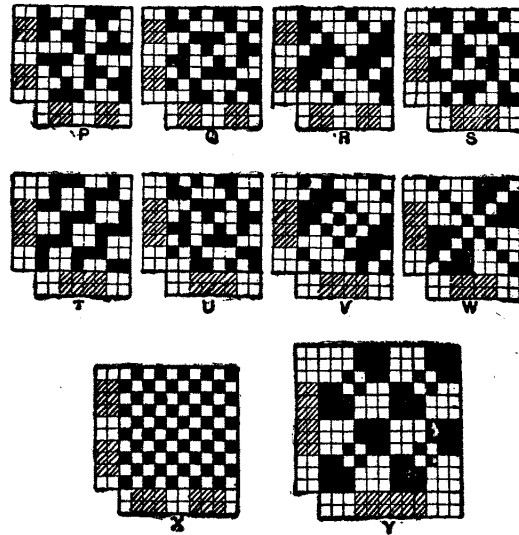


Fig. 161.

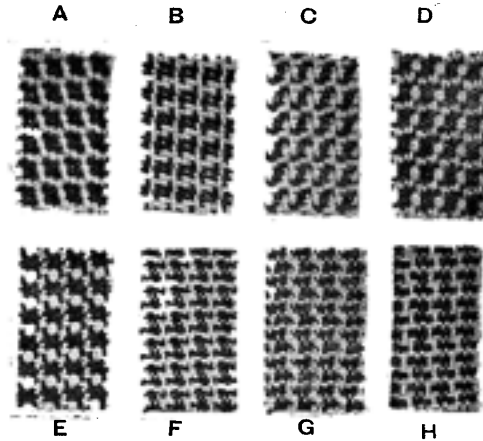


Fig. 162.

there is, in addition, a tendency for the threads which work alike to twist round each other.

Patterns E to H in Fig. 166, and the corresponding plans E to H in Fig. 167, show further examples produced in the 4-thread warp sateen weave, the effect at E being 3 dark, 1 light; at F, 2 dark, 1 medium, 1 light; at G, 1 dark, 1 medium, 1 dark, 1 light; and at H the single-thread hairline in 4 shades.

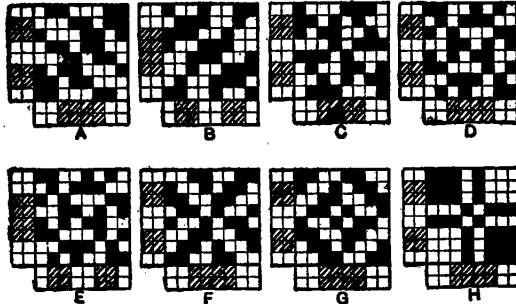


Fig. 163

The hairline effects obtainable in the 4-thread sateen weave can also be produced in the 4-thread twill. Thus the patterns C to H in Fig. 166 respectively result from the arrangements given at I to N in Fig. 167, in which the 1-and-3 warp twill weave is employed. The 4-thread sateen, however, is usually better than the 4-thread twill, because a straight twill always tends to yield a harsher texture than a weave of the sateen type.

The plans in Fig. 168 are lettered the same as the plans in Fig. 167, and correspond to them, except that in this case the weaves and colourings are arranged to produce horizontal hairlines, taking the weave marks to indicate warp. Thus, A and B in Fig. 168 respectively produce the single- and double thread horizontal hairlines in two colours, which are shown at O and P in Fig. 166. Plans C to H in Fig. 168 show the 4-thread weft sateen, and plans I to N the 4-thread weft twill

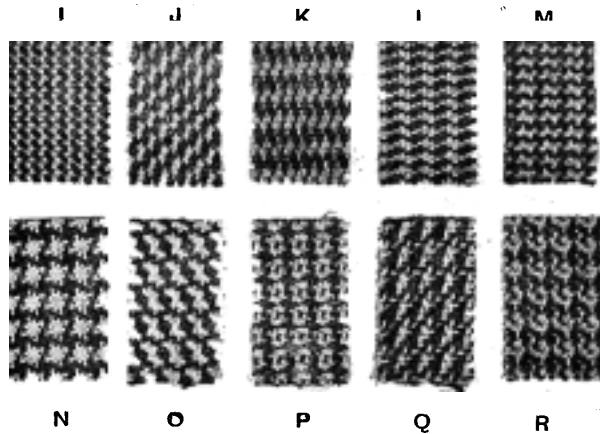


Fig. 164.

arranged to produce horizontal effects, which will correspond to the vertical hairlines given at C to H in Fig. 166. If the weave marks in Fig. 168 are taken to indicate weft, the plans will produce vertical hairlines. On account of their barry appearance the horizontal hairlines are not much used, except in combination with the vertical hairlines and other effects in the construction of stripe, check, diagonal, and spotted patterns.

The construction of hairlines in the 3-thread twill weaves is illustrated at Q to T in Fig. 169, Q producing a vertical effect in two colours, and R in three colours while S and T produce corresponding horizontal patterns. U in Fig. 169, which will produce exactly the same style of stripe as R—viz., 1 dark, 1 medium, 1 light, shows the 1-and-2 twill modified to fit a loom with changing-boxes at one end only. The plans given at V and W, which are also modifications of the 1-and-2 twill, will each produce a pattern in 2 dark, 2 medium, 2 light; and as the weaves U, V, and W are looser in structure than the 3-thread twill, they permit a larger number of ends and picks per inch to be inserted, and can therefore be used for heavier makes of cloth. The weave X shows the 1-and-2 twill specially modified to produce the vertical hairline represented at X in Fig. 166, in which the colours are arranged 2 dark, 2 medium, 2 dark, 2 light. This pattern also results from the arrangements given at Y and Z in Fig. 169, which are modifications of the 4-thread warp sateen. The plans U to Z thus show how an ordinary weave may be modified to fit a required order of colouring when a special cloth structure or special effect is desired.

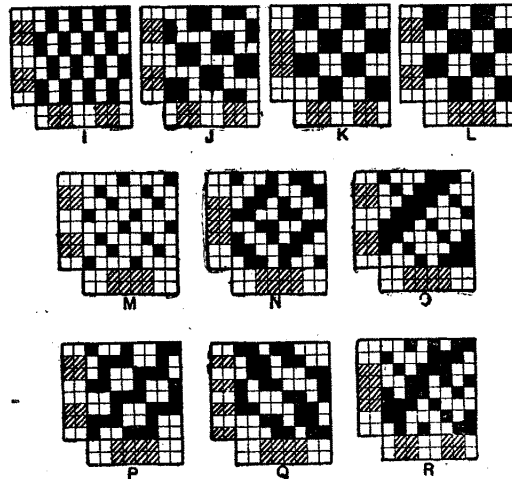


Fig. 165.

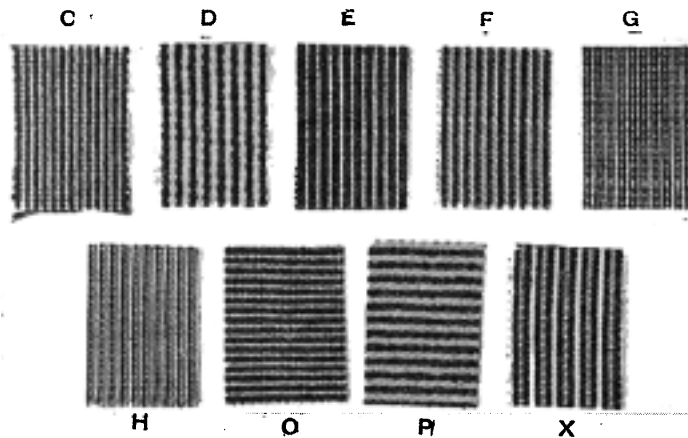


Fig 166.

A comparison of the weaves with the orders of colouring in Figs. 167, 168, and 169 will show that in constructing solid coloured hairline patterns the following rules are applicable :—The same shades should be used for the weft as for the warp. For vertical hairlines each warp thread should pass under the corresponding colour

of weft, and be raised over the other colours. For horizontal hairlines, each weft pick should pass under the corresponding colour of warp, and over the other colours. For example, assuming that a single thread vertical hairline in five colours is required, the weave must necessarily be so arranged that each end is down for one pick and up for four picks; hence the 5-thread warp twill, or, as shown at A in Fig. 170, the 5-thread warp sateen may be employed. B shows the colour plan for the warp indicated along the bottom, the five shades being represented by different marks. The order of wefting, in the same five shades as the warp is obtained by noting, pick by pick, the colour of the warp thread which is depressed. Thus, as shown at C, the first pick is the same in colour as the first end, which is depressed on the

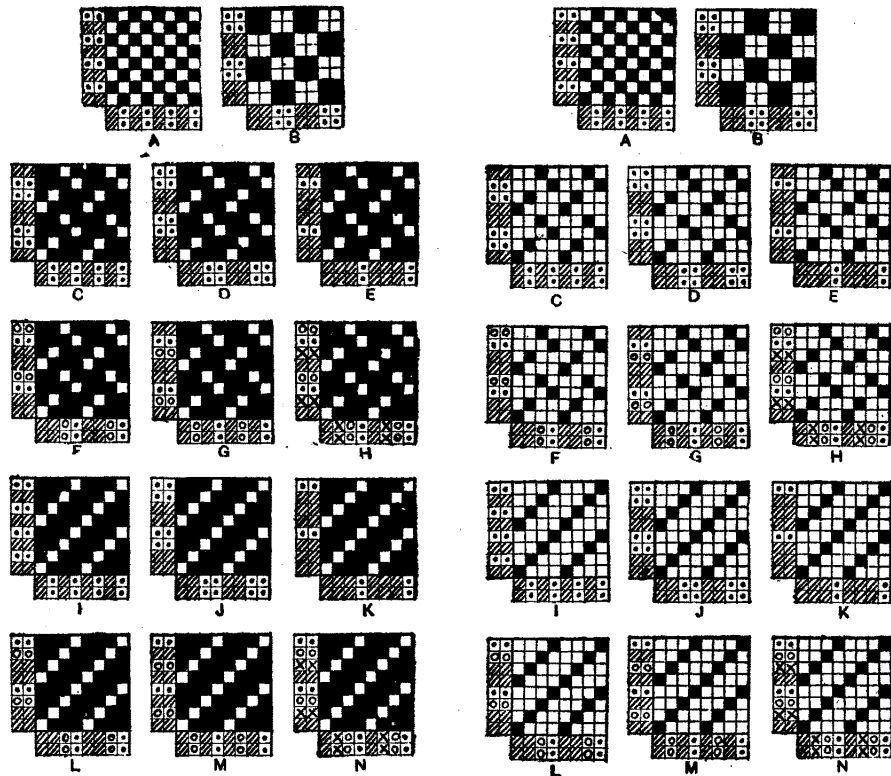


Fig. 167.

Fig. 168.

first pick, The second pick is in the same colour as the fourth end; the third pick, as the second end; the fourth pick, as the fifth end; and the fifth pick, as the third end.

For the single-thread horizontal hairline in five colours, each pick must pass under one end and over four; the colour of each being determined by the colour of the end which it passes under, as shown at D in Fig. 170. If the 1-and-4 twill weave is employed, the order of wefting is the same as the order of warping, as shown at E and F, which correspond with C and D.

Other examples of 5-thread vertical hairlines, producible in the 5-thread warp sateen weave, are given at G to K in Fig. 170, the effect at G being 1 dark, 4 light;

at H, 2 dark, 3 light ; at I, 2 dark, 1 light, 1 dark, 1 light ; at J, 2 dark, 2 medium, 1 light ; and at K, 3 dark, 1 medium, 1 light.

Step Patterns.—In these, vertical and horizontal lines unite and form zig-zag lines of colour which run in a diagonal direction. Examples are given at L to P in Fig. 171, and the corresponding plans similarly lettered in Fig. 172. They can be constructed with any ordinary twill weave in which there are two intersections, and the floats of warp and weft are equal, by arranging the colour plan on a number of threads, which is equal to half the number of threads in the repeat of the weave. Thus, at L the 2-and-2 twill is coloured 1 dark, 1 light ; at M, the 3-and-3 twill is coloured 2 dark, 1 light ; and at N, the 4-and-4 twill is coloured 2 dark, 2 light. A 3-shade step pattern can be produced in the 3-and-3 twill by colouring 1-and-1 in three shades, and in the 4-and-4 twill by colouring 1-and-1 in four shades. O shows a form of step pattern which is produced by colouring the mayo weave 2 dark, 2 light, while P is an irregular effect produced by colouring an 8-thread twill 2-and-2 in the warp and 1-and-1 in the weft. The weave Q in Fig. 172 produces exactly the same style of pattern in the 2-and-2 order of colouring as the 4-and-4 twill, and can be used in place of the latter when greater firmness of cloth is required. The 3-thread twill,

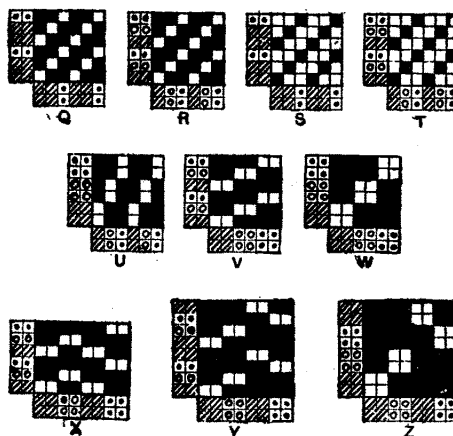


Fig. 169.

is produced by colouring the mayo weave 2 dark, 2 light, while P is an irregular effect produced by colouring an 8-thread twill 2-and-2 in the warp and 1-and-1 in the weft. The weave Q in Fig. 172 produces exactly the same style of pattern in the 2-and-2 order of colouring as the 4-and-4 twill, and can be used in place of the latter when greater firmness of cloth is required. The 3-thread twill,

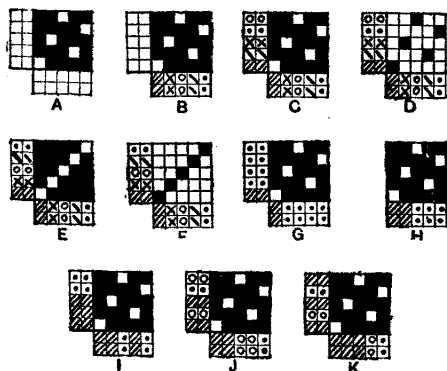


Fig. 170.

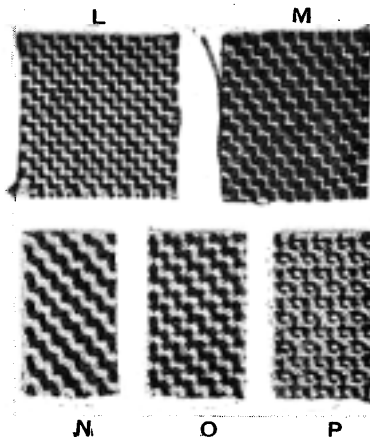


Fig. 171.

when coloured 1-and-1, as shown at R in Fig. 172, produces an interesting step pattern, while a great variety of effects can be obtained in the 1-and-1 order of colouring by using twill weaves in which the floats are combined with plain weave, as shown at S.

All-over Effects.—In all-over patterns the colour effect runs more or less

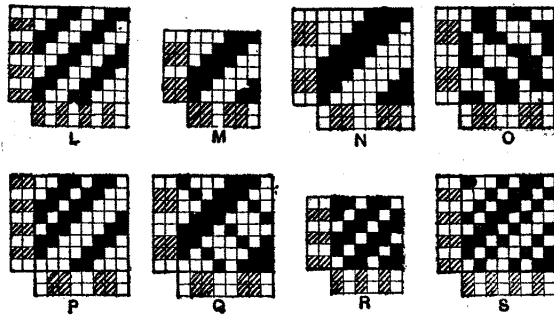


Fig.,172.

connectedly over the surface of the cloth. They are best constructed by arranging the repeat of the colour plan and the repeat of the weave on such numbers that two or more repeats of each are required to produce one complete repeat of the pattern. For example: Assuming that the 2-and-2 twill is coloured 4 dark, 4 light, 4 dark, 3 light, fifteen repeats of the weave and four repeats of the colour plan are necessary, the complete effect being on

and four repeats of the colour plan are necessary, the complete effect being on

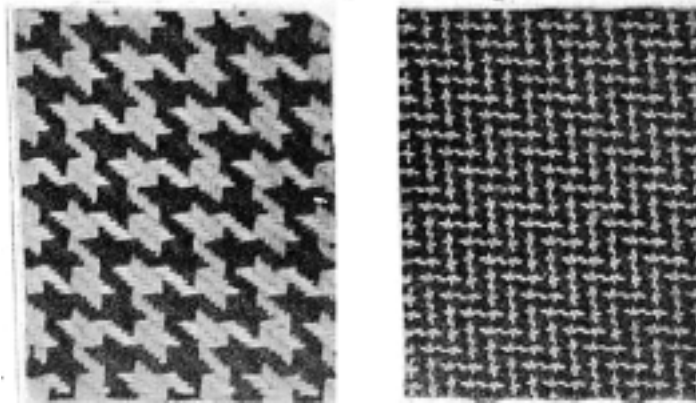


Fig. 173.

60 threads. Pattern T in Fig. 173 shows the effect produced by colouring the

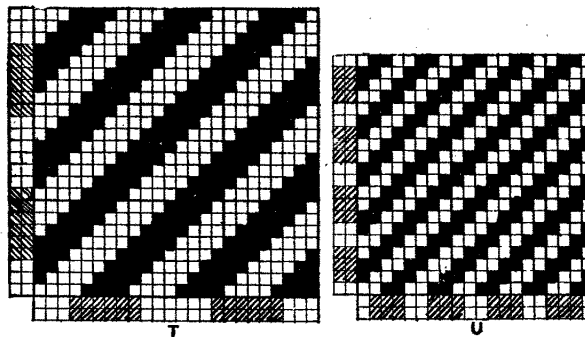


Fig. 174.

4-and-4 twill 6 dark, 6 light; while pattern U shows the 2-and-2 twill coloured 3 dark, 2 light, as indicated at T and U respectively in Fig. 174.

CHAPTER XII

COLOUR AND WEAVE STRIPES AND CHECKS

Stripe Colour and Weave Effects—Changing the relative Position of the Weave and Colouring—Simple Weave and Simple Wefting with Compound Warping—Stripe Weave and Simple Wefting with Simple and Compound Warpings. *Check Colour and Weave Effects*—Changing the relative Position of the Weave and Colouring—Simple Weave, Compound Warping, and Compound Wefting—Stripe Weave and Compound Wefting with Simple and Compound Warpings—Cross-over Weave and Compound Warping with Simple and Compound Weftings—Check Weave and Simple Wefting with Simple and Compound Warpings.

STRIPE COLOUR AND WEAVE EFFECTS

Changing the Relative Position of the Weave and Colouring.—It has previously been shown that variety of pattern can be produced in the same weave and the same

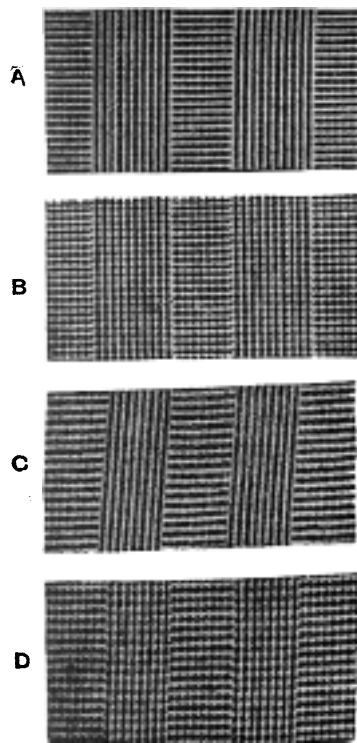


Fig. 175.

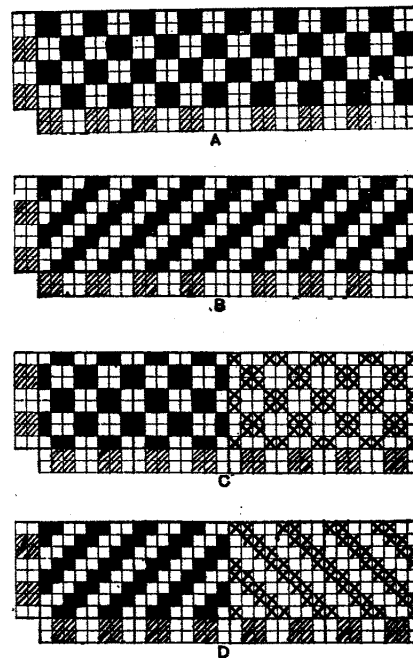


Fig 176.

order of colouring by changing the position of one in relation to the other. The change of effect thus obtained may be made use of in the production of colour-and-weave stripe patterns, by modifying the warp colour, or the weave, in such a

manner that their relative positions are different in succeeding sections of the design.

Examples illustrating the method of modifying the warp colour order are given at A and B in Fig. 175, and of modifying the weave at C and D. The corresponding plans, with the positions of the dark threads indicated by the shaded marks, are shown at A to D in Fig. 176, the weave marks representing warp float. In order to obtain the same width of stripe as is shown in the patterns, each section on the point-paper will require to be repeated. Sufficient is indicated of each section, however, as will enable the patterns to be reproduced, and it will be understood that

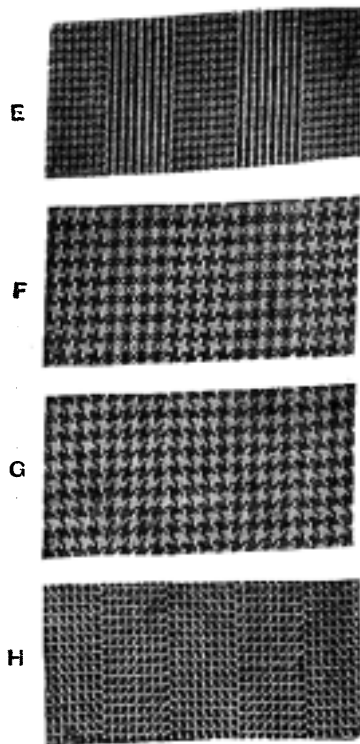


Fig. 177.

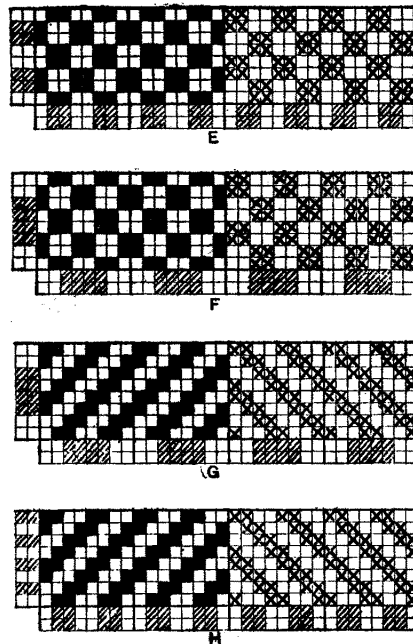


Fig. 178

diversity of form can be obtained by varying the widths of the sections. The object in preparing these and subsequent examples has been, by working on broad lines, to enable the different effects to be readily seen. It will be observed in A, Fig. 176, that the 2-and-2 hopsack weave is employed throughout, and in B the 2-and-2 twill. But in the warp, instead of the 2 dark, 2 light order of colouring being continuous a 4 of light occurs at each change of the pattern, the colouring being arranged in the first section in the order of 2 dark, 2 light, and in the second section 2 light, 2 dark, finishing with 4 light. The introduction of the 4 light throws the colouring on to a different footing in relation to the weave. In C and D, on the other hand, the order of colouring is 2-and-2 throughout, but while the weaves are the 2-and-2 hopsack

and the 2-and-2 twill respectively, a change of footing is made in them where the pattern changes. A comparison of A and B with C and D in Fig. 175 will show that the two methods produce similar styles. The first method is usually the more convenient, since with a straight draft it is necessary only to modify the warp order of colouring according to the form of pattern required, whereas in the second method a special order of drafting is necessary.

Further examples illustrating the effect of changing the position of the weave are given in Fig. 177, and the corresponding plans, similarly lettered, in Fig. 178. In E and F the modified 2-and-2 hopsack weave is respectively coloured 2 dark, 2

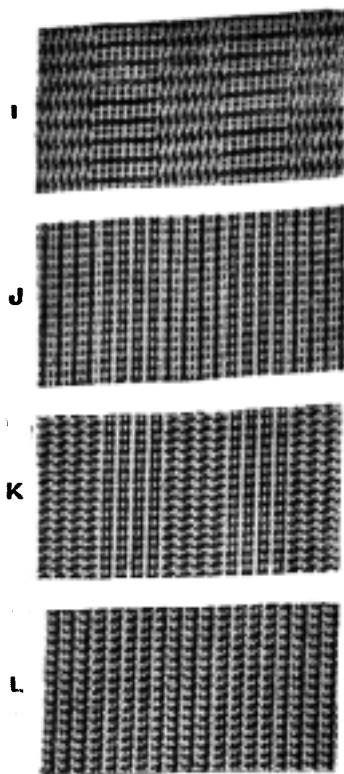


Fig. 179

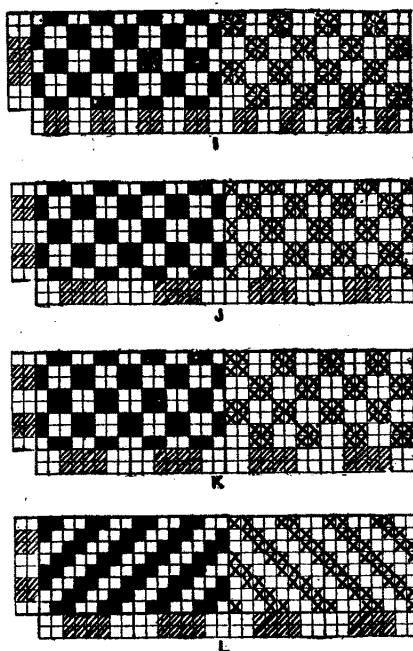


Fig. 180.

light, and 4 dark, 4 light in warp and weft ; in G the 2-and-2 twill reversed in sections, is coloured 4 dark, 4 light, while H shows the same weave coloured 2-and-2 in the warp, and 1-and-1 in the weft. The patterns I to L in Fig. 179 and the corresponding plans in Fig. 180 are similar styles in which a 2-and-2 order of colouring in one direction is combined with a 4-and-4 order in the other direction.

Usually colour and weave stripe patterns are produced in simple orders of wefting by employing :—(1) simple weaves and compound orders of warping ; (2) stripe weaves and simple orders of warping ; (3) stripe weaves and compound orders of warping.

Simple Weave and Simple Wefting with Compound Warping.—Examples of this class are represented at M to P in Fig. 181, and the corresponding plans similarly lettered, are given in Fig. 182. In each example the weave is 2-and-2 hopsack, while the arrangement in the warp is a compound of 2 dark, 2 light, and 4 dark, 4 light orders of colouring. A 2-and-2 order of wefting is employed for both M and N, the difference of effect in which is due entirely to the positions of the weft colours having been changed by turning the pattern chain forward two picks. This system of varying the relative positions of the weaves and colouring in some cases does not enable all the possible effects to be obtained, but it is usually the simplest and

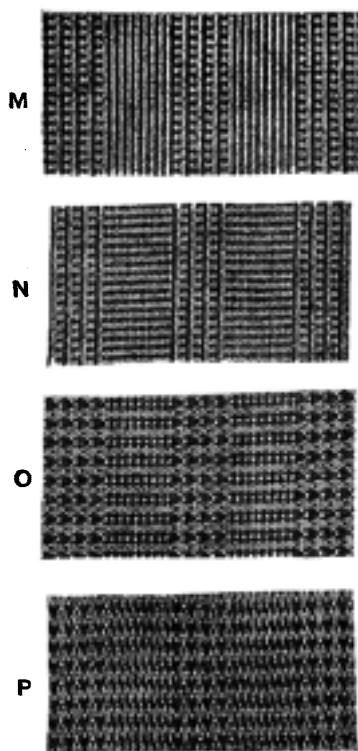


Fig. 181.

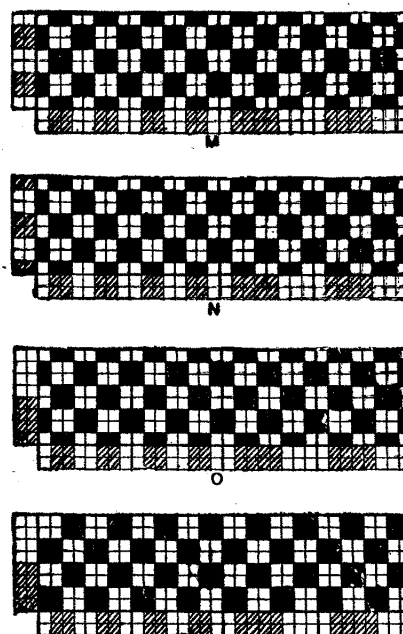


Fig. 182.

most expeditious method of effecting a distinct change in any form of colour and weave pattern.

The difference of effect between the patterns O and P in Figs. 181 and 182, which are coloured 4-and-4 in the weft, is due to varying the position of the weaves, the change in this case not being possible by simply altering the position of the weft colours.

The patterns represented at Q to T in Fig. 183, and the corresponding plans given in Fig. 184 show the application of the 2-and-2 twill weave to a compound of 2 dark, 2 light, and 4 dark, 4 light orders of warping. The wefting plan at Q is 1-and-1; at R and S, 2-and-2; and at T, 4-and-4. It will be noted that the difference between R and S is entirely due to the weft colours having been reversed in position.

The illustrations given in Figs. 181 to 184 only illustrate the application of one compound order of warping to two weaves, and only a few orders of wefting are shown. Very many different compound orders of warping can be readily arranged, to which different weaves and orders of wefting can be applied; and it will be evident that even within the limits of tappet shedding there is very great scope for the production of stripe colour-and-weave effects.

Stripe Weave and Simple Wefting with Simple and Compound Warpings.—Examples of both of these classes of stripe colour-and-weave patterns are for convenience illustrated together in the following figures. The fabrics represented in

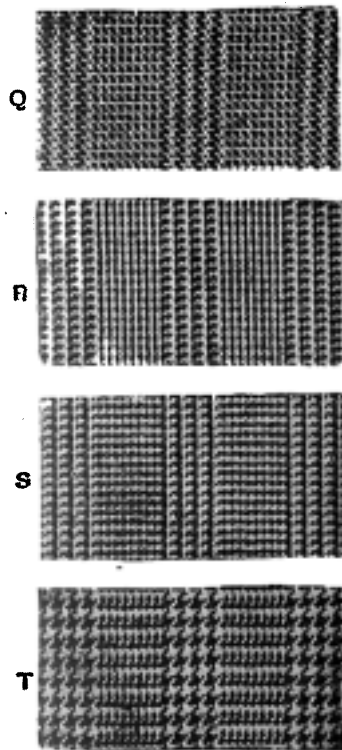


Fig. 183

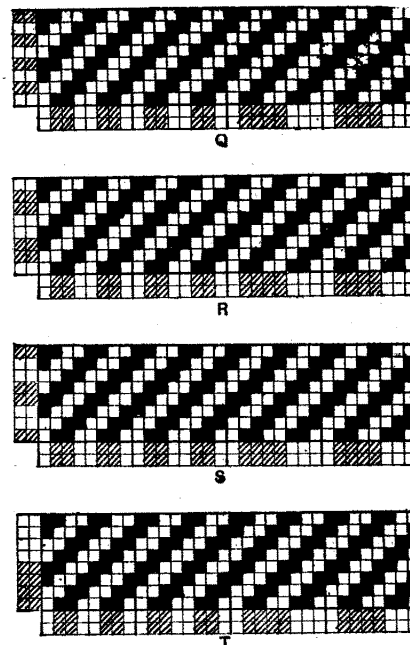


Fig. 184.

Figs. 185, 186, 187, and 188 result from the designs and orders of colouring given in Fig. 189. Three orders of warping are employed for each design, while the wefting plan in all cases is 2-and-2, as shown along the bottom and at the side of Fig. 189, by the shaded squares, which indicate the positions of the dark threads. In Fig. 189 a letter is indicated in each case alongside the order of warping, which, in conjunction with the design above and the 2-and-2 order of wefting, will produce the pattern which is lettered to correspond in Figs. 185 to 188. The three patterns in each figure are produced by the same design and the same order of wefting, the difference between them being due to the order of warping being varied. Thus, the design for A, B, and C in Fig. 185 consists of a modified 2-and-2 twill and ordinary twill; for

D, E, and F in Fig. 186 of an 8-thread cut weave and 2-and-2 twill; for G, H, and I in Fig. 187 of the 8-thread twilled mat and 2-and-2 twill; and for J, K, and L in Fig.

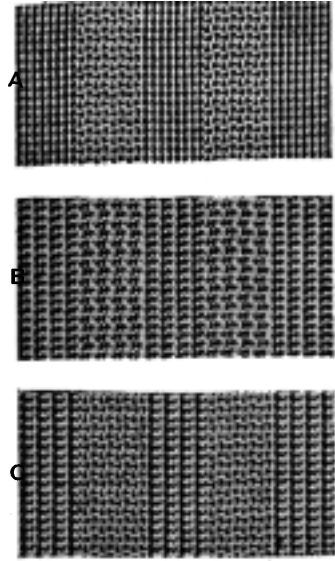


Fig. 185.

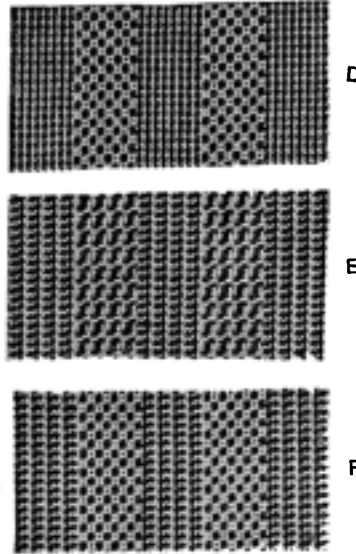


Fig. 186.

188 of the Mayo weave and 2-and-2 hopsack. The first pattern in each figure is warped 2-and-2, and the second 4-and-4, while in the third pattern the warping plan is a compound of a 2-and-2 and a 4-and-4 order.

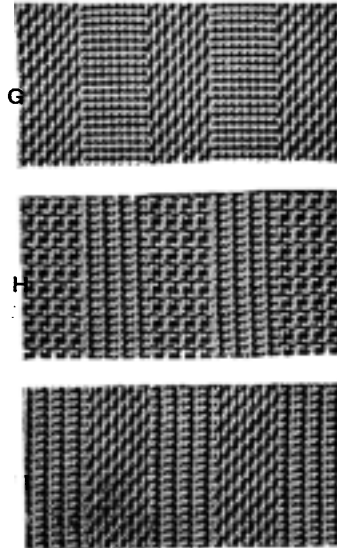


Fig. 187.

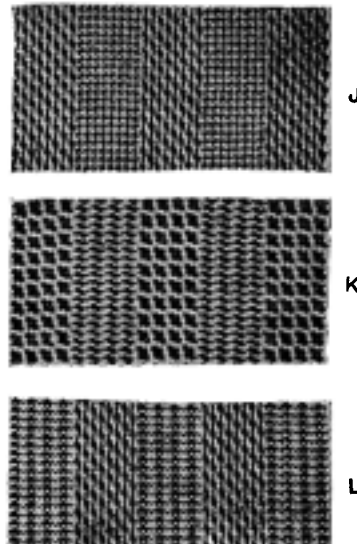


Fig. 188.

The examples in Figs. 190, 191, 192, and 193 show further diversity of effect

produced in the same warping and wetting as the previous patterns. The designs, with the orders of colouring indicated, are given in Fig. 194, the weave marks, as before indicating warp float. The letters alongside the orders of warping will enable each arrangement to be compared with the corresponding pattern. The design for M, N, and O in Fig. 190 is a combination of the Mayo weave and 2-and-2 twill, and by comparison with the examples shown in Fig. 188, in which the Mayo weave is also used, the patterns are a good illustration of the

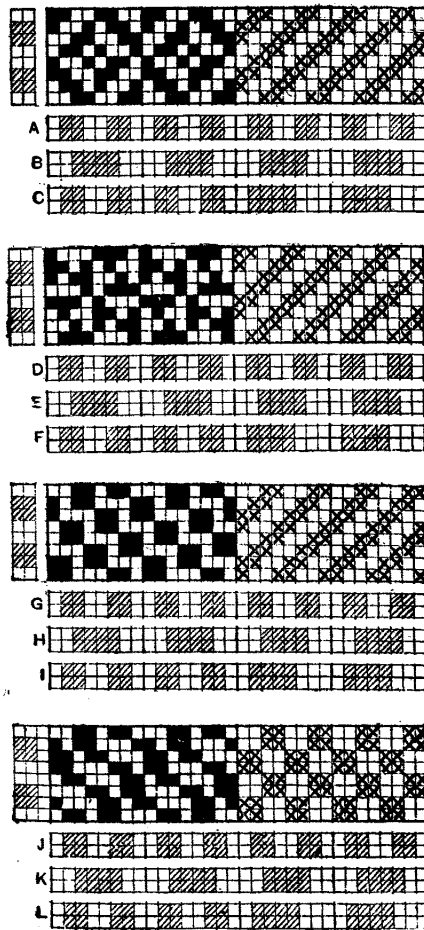


Fig. 189.

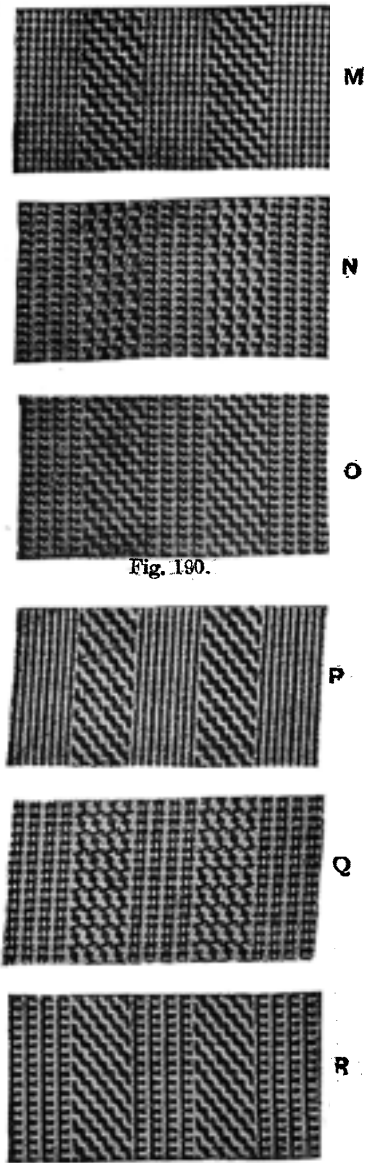


Fig. 190.

Fig. 191.

complete change of effect which frequently results when the relative positions of the weave and colouring are changed. The design which produces P, Q, and R in Fig. 191 is a combination of a fancy 8-shaft twill and 2-and-2 hopsack,

the former weave being used in preference to the 4-and-4 twill (which produces a similar effect) because it is firmer in structure, and about equal in wetting capacity to the hopsack weave with which it is combined. In S, T, and U in

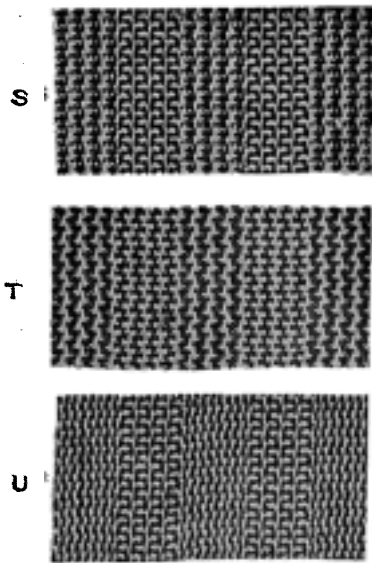


Fig. 192.

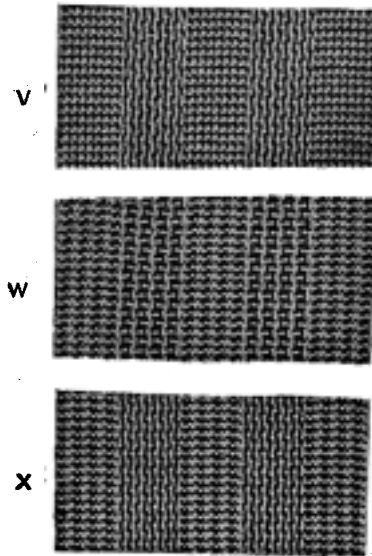


Fig. 193.

Fig. 192 a fancy 8-shaft weave is combined with a 4-thread weave which is based on the 4-and-4 twill, while for V, W, and X in Fig. 193, the same 8-shaft weave—turned over and commenced in a different position in relation to the colouring—is combined with a weave based on the 2-and-2 twill.

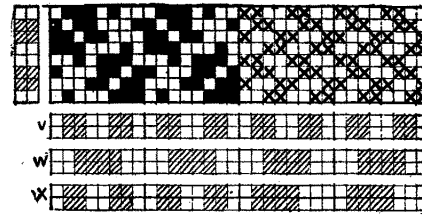
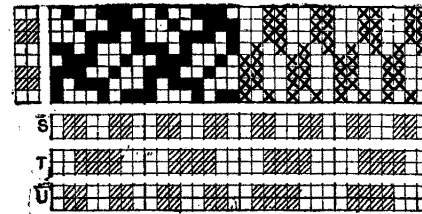
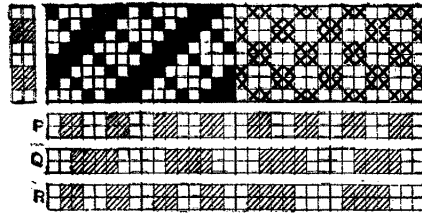
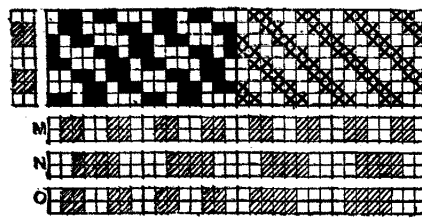
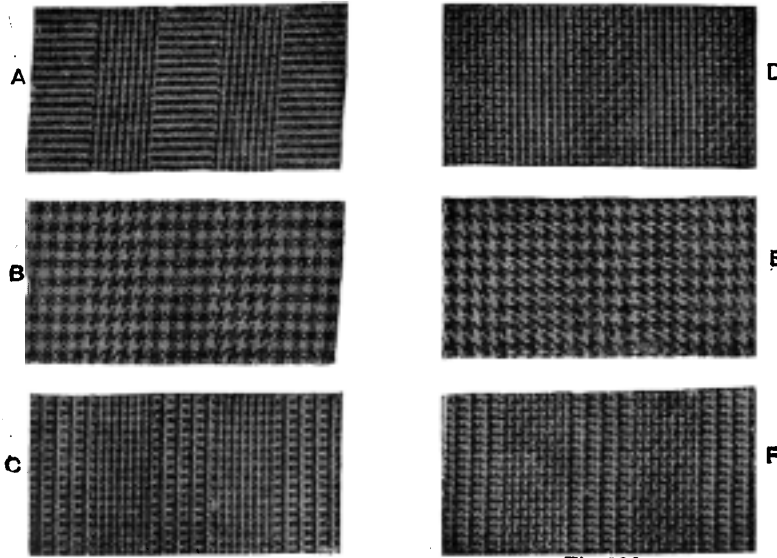


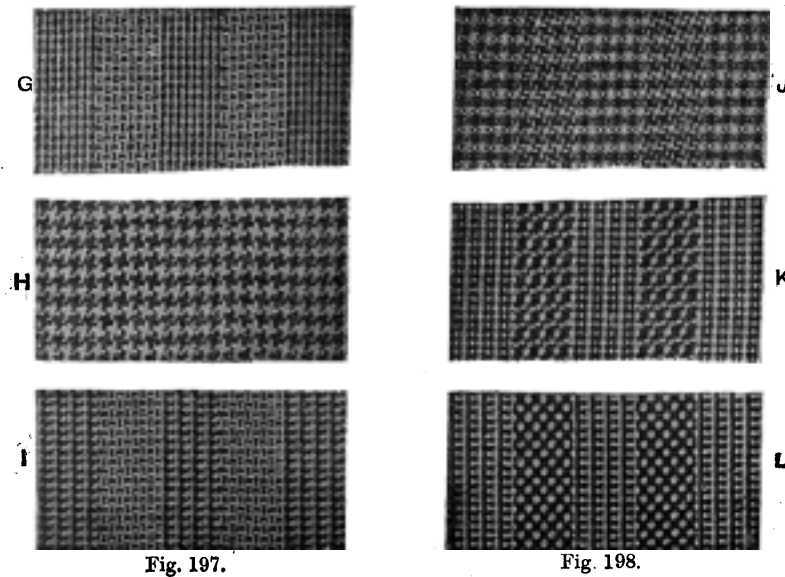
Fig. 194.

The examples illustrated in Figs. 195, 196, 197, and 198 correspond with the plans given in Fig. 199. The warp and weft orders are lettered and connected by curved lines in Fig. 199, in order that each combination may be compared with the

corresponding fabric that is lettered the same in Figs. 195 to 198. In Figs. 195, 196, and 197 the first pattern is warped and wefted 2-and-2; and the second, 4-and-4;



while in the third, a compound of a 2-and-2 and a 4-and-4 order of warping is crossed with 2-and-2 wefting. In Fig. 198 the first pattern is warped and wefted 4-and-4;



the second pattern is warped 4-and-4, and wefted 2-and-2; and in the third pattern the compound warping order is crossed with 2-and-2 wefting. The design for A, B,

and C in Fig. 195 is a combination of 2-and-2 twill and 2-and-2 hopsack, which may be produced by 4-shaft tappets; for D, E, and F in Fig. 196, of a fancy 8-shaft weave and 2-and-2 twill; for G, H, and I in Fig. 197 of an 8-shaft weave, and 2-and-2 twill; and for J, K, and L in Fig. 198 of an 8-shaft cut weave and 2-and-2 hopsack.

In the fabrics represented in Figs. 200 and 201 a 4-and-4 order of wefting is crossed with three orders of warping as shown in the corresponding arrangements given in Fig. 202. The

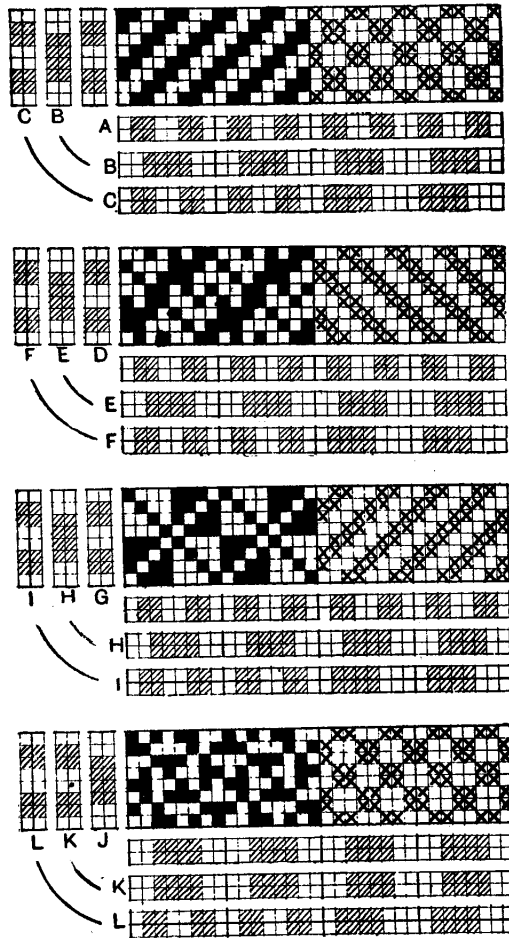
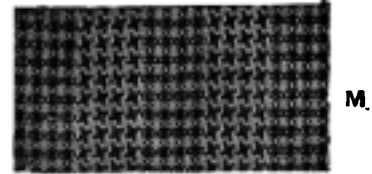
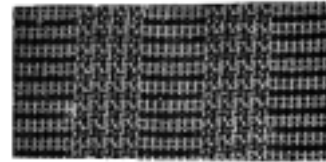


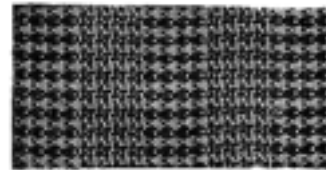
Fig. 199.



M.

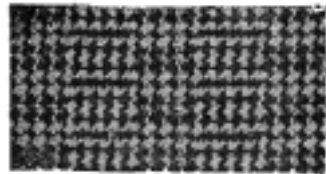


N

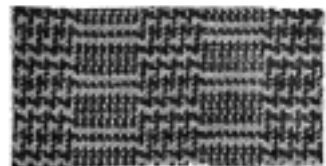


O

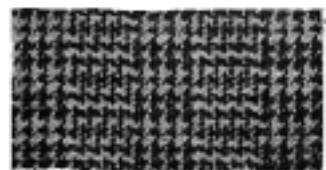
Fig. 200.



P



Q



R

Fig. 201.

design for M, N, and O in Fig. 200 is a combination of a fancy 8-shaft weave and 2-and-2 hopsack, while P, Q, and R in Fig. 201 can be woven by means of 3-and-3 twill tappets.

The examples S to X in Fig. 203 are illustrative of the diversity of pattern