

# ADVANCED TEXTILE DESIGN

*BY THE SAME AUTHOR*

TEXTILE DESIGN AND COLOUR

ELEMENTARY WEAVES AND FIGURED FABRICS

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# ADVANCED TEXTILE DESIGN

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*WITH DIAGRAMS*

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## P R E F A C E

THE designing and colouring of cloths, which are composed of one series of warp and one series of weft threads, are exhaustively treated in the accompanying book, entitled "Textile Design and Colour, Elementary Weaves and Figured Fabrics." This book forms a continuation of the subject, and deals in an equally complete manner with compound and special cloths in which two or more series of threads are employed in one or both directions, or which are produced in special methods. There is no separate section on colour, but the principles upon which colours are applied to the various classes of cloths are described and illustrated.

Many branches of Textile Design need specialisation, and with this object in view, and as an aid to the adequate treatment of each branch, a large proportion of the matter contained in this work has been specially prepared in the form of separate serial articles which have appeared in textile journals. The chapters on double cloths, special classes of double cloths, wadded and centre-stitched double cloths and treble cloths, on lappet and swivel weaving and designing, and on plain and figured warp pile fabrics, and book-harness muslins, have been published in the *Textile Manufacturer*; the sections on extra weft and extra warp figuring, and gauze and leno fabrics in the *Textile Recorder*; while portions of the chapters on weft pile fabrics and Turkish towelling structures have appeared in *Cotton* (U.S.A.). In re-issuing the matter in book form, most of the original illustrations have been used, but new examples have been introduced and the text has been carefully revised. Further, in order to make the book a complete work on the design and structure of compound and special cloths, chapters have been added on weft and warp-backed cloths, imitation backed fabrics, and backed cloths with wadding threads; on damasks, tapestry and upholstery cloths, ingrain carpets, fancy toilet and quilt fabrics, Brussels, Wilton, Tapestry, and Axminster pile carpets, etc.

Special jacquard and harness mountings, such as sectional jacquard arrangements, pressure and split harness mountings, self-twilling, double-

cloth, twin, and pile carpet jacquards, inverted hook machines, jacquards with working comber-boards, and gauze and Madras mountings, are fully described and illustrated, as are also the special mechanisms used in weaving lappet, swivel, and Turkish towelling fabrics. The book contains 461 figures, which embody over 2,000 designs, diagrams, and representations of woven fabrics.

The writer wishes to express his indebtedness to several textile engineering firms and many friends for the willingness with which they have placed information at his disposal, and to the publishers and printers for their attention to his wishes in the preparation of the book.

W. W.

GLASGOW, *December*, 1912.

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# ADVANCED TEXTILE DESIGN

## CHAPTER I

### BACKED CLOTHS

Introduction of Extra Threads—Principles of Tying or Stitching. *Weft-Backed Cloths*—Method of Designing—Reversible Weft-backed Weaves—Methods of Weft-Backing Standard Twill and Hopsack Weaves—Warp-Face Weaves Backed with Weft—Method of Selecting Weft Ties—Special Examples of Weft-Backing. *Warp-Backed Cloths*—Method of Designing—Reversible Warp-Backed Weaves—Beaming and Drafting Warp-Backed Designs—Methods of Warp-Backing Standard Weaves—Method of Selecting Warp Ties—Special Examples of Warp-Backing—Comparative Setting of Backed Cloths. *Imitation or Pseudo-Backed Cloths*—Imitation Weft Backing—Imitation Warp Backing. *Backed Cloths with Wadding Threads*—Weft-Backed and Warp-Wadded Designs—Warp-Backed and Weft-Wadded Designs.

**Introduction of Extra Threads.**—The backed, double, treble, etc., principles of construction are employed for the purpose of increasing the warmth-retaining qualities of a cloth, and in order to secure greater weight and substance than can be acquired in a single structure which is equally fine on the surface. A heavy single cloth can only be made by using thick yarns, in conjunction with which it is necessary to employ only a comparatively few threads per unit space. A heavy single texture is therefore obliged to be somewhat coarse in appearance. By interweaving extra weft, or extra warp, or both extra weft and extra warp threads on the underside of a cloth, it is possible to obtain any desired weight combined with the fine surface appearance of a light single fabric.

In addition to being employed for the sole purpose of giving greater weight and substance to a cloth, extra threads are very frequently introduced for ornamental purposes only, the additional weight of the threads being of no account, while in other cases they are introduced both for weight and ornamentation. In order that comparisons may be made, three classes of cloths are represented in Fig. 1, which are illustrative of the three reasons for introducing extra threads. A shows the face and B the underside of a warp-backed trousering fabric, in which the extra threads are introduced only to give additional weight and substance ; C shows the face, and D the underside of an extra-warp figured dress texture, in which the extra threads are solely for the purpose of ornamentation ; while E and F show the two sides of a figured double-cloth reversible rug structure, in which the extra threads serve both for weight and ornamentation.

When the extra threads are inserted solely to give additional weight, the idea is to employ them in forming a back to a face fabric ; and one of the advantages of the backed, double, treble, etc., systems of construction is that the extra weight can be obtained in an economical manner, since material which is inferior to the face yarns may be used on the underside. Backed cloths are constructed on both the extra weft and the extra warp principle ; a cloth consisting in the former case of

two series of weft threads and one series of warp threads, and in the latter of two series of warp threads, and one series of weft threads. Double cloths are composed of two series both of weft and warp threads, and treble cloths of three series; while there are other structures which consist of three series of threads in one direction and two series of threads in the other direction. Cloths are not limited to three series of threads in one or both directions, but it is only in special cases that a greater number of series is employed.

**Principles of Tying or Stitching.**—When extra yarns are employed for weight-

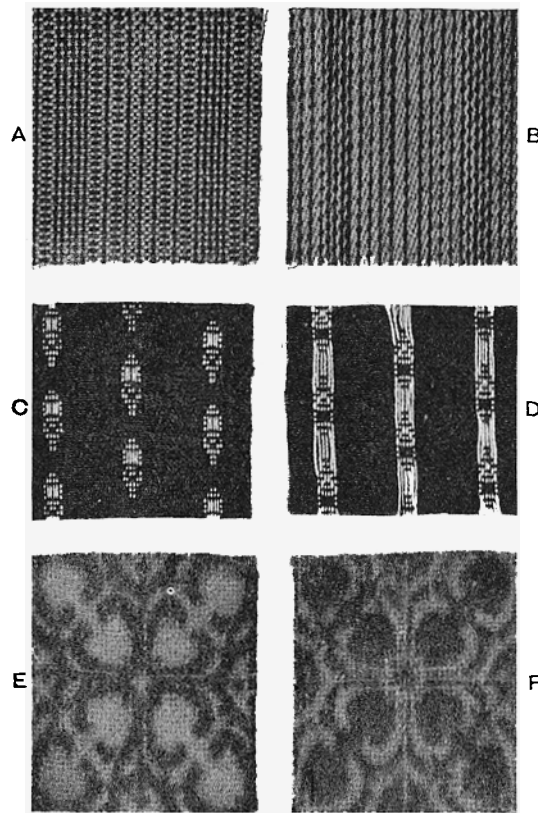


Fig. 1.

giving purposes, it is very important that the threads on the underside are bound to the face-texture with the proper degree of firmness, and that they are entirely invisible from the face side of the cloth. There are many features in tying or stitching which are common to the different classes of cloths, and these features are illustrated in a general way by the illustrations given in Figs. 2, 3, 4, and 5. Each flat view in the figures is shown connected by lines with a plan of the face weave of the cloth that is represented. The dotted lines in the flat views indicate the positions of warp and weft threads on the underside, while the solid black marks show the places where the back threads are raised over the face threads for tying. Corresponding positions of the ties are indicated by the black marks between the squares of the face plans. Assuming that the cloth is simply backed (with warp or weft as the case may be) the stitching marks indicate how the

back threads are interwoven; but if it be assumed that both warp and weft threads are employed in forming a cloth below the face fabric the marks only show how the two cloths are united.

In order to avoid the formation of marks or indentations in the face of a cloth, the threads on the underside should float over the threads of the face fabric between corresponding floats in the face weave. It is therefore necessary to carefully select suitable positions for the stitches or ties in the face weave, and for this reason the face weave that is employed largely determines the arrangement of the ties that is most applicable. The basis on which the face weave is constructed should be

ascertained, as from this the best order of distributing the ties can, in most cases, be judged. The following orders of distribution are in general use:—(a) Twill order, used for twill face weaves. (b) Sateen order, used for weaves based upon sateens, and also for the loose binding of twill weaves. (c) Plain or alternate order, used in binding certain weaves very firmly. (d) Irregular order, used for irregular weaves.

A in Fig. 2 represents a twill order of stitching a 2-and-2 twill face cloth with

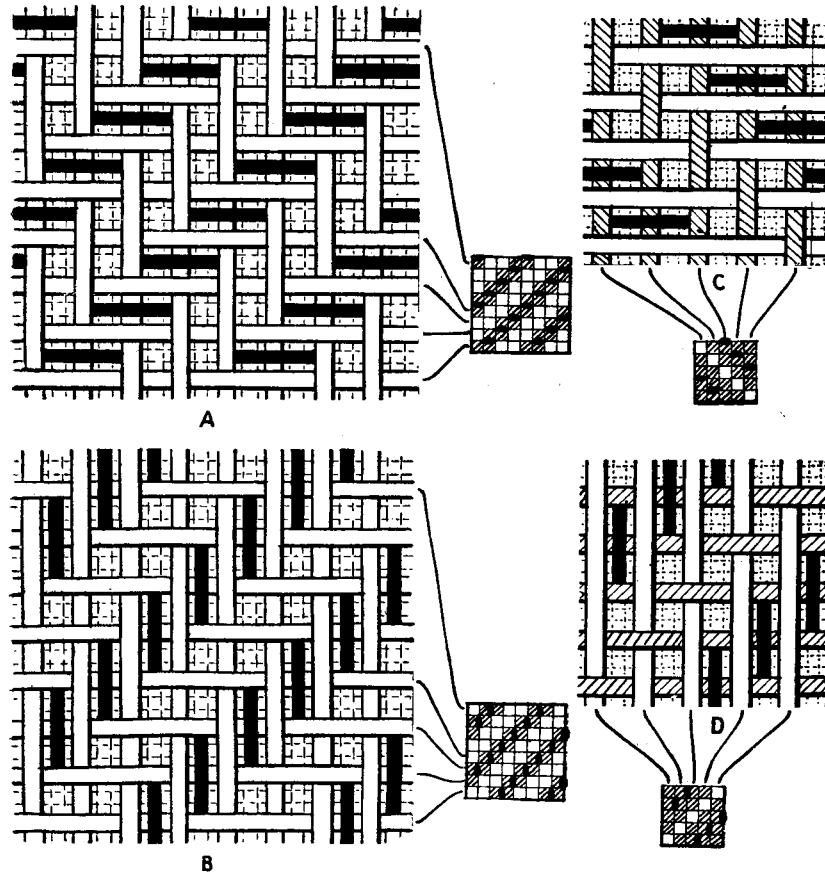


Fig. 2.

backing weft, and B with backing warp. In each case the backing threads are stitched with the face threads between corresponding floats in the face weave—*e.g.*, in A, each backing weft stitch is indicated between face-weft floats, and in B, each backing warp stitch between face-warp floats. In the plan which corresponds with diagram A, the shaded marks represent the face-weft floats, while the black marks between the squares show where the backing picks float over the face ends, and coincide with the stitches shown in the flat view. The shaded squares, in the plan that corresponds with B, represent warp up, while the black marks between the squares, which coincide with the stitches shown in the flat view,

indicate where the backing ends float over the face picks. Similarly, C in Fig. 2 represents a 4 weft-and-1 warp twill face cloth, the ends of which are stitched in twill order by the backing picks; while D shows a 4

warp-and-1 weft twill in which the backing ends are raised in twill order over the face picks.

The examples given in Fig. 3, in each of which the face weave is 3-and-3 twill, show by comparison that a twill face weave may be stitched either in twill or sateen order. The horizontal black marks in the flat-views represent back weft stitches, and the vertical black marks, back warp stitches. The former would be used in weft backing, and the latter in warp backing; but in a double-cloth structure either of the two, or both methods in combination may be employed, the term "double - stitching" being applied in the latter case. In the plans given in Fig. 3 the weave marks represent warp up, and it will be seen that a warp tie is indicated between two marks, and a weft tie between two blanks. The twill order of stitching, shown at E, coincides with one repeat of the face twill weave, but

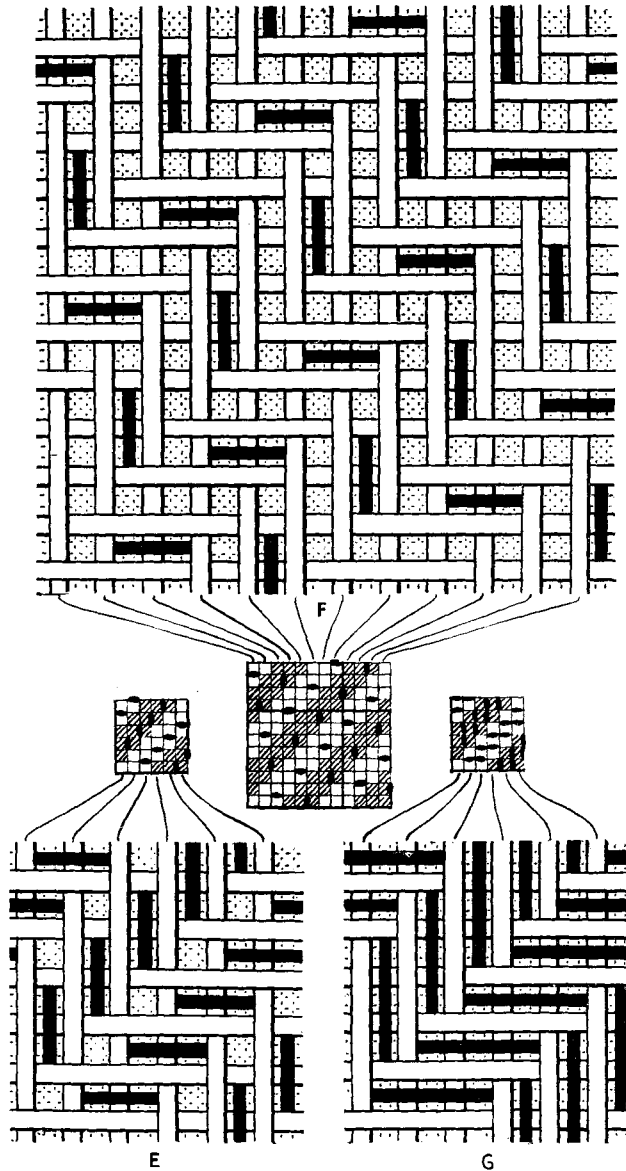


Fig. 3.

the sateen order requires the face twill to be extended to two repeats in each direction, as shown at F. Such an extension is necessary, in the 1 face, 1 back arrangement, when the face twill repeats on an even number of threads, whereas

a twill that repeats on an odd number of threads requires to be extended to three repeats in each direction to fit with a sateen order of stitching. A sateen order of stitching may be employed for a twill repeating on an odd number of threads, by extending the twill to four repeats in each direction, but in this method the distribution of the ties is not uniform in relation to the twill lines.

As a rule, a backing thread should float over only one face thread at a place, but a system of tying on two consecutive face threads is sometimes employed, as shown at G in Fig. 3, in order to secure firmer stitching than is obtained in the ordinary method. The system can, of course, only be practised when the floats of the face weave are suitable, and when the backing yarn is not too thick. It is very important to obtain the proper degree of firmness of stitching, because the solidity, strength, and wearing quality of a cloth are thereby influenced. For a firm handling cloth the ties require to be more frequent than when a soft handle is desired, while in heavily-milled woollen cloths, the felting of which assists in uniting the back yarns to the face, the stitches do not require to be so frequent as in cloths which are not milled. From a careful examination and comparison of the examples given in Fig. 3, it will be seen how different degrees of firmness of stitching may be obtained in a

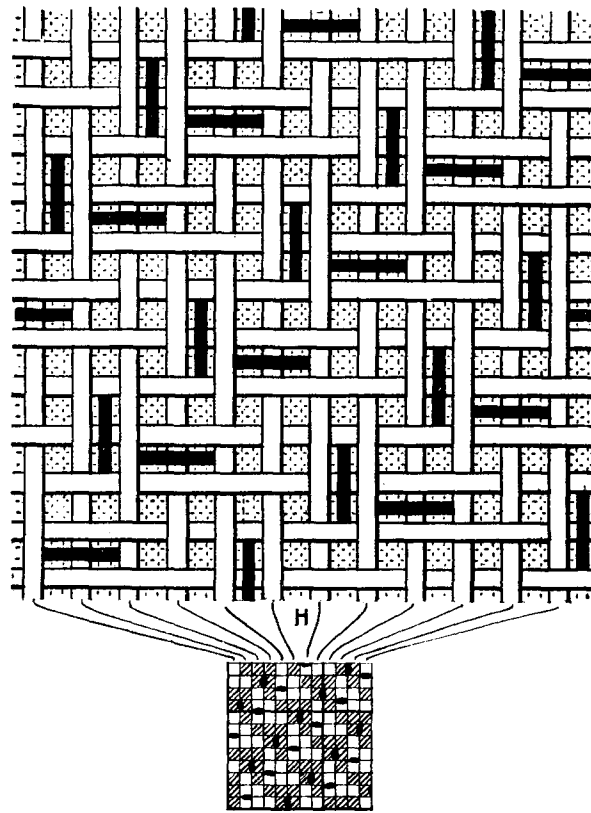


Fig. 4.

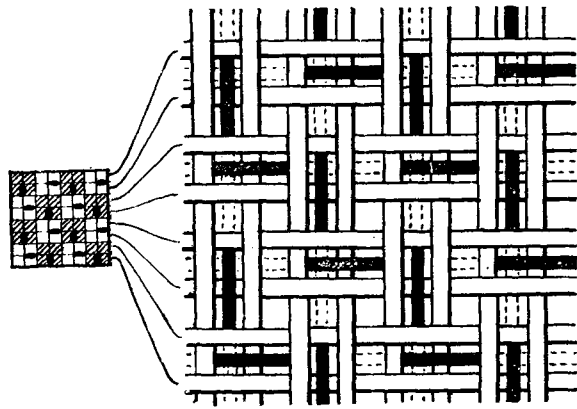
weave. Thus, assuming that a double cloth is represented in each case, both series of backing threads may be stitched over two face threads in twill order, as shown at G; or over one face thread in twill order, as indicated at E; or over one face thread in sateen order, as shown at F. Or one series of backing threads (either warp or weft) may be stitched to the face in one of the orders represented at G, E, and F. A 3-and-3 twill face weave gives greater scope for variety of stitching than the majority of weaves, but in most cases the firmness can be varied according to requirements.

The flat view given at H in Fig. 4, and the corresponding plan (in which the



weave marks indicate warp up), illustrate both the backing-warp and the backing-weft methods of stitching a sateen derivative face weave, the basis of which is the 12-thread regular sateen. A 12-sateen order of stitching to correspond is employed, and it will be seen that when one tying position has been selected the others follow in regular order according to the basis of construction of the face weave.

A plain or alternate order of stitching is illustrated at I in Fig. 5, in which the 2-and-2 hopsack weave forms the face, while the threads are arranged in the proportion of 2 face to 1 back. Both backing warp and backing weft stitching are shown,



and the weave marks in the face plan indicate warp up. This is a very firm order of tying, and in warp stitching enables the minimum number of healds to be employed.

J in Fig. 5 illustrates an irregular order of distributing the stitches which is suitable for the irregular face weave that is employed. Warp tying only is shown, but by turning the example one-quarter round, weft tying will be illustrated, the weave marks of the face plan, in the latter case, indicating weft.

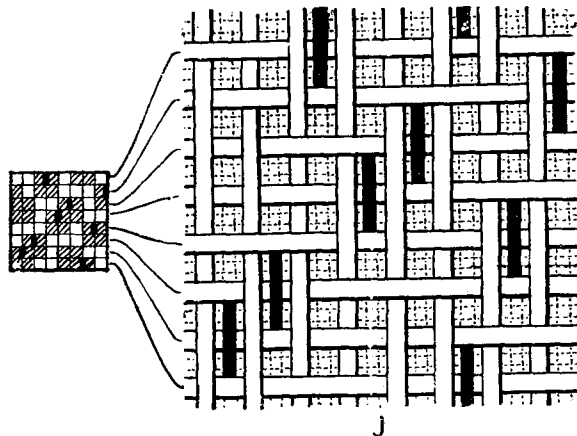


Fig. 5.

Whenever possible it is advisable to obtain the same number of ties on each thread of the series that is employed for tying, and to distribute the ties as regularly as possible over the repeat area. Minor conditions, such as the following, should also be noted. In stitching twill weaves in twill order the

ties should fall equally on each warp or weft twill line. If they fall on alternate lines of the twill (as shown in the example given at V in Fig. 8 (p. 9) and at A and B in Fig. 43 (p. 51), adjacent twill lines will appear different from each other. Also, the ties should not run in twill order in the opposite direction to the face twill, as this has a tendency to form a somewhat indistinct cross twill in the cloth. Examples showing this defective arrangement are given at Z in Fig. 8, and at C and D in Fig. 43. In backing-weft tying, if there is a choice of two consecutive positions for a tie in the face weave, it is better to select the first. Thus, in the

examples given at E and F in Fig. 3, and at H in Fig. 4, each weft tie would have been situated between face weft floats if it had been placed on the same face end one pick later, but the position indicated is the better, because the beating up of two succeeding covering picks conceals the tie more effectively.

In weft and warp-backed cloths the order of stitching determines the weave on the underside, and for certain kinds of face weaves the back weave may be of two classes—viz. (a) The same weave as, or a weave similar to the face weave, the cloth then having very much the appearance of a single structure. (b) A loose back weave which is soft in the handle.

## WEFT-BACKED CLOTHS

The standard orders of arranging the picks in weft-backed cloths are : (1) 1 face to 1 back ; (2) 2 face to 1 back ; (3) 3 face to 1 back ; (4) 2 face to 2 back ; (5) 4 face to 2 back The last two arrangements are used in place of the first two when a different kind of backing weft from face weft has to be inserted in looms with changing boxes at one end only.

**Method of Designing.**—In designing weft-backed effects it is much more convenient to indicate weft than warp up, and in the accompanying designs the weave marks represent weft. B, C, and D in Fig. 6 illustrate the construction of a design in stages ; the face weave is 3-weft and 1-warp twill, as shown at A, and the picks are arranged 1 face to 1 back. First, the position

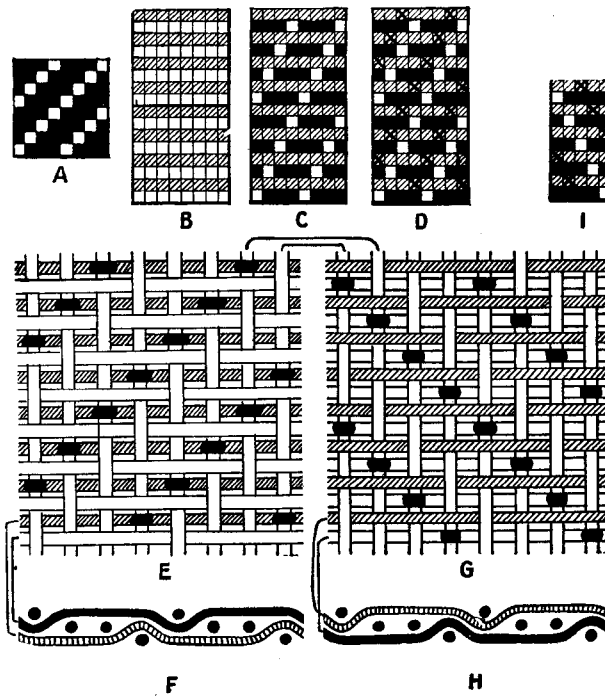


Fig. 6.

of the backing picks is indicated in pencil or a light wash of colour, as represented by the shaded horizontal spaces in B. Second, the face weave is indicated on the blank horizontal spaces, as shown by the solid marks in C. Third, the stitches are inserted on the backing picks as shown by the crosses in D, care being taken that there is a face weave mark above and below each stitching mark. In the example the stitches are arranged in 1-and-3 twill order, so that the weave on the underside is just the same as that on the face except that the twill runs in the opposite direction when the cloth is turned over. This is illustrated by the

diagrams E, F, G, and H in Fig. 6; E shows the face side, and G the underside, assuming that the cloth is turned over from left to right, while F and H represent the interlacing of the first two picks of the respective flat views.

The design I in Fig. 6 will produce a 4-weft and 1-warp twill weave—running to the left on the face side, and to the right on the reverse side when the cloth is turned over. This example corresponds as regards the face weave and the order of stitching with the example given at C in Fig. 2 (p. 3).

**Reversible Weft-Backed Weaves.**—Weft-backed designs, in which the same weft-face weave is formed on both sides, as in the examples given at D and I in Fig. 6, are a distinct class that is chiefly used for heavily felted cloths which are composed of woollen weft and cotton warp. It is customary to use much thicker weft than warp in this structure, and to insert more picks than ends per unit space, so that the felted and raised finish that is applied to the cloth causes the weft to entirely conceal the warp. A number of designs are given in Fig. 7, which form a weft-sateen weave on both sides, and each design is shown connected by lines with a plan of the face

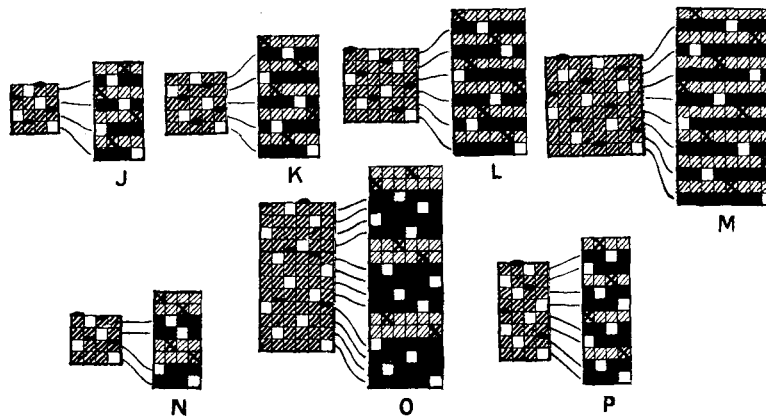


Fig. 7.

weave. The backing weave is shown by the crosses that are placed on the backing picks, and also by corresponding marks which are indicated between the squares of the face weave. As sateen weaves form a smoother surface than twills, they are more suitable than the latter for the heavily felted woollen weft and cotton warp structures. The designs J, K, L, and M are arranged in the order of 1 face pick, 1 back pick, and they respectively form the 4, 5, 6, and 8-thread weft sateens on both sides of the cloth. In the design N in Fig. 7, the 4-thread weft sateen on both sides is arranged to suit a 2-and-2 order of wefting; in the design O the 6-thread weft sateen is similarly arranged with 4 picks face to 2 picks back; whereas the design P shows the 4-thread weft sateen on both sides arranged 2 picks face to 1 pick back.

Suitable weaving particulars for the design J are:  $2/32$ 's cotton warp 40 ends per inch, 12 skeins woollen weft, 60 picks per inch; and for the design K  $2/40$ 's cotton warp, 56 ends per inch, 16 skeins woollen weft, 80 picks per inch. The cloths are shrunk from 20 to 30 per cent. in width.

By employing differently coloured wefts for the face and back a cloth is produced in which the two sides are differently coloured, since each weft is retained on one

side, while by interchanging the wefts, elaborate designs for dressing gowns, motor-coats, carriage rugs, etc., are woven. (See Figs. 141 to 144.)

**Methods of Weft-Backing Standard Twill and Hopsack Weaves.**—The examples given in Fig. 8 illustrate different methods of weft-backing the 2-and-2 twill. In the design Q the picks are arranged 1 face, 1 back, and the order of tying corresponds with that represented in the diagram given at A in Fig. 2 (p. 3). The weave on the underside is 1-warp and 3-weft twill, and the cloth is thus as firm on the back as on the face. The drawing R in Fig. 8 shows how the picks 1 and 2 of Q interlace. In the design S the picks are arranged 1 face, 1 back, but the back weave is 8-thread weft sateen. The cloth in this case is looser and softer on the back than on the face, as long weft floats are formed on the underside, as shown at T, which represents how the picks 1 and 2 of the design S interlace. In U, V, and W in Fig. 8 there are 2 face picks to 1 backing pick, but each design, although used in practice, is defective in that the stitches occur only on alternate ends, so that the odd and even ends are liable to vary as regards "take-up." The design V is additionally defective because the ties occur only on alternate face weft twill lines. In U the stitches produce a very firm back, whereas in W the weave on the underside is very loose; the latter design can be drafted into ten healds, as shown at X. The design Y is imperfect, but it shows the best method of weft-backing the 2-and-2 twill when the picks are arranged 2 face to 2 back.

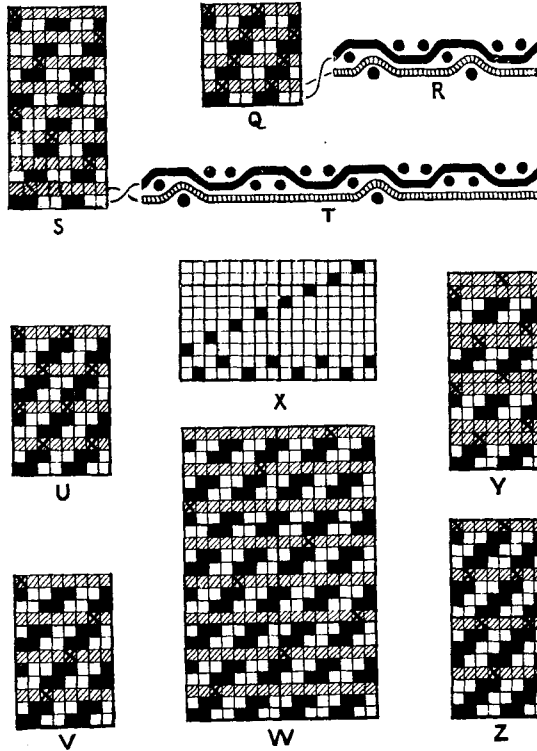


Fig. 8.

In the design Z the picks are arranged 3 face to 1 back, and the stitches are arranged in twill order in the reverse direction to the face twill so that there is a liability of a cross twill appearing in the cloth.

Suitable weaving particulars for the design S in Fig. 8, in a worsted cloth are—warp, 2/48's, 62 ends per inch; weft, 20's, 112 picks per inch.

The designs A, B, and C in Fig. 9, which are wefted in the order of 1 pick face, and 1 pick back, correspond, as regards the 3-and-3 twill face weave and the positions of the weft stitches, with the illustrations given respectively at E, G, and F in Fig. 3 (p. 4). In A the backing weave is 1-and-5 twill, and in B 2-and-4 twill, the latter order of stitching being firmer than the former. In C the backing weave is 12-thread sateen, one repeat of which occupies the same number of threads as two repeats in

each direction of the 3-and-3 twill. The design D is wefted 1 pick face, 1 pick back, and shows a 12-thread sateen derivative face weave backed in corresponding sateen order, this example coinciding as regards the face weave and the weft stitches with H in Fig. 4 (p. 5). The design E, in which the face weave is 3-and-2 twill, illustrates that in a 1-and-1 arrangement of the threads three repeats each way of a twill on an odd number of threads are required when a sateen back weave is formed. The design F shows the 3-and-2 twill backed with weft in the proportion of 2 face picks to 1 back pick, and this example illustrates that a face weave which repeats on an odd number of threads must be extended to two repeats to fit with a 2-and-1 arrangement. Thus, the design contains 10 face picks and 5 back picks, and repeats on 5 ends, and it

will be seen that the back weave is 5-thread sateen.

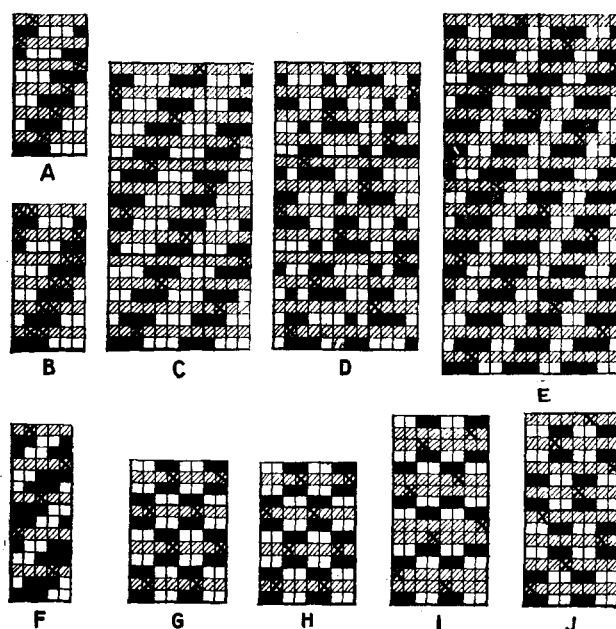


Fig. 9.

The designs G, H, I, and J in Fig. 9 show different methods of weft-backing a 2-and-2 hopsack weave. G and H are wefted in the proportion of 2 face picks to 1 back pick, the backing weave in the design G corresponding with the arrangement of the weft stitches given at I in Fig. 5. H shows a better arrangement of the stitches than G, because in this case a tie is placed on every warp thread. I in Fig. 9 is wefted in the proportion of 2 picks face to 2

picks back, and a stitch is placed on each warp thread. It will be seen that each design, G, H, and I, is so arranged that a backing pick is placed between two face picks that are in the same shed, and not between two picks that cut with each other, so that it is possible to place each stitch with a face weft float on both sides. In the design J the 2-and-2 hopsack weave is backed with weft in the order of 1 face 1 back, and in this case therefore it is only possible to arrange one half the stitches with a face weft float on both sides. A stitch, which is covered on one side only by the face weft, should precede the covering pick, as shown in J, because it is better concealed by the subsequent beating up of the covering pick than if the latter preceded the tie.

**Warp-Face Weaves Backed with Weft.**—The designs given in Fig. 10 illustrate warp-face weaves that are backed with weft, in which it is only possible to cover each tie on one side. In each example the face weave is shown alongside with the positions of the stitches indicated between the squares, and it will be seen that the back

weave is looser than the face weave. The designs K and L both show the 4-thread warp twill backed with 8-thread sateen, but the former, in which the ties follow the face weft floats, is given simply to illustrate incorrect placing of the stitches, the correct method being indicated at L. The design M shows the 4-thread warp sateen backed with a loose irregular weave, while in the design N the face is 5-thread warp sateen, and the back 10-thread weft sateen; the arrangement of the picks is 1 face, 1 back, in each case. The design O is also 5-thread warp sateen face, but the picks are in the proportion of 2 face to 1 back, and the backing weave is the extended 5-sateen.

The type of design given in Fig. 10 is employed for a class of piece-dyed coatings in which a worsted face warp largely predominates in quantity over the face weft (the latter is frequently cotton), while thick woollen weft is used for the back. The cloth is felted and raised on the underside, and is thereby made soft and full to the feel. Suitable weaving particulars for the design N are: Warp, 2/50's worsted,

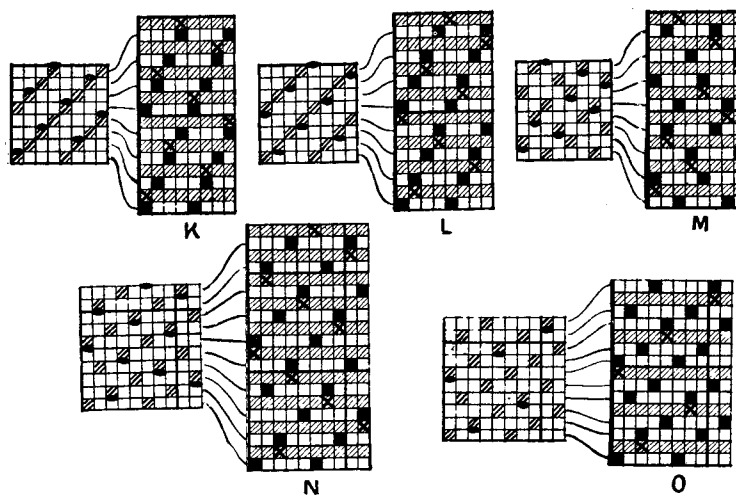


Fig. 10.

102 ends per inch; face weft, 2/40's cotton, backing weft, 10 skeins woollen, 96 picks per inch.

**Method of Selecting Weft Ties.**—The ties for face weaves that are regular in construction are, as a rule, easily arranged, but before constructing a backed design it is convenient, in many cases, to indicate the face weave lightly, and to scheme the distribution of the ties by inserting marks between the squares, in the manner illustrated for example, in the face weave shown alongside the design M in Fig. 10. The ties for irregular face weaves are sometimes difficult to arrange, and in Fig. 11 a convenient method of working is illustrated in stages at A, B, C, and D. The positions of the backing picks, in the order in which they are inserted with the face picks, are indicated, as shown by the marks alongside the face weave given at A; and the first ties are marked between the face picks where only one tying position is available. Second, the ties are marked on the ends which afford only one suitable tying position, as shown at B on the third and seventh ends. Third, the ties are marked in the remaining positions, care being taken to indicate one for each backing

pick, and, if possible, to so distribute them that one tie is placed on each end. In the plan C seven ties are correctly indicated, only that of the fourth backing pick being omitted. It will be seen that in order to cover the remaining tie between the floats of the fourth and fifth face picks it is necessary to place it on the second or the eighth end, on both of which, however, a tie has already been indicated. In a case of this kind, unless there is a strong contrast in colour between the face and back wefts, it is better to place the stitch with a face weft float on one side only, as shown at D, and thus have the ties properly distributed, than to stitch twice on one of the ends. The complete design may then be readily made, as shown at E, but it is quite convenient to peg the dobbie lags straight from a face plan, constructed as shown at D.

**Special Examples of Weft-Backing.**—As previously shown, in 2-and-1 weft backing, it is frequently impossible to place a tie on every warp thread, and it is only in certain weaves that perfect distribution can be obtained. Twill weaves that repeat on an odd number of threads, are examples in which every thread may be stitched,

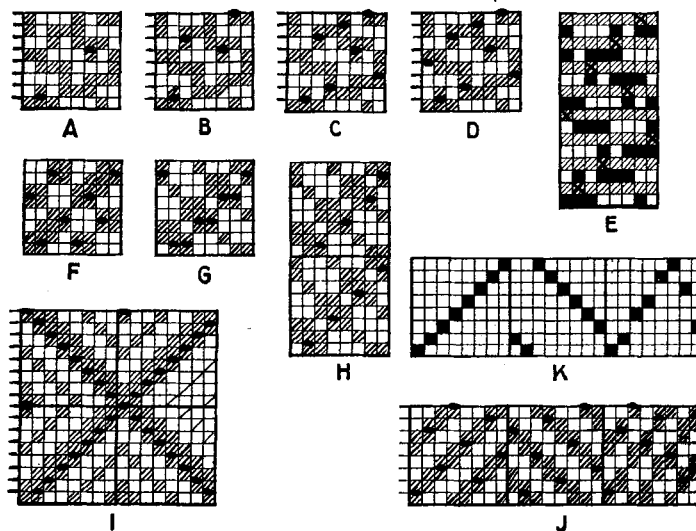


Fig. 11.

as shown in the design F, Fig. 9. A face weave, such as that given at F in Fig. 11, may be stitched on every end, by placing two ties on each backing pick, as shown; while G is an example in which a similar result is obtained by floating each tie over two consecutive ends. A weave, such as G, however, can be stitched on every end by extending it to two repeats, as shown at H (the tie formed by the last backing pick of H should have been indicated on the first end). The design I in Fig. 11 illustrates the principle of weft-backing a diamond weave with the same number of stitches on each end.

In weft-backing a stripe face weave which is composed of derivatives of a simple weave, the stitches require to be carefully arranged in order to avoid needlessly complicating the healds. An example is given at J in Fig. 11, in which the face weave consists of 2-and-2 twill and 2-and-2 twill derivative; the ties are so distributed that an equal number of ends will be drawn on each heald, as shown in the draft given at K.

WARP-BACKED CLOTHS

The arrangement of two series of warp threads to one series of weft threads enables a considerable saving in the cost of production to be effected, as compared with the weft-backed principle, and also permits of the formation of stripe patterns on the underside of the cloth which is impossible in weft-backed textures. Because of the greater strain in weaving, however, such a low quality of backing yarn cannot be used as in weft backing; the drafts are usually more complicated, and a greater number of healds are required in producing similar effects.

The standard orders of arranging the ends in warp-backed cloths are: 1 face to 1 back, 2 face to 1 back, and 3 face to 1 back (there is no necessity to arrange the ends in 2-and-2, or 4-and-2 order); while in some cases a backed weave is combined in stripe or check form with a single weave.

**Method of Designing.**— In constructing warp-backed designs it is convenient to indicate warp up, and in the accompanying plans the weave marks indicate warp. If the foregoing illustrations of weft-backed designs are turned one-quarter round, and the marks are taken to indicate warp, they will represent warp-backed effects; the following examples are given chiefly in order to enable the two systems of construction to be compared.

The illustrations given at A to I in Fig. 12 respectively correspond with those similarly lettered in Fig. 6 (p. 7), the construction of a warp-backed design being shown in stages at B, C, and D. The face weave is 3-warp and 1-weft twill, as indicated at A, and the ends are arranged 1 face, 1 back. The position of the backing ends is first indicated lightly, as shown by the shaded squares in B; then the face weave is inserted on the blank vertical spaces, as shown by the solid marks in

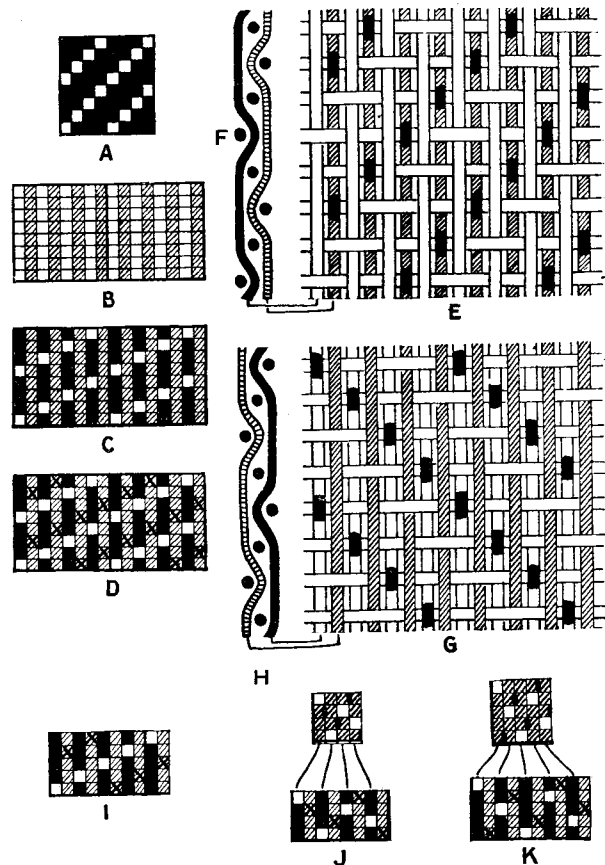


Fig. 12.



C. Afterwards the stitches are marked in, as shown by the crosses in D; and, in this case, there should be a face weave mark at both sides of each stitching mark. The order of tying in the example produces a 3-warp and 1-weft twill on the underside so that the cloth is perfectly reversible except for the difference in the direction of the twill lines, as is illustrated by the corresponding diagrams. The flat view, given at E, represents the structure as viewed from the face side, and that shown at G, as

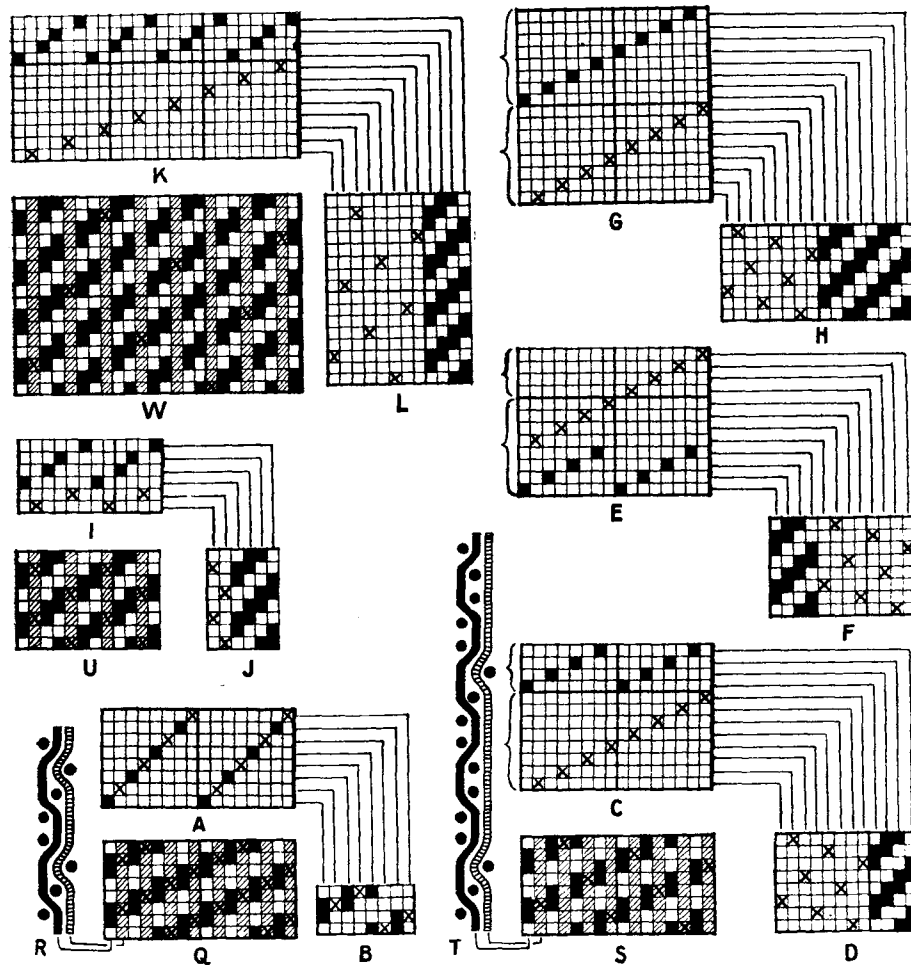


Fig. 13.

viewed from the back, assuming that the cloth has been turned over vertically, while F and H show how the first two ends of the respective flat views interlace.

**Reversible Warp-Backed Weaves.**—The design given at I in Fig. 12, in which the face weave and the order of stitching correspond with the diagram D in Fig. 2 (p. 3), will produce a reversible 4-warp and 1-weft twill weave. Warp sateen weaves on both sides of the cloth are constructed in a similar manner, and J and K in Fig. 12 respectively represent the 4 and 5-thread sateen weaves made reversible. (These

designs correspond with J and K in Fig. 7.) The cloths may also be made reversible as regards the colouring, or different colour patterns may be formed on the two sides by employing different schemes of colouring for the two series of warp threads.

**Beaming and Drafting Warp-Backed Designs.**—Fig. 13 shows various methods of warp-backing a 2-and-2 twill face weave, and also illustrates different systems of drafting warp-backed designs. (Q, R, S, T, U, and W in Fig. 13 correspond with the examples that are similarly lettered in Fig. 8.) The designs Q and S are arranged 1 face end, 1 backing end. The order of stitching in Q corresponds with that shown at B in Fig. 2 (p. 3), while R represents the interlacing of the first and second ends of the design. A 3-warp and 1-weft twill is formed on the underside, and the cloth is therefore as firm on the back as on the face. In the design S a loose sateen weave is formed on the underside, as shown at T, which indicates how the first and second ends of S interlace.

In the designs U and W in Fig. 13 there are two face ends to each backing end, but a commencement is made with one face end in order that the backing ends may be readily dented in the reed with a face end on each side. In the design U a plain or alternate order of stitching on the odd face picks is employed, and in W a sateen order is similarly arranged, the ties thus occurring on only half the face picks.

For the design S the following are suitable weaving particulars in a worsted cloth :—Face and back warp, 2/40's, 19 splits per inch with 6 ends per split; weft, 20's, 60 picks per inch. The design U might be woven in a woollen cloth with 30 skeins face warp, 20 skeins backing warp, 10 splits per inch with 6 ends per split; weft 30 skeins, 40 picks per inch.

In beaming the warp for a warp-backed cloth all the threads may be placed on one warp beam, so long as the face and back yarns are similar, and the face and back weaves are equal in firmness, as in the design given at Q in Fig. 13. As a general rule, however, the two series of threads are placed on separate beams, in order that they may be independently tensioned, and there is then no restriction as to the comparative firmness of the weaves or thickness of the threads.

In drafting warp-backed designs simple patterns may be drawn straight over, as shown at A in Fig. 13, which is the draft for the design given at Q. The corresponding pegging plan, given at B, is exactly the same as the design Q. In the draft A the healds which carry the backing ends are intermingled with those upon which the face ends are drawn, and a similar order of drafting upon 16 healds can be employed for the design S, the latter then forming the pegging plan. In cases, however, where there is difference in thickness or material between the face and backing ends, or if different warp patterns for the two sides of the cloth are employed, or if the face weave requires a special draft, it is better to draw each series through a separate set of healds. The healds through which the weaker yarn is passed should be placed at the front, and under ordinary circumstances these are the backing healds, as the backing yarn is usually inferior to the face yarn. If, however, the face and backing yarns are similar the more crowded set of healds may be placed at the front. The two positions of the face and backing healds are illustrated at C and E in Fig. 13, which show two methods of drafting the design S upon the smallest number of healds, while the respective pegging plans are given at D and F. In the draft C the backing healds are shown in front of the face healds, and in E behind them.

The use of only four healds for the face weave, as shown at C and E in Fig. 13, gives very little scope for producing different weaves in the same draft, whereas if

eight face healds are employed, as shown in the draft given at G, any face weave that repeats on four or eight threads may be woven. H shows the corresponding pegging plan for the design S.

The draft and pegging plan for the design U in Fig. 13 are given respectively at I and J, and for the design W at K and L; the backing healds in each case being placed in front of the face healds. Fewer healds are required in forming a firm back than a loose back, as will be seen from a comparison of the drafts I and K.

**Methods of Warp Backing Standard Weaves.**—The examples in Fig. 14 coincide with the designs that are similarly lettered in Fig. 9. Also the designs A, B, and C in Fig. 14 correspond, as regards the face weave and the warp stitches, with the diagrams given at E, G, and F respectively in Fig. 3 (p. 4). The twill order of stitching in A and B coincides with one repeat of the 3-and-3 twill face weave (in the latter design the backing ends are stitched on two consecutive face picks), whereas

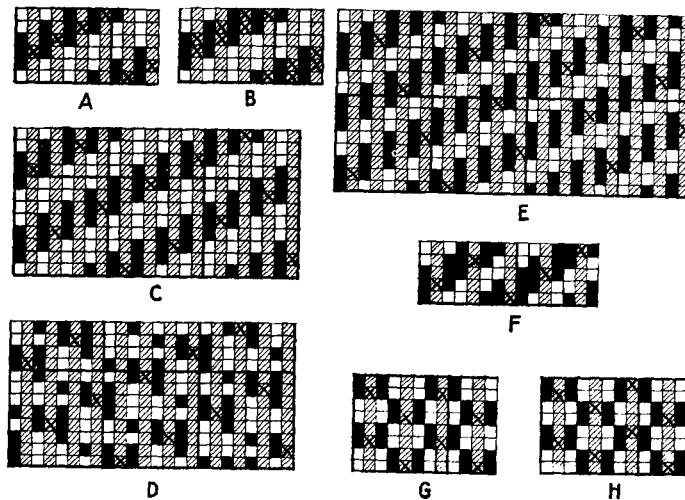


Fig. 14.

the sateen order of stitching in the design C requires that the face weave be extended over two repeats in each direction.

The design D in Fig. 14, which corresponds with the face weave and the warp stitches represented at H in Fig. 4 (p. 5), shows a sateen-derivative face weave backed in sateen order. E shows the extension over three repeats in each direction of a twill face weave that repeats upon an odd number of threads in order that it will coincide with a sateen order of stitching. F shows the same face weave as E, extended to two repeats horizontally to fit with a 2-and-1 arrangement of the ends. The design G corresponds, as regards the 2-and-2 hopsack face weave and the warp stitches with the diagram given at I in Fig. 5, while H shows the same face weave backed in 4-sateen order. The latter is a better arrangement than that shown at G.

**Method of Selecting Warp Ties.**—A convenient system of arranging the ties in warp-backing an irregular face weave is illustrated in stages at I, J, and K in Fig. 15. The face weave is marked in, and the positions of the backing ends—in the order in which they are arranged with the face ends—are indicated below the face plan, as shown at I. The ties are first indicated between the face ends in the places where

only one tying position is available, as shown by the marks between the squares of J. Then, as shown at K, the remaining ties are indicated in the positions which will give the most regular and uniform distribution. Afterwards, the draft and pegging plan may be constructed directly from the face plan in the manner represented at L and M.

**Special Examples of Warp-Backing.**—N in Fig. 15 shows a type of design in which, in a 1-and-1 order of warp-backing, certain of the stitches of the backing ends—in this case the fourth and eighth—can only be covered on one side by a face warp float. In a 2-and-1 order of backing the design, however, it is possible to avoid placing

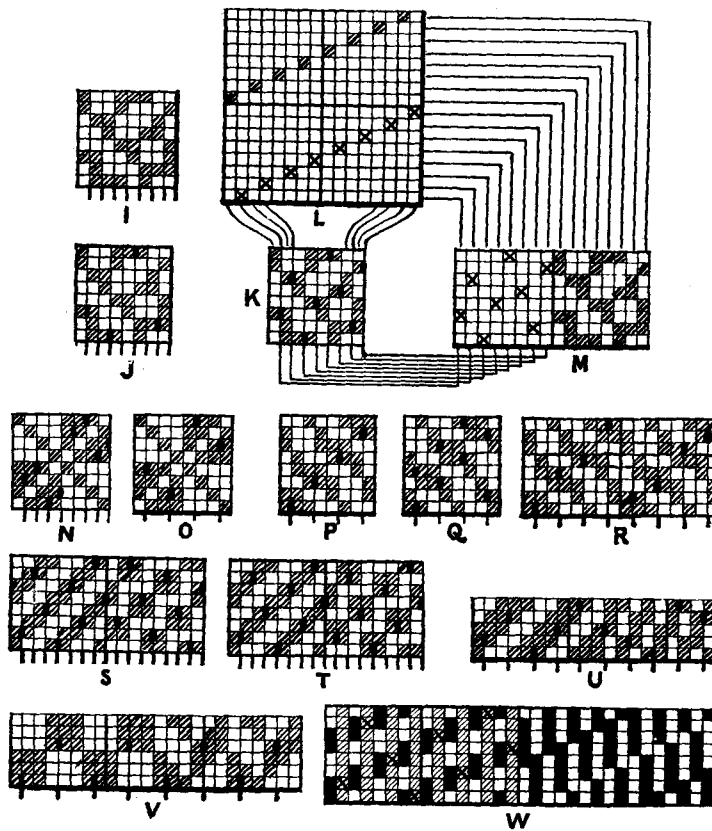


Fig. 15.

a backing thread between the face threads that cut with each other, so that proper positions for the ties can be readily found, as shown at O.

P, Q, and R in Fig. 15 show different methods of backing the Mayo weave with warp in the proportion of 2 face to 1 back. In the design P the ties are placed on alternate picks only, but Q shows the face weave in a different position relative to the backing ends which permits each to be tied twice so that a stitch is placed on every pick. R shows another method of tying the Mayo weave on every pick; the face weave in this case is extended over two repeats and each backing end is only

stitched once, hence the backing weave is as loose as in the design P. An examination will show, however, that the design R requires twice as many backing healds as either P or Q.

The designs S and T in Fig. 15 show two arrangements of the stitches in a 1-and-1 warp-backed weave, which is composed of 2-and-2 twill and twilled hopsack. In both designs the stitches are correctly placed as regards being covered on both sides by face warp floats, but in S the distribution is not so good as in T. Further, a complicated draft of the backing ends is required in the former, whereas in the latter the draft of these ends is quite regular.

The design U in Fig. 15 shows a stripe face weave, composed of 3-and-2 twill and Venetian, which is backed in 2-and-1 order. In the twill section of the face weave the ties are arranged in sateen order with the picks, and in the Venetian section in twill order, so that in this case both the face and the backing threads require to be specially drafted.

The design V in Fig. 15 shows a stripe weave composed of 3-and-3 hopsack and 3-and-3 twill derivative that is backed with warp in the proportion of 3 face to 1 back. The 3-and-1 arrangement of the threads is particularly suited to the face weave, and the ties are so distributed that only two backing healds are required.

W in Fig. 15 illustrates the combination of a warp-backed 2-and-2 twill with a single weave consisting of an 8-shaft warp corkscrew. The proper ratio of setting the two sections is four ends per split in the backed 2-and-2 twill to three ends per split in the corkscrew.

**Comparative Setting of Backed Cloths.**—In both warp and weft-backed cloths in which there are two or three face threads to each backing thread, it is customary to use a thicker and poorer quality of backing yarn than face yarn; and the count number of the backing yarn may be from one-half to two-thirds that of the corresponding face series of threads. The face texture of a backed cloth should generally have rather fewer picks or ends per unit space (according to whether it is weft or warp-backed) than a well-built similar single cloth, this being particularly the case in the 1-and-1 order of backing. For instance, a 2-and-2 twill single worsted cloth made in 2/40's warp and 20's weft, with 60 ends and 60 picks per inch, if backed in 1-and-1 order with weft should have about 60 ends and 112 picks per inch; and if with warp, about 112 ends and 60 picks per inch.

### IMITATION OR PSEUDO-BACKED CLOTHS

Nearly any ordinary weave can be so modified as to produce a structure which very closely resembles a weft or a warp-backed texture, but in which each thread interweaves regularly on both sides of the cloth. The system has the advantages that a heavy single cloth is produced which has a fine surface appearance, and is elastic and soft in the handle, while the threads sustain an equal amount of friction in the manufacture and wear of the cloth. An interior quality of yarn cannot, however, be introduced on the back, since each end and pick is interwoven on both sides, while colours cannot be so effectively applied to the surface as in proper backed cloths. For piece-dyed fabrics, however, the principle of construction is very useful. The designs may be made in imitation of either the 1-and-1, or the 2-and-1 order of backing.

**Imitation Weft Backing.**—The method of constructing imitation weft-backed

designs is illustrated in Fig. 16, in which the marks indicate weft up. In modifying the 2-and-2 twill weave, given at A, to imitate a 1 face, 1 back order of wefting, the repeat of the imitation weave is made one thread less, or one thread more, than twice the number of threads in the repeat of the twill. Thus, in B and C, both of which are imitations of a weft-backed 2-and-2 twill, the respective repeats are on 7 and 9 ends and picks, the former producing an effect which is between a 2-and-2 and a 2-and-1 twill, and the latter an effect between a 2-and-2 and a 3-and-2 twill. A line or marks of the original twill is inserted on alternate horizontal spaces of B and C, but as the repeats contain an odd number of picks the twill marks fall first

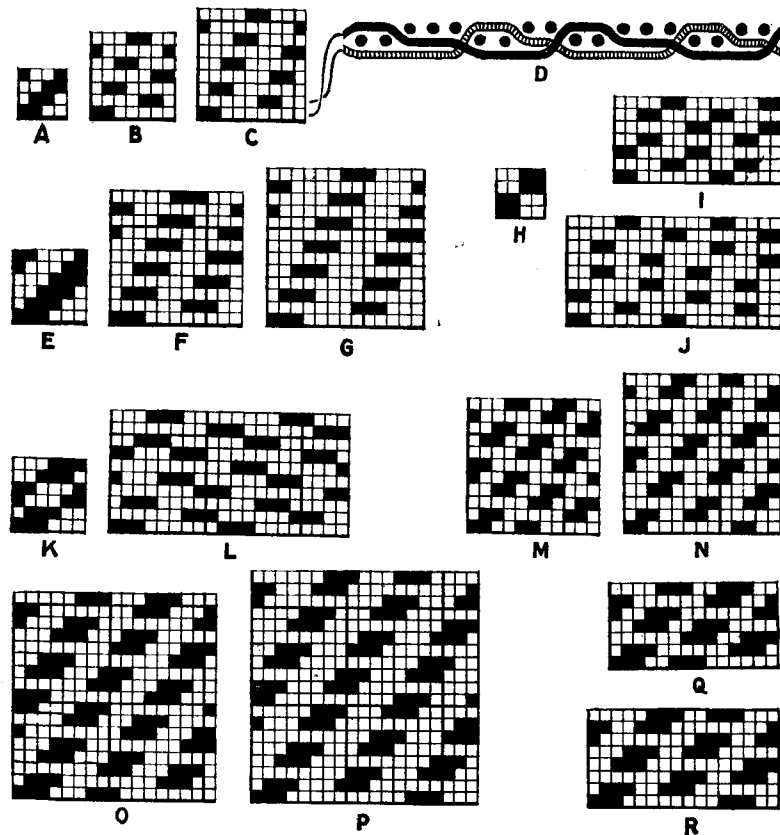


Fig. 16.

on the odd and then on the even horizontal spaces. As shown in the diagram given at D, which represents the interlacing of the picks 1 and 2 of C, the odd and even picks form separate twill lines behind which the even and odd picks respectively float. The designs should be woven with about twice as many picks as ends per unit space in order that the picks will be beaten up very close together, and so cause the twill lines to appear as solid as in an ordinary single cloth. The long weft floats on the underside give the appearance of a loose or sateen back weave, and complete the resemblance to a weft-backed structure.

E, F, and G in Fig. 16 illustrate the modification of a 3-and-3 twill on the 1-and-1

principle; the design F being between a 3-and-3, and a 3-and-2 twill, and the design G between a 3-and-3, and a 3-and-4 twill; the larger weave, of course, allowing of finer setting than the smaller. In the same manner, H, I, and J in Fig. 16 illustrate the modification of 2-and-2 hopsack weave, and K and L of a 3-and-3 twill derivative. In constructing imitation designs that are not twill weaves, a series of floats of the original weave is inserted on the odd horizontal spaces, then a second series is run in on the even spaces, at such a distance from the first series as will give the nearest resemblance to the weave when the picks are beaten close together. In some cases, as shown at J and L, it is necessary to insert several lines of the floats in order to

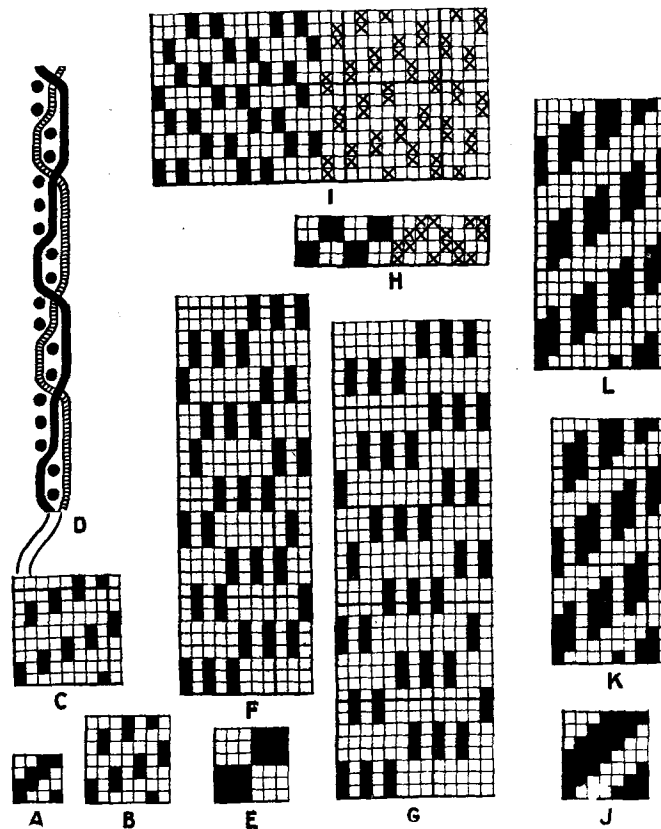


Fig. 17.

complete the design, each line being placed in the same relative position to its neighbours as the first two lines are to each other.

In re-arranging twill weaves in imitation of the 2-and-1 order of weft backing, the repeat is made one thread less or one more than three times the number of threads in the repeat of the twill. For instance, a 2-and-2 twill imitation weave may be made on 11 or 13 threads as shown at M and N respectively in Fig. 16; and a 3-and-3 twill imitation weave on 17 or 19 threads, as represented at O and P respectively. A design in imitation of a twill that repeats on an odd number of threads is complete on twice as many threads in one direction as the other, as shown at Q and R in Fig. 16.

These are weft-backed imitations of a 3-and-2 twill and repeat respectively on 14 ends by 7 picks, and 16 ends by 8 picks. Assuming that the 3-and-3 twill modifications given at G and P are woven in 2/36's worsted warp and weft—64 ends and 128 picks per inch will be suitable for the former, and 64 ends and 96 picks per inch for the latter, and in each case the twill will run at 45° angle.

**Imitation Warp Backing.**—Imitation warp-backed designs are constructed on the same principle as imitation weft-backed effects, and if Fig. 16 is turned one-quarter round and the marks are taken to indicate warp up, the example will illustrate imitation warp-backed structures. In the designs given in Fig. 17, the marks indicate warp, and in order that comparison may be made, the construction of an imitation warp-backed 2-and-2 twill is illustrated at A, B, C, and D, which correspond with the examples similarly lettered in Fig. 16. In this case a line of marks of the original twill is inserted alternately on the odd and even vertical spaces of B and C, so that the odd and even ends form separate twill lines with long floats at the back, as represented in the diagram given at D.

F and G in Fig. 17 illustrate the arrangement in two ways of the 3-and-3 hopsack weave E in imitation of 1-and-1 warp backing; while I shows a 1-and-1 warp-backed imitation of the stripe weave given at H.

The designs K and L in Fig. 17 show 2-and-1 imitation warp-backed modifications of the 4-and-3 twill given at J, the former containing one pick less, and the latter one pick more than three times the number of picks in the twill.

The 1-and-1 imitation warp effects should have about twice as many ends as picks per unit space, while in the 2-and-1 styles the proportion of ends to picks should be about 3 to 2.

### BACKED CLOTHS WITH WADDING THREADS

In this principle of construction the object is to obtain increased weight—as compared with backed cloths—by introducing a thick cheap yarn between the face texture and the backing threads, with neither of which is it usually interwoven. In weft-backed cloths the wadding threads are introduced in the warp, and in warp-backed cloths in the weft, each type thus consisting of two series of warp and two series of weft threads.

**Weft-Backed and Warp-Wadded Designs.**—The system of constructing weft-backed and warp-wadded designs is illustrated in Fig. 18, in which the weave marks indicate weft. In order that comparisons may be made, the 4-and-4 twill weave given at A is shown arranged on the ordinary weft-backed principle at B, while the construction of a wadded design to correspond is illustrated in stages at C, D, and E. The positions of the backing picks and wadding ends are indicated by different markings at C; the arrangement is 1 face pick, 1 backing pick, and 1 face end, 1 wadding end. At D the marks of the face weave A are inserted where the face ends and face picks intersect, as shown by the solid marks, while the backing weft stitches, which are represented by the crosses, are indicated between face weft floats where the face ends intersect the backing picks. It will be seen that the weave marks in B are indicated on the odd vertical spaces of D. E shows the completion of the design, the wadding ends being marked down, as shown by the dots, on the face picks. On the backing picks the wadding ends are left blank so that they are raised, and may therefore lie between the face texture and the backing picks, as shown in



the diagram given at F, which represents the interlacing of the picks 1 and 2 of E. G shows the appearance of the design E when only one kind of mark is used to represent weft up. All the wadding ends work alike so that only one heald is actually necessary to operate them.

The design represented at H in Fig. 18 shows the weft-backed 3-and-3 twill, which is given at C in Fig. 9 (p. 10), arranged on the warp-wadded principle; the marks of the weft-backed design correspond with those indicated on the face ends of H. In this case there are two face ends to each wadding end, and, as shown by the shaded squares in H, the threads are arranged 1 face, 1 back in the weft, and 1 face, 1 wadding, 1 face in the warp.

A third arrangement of the threads is given at I in Fig. 18, which shows the weft-backed 2-and-2 hopsack weave, represented at H in Fig. 9 (p. 10), wadded with

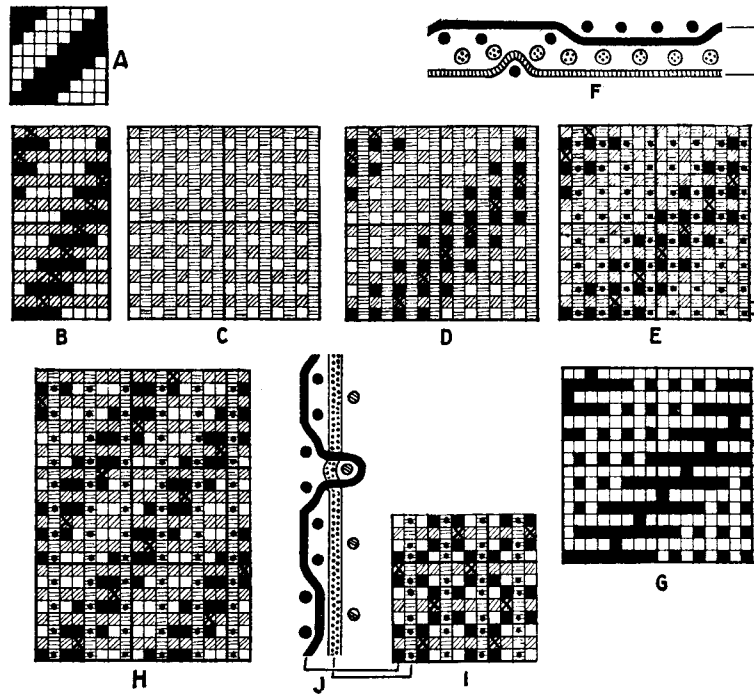


Fig. 18.

warp in the proportion of 2 face to 1 wadding end. The picks are arranged in the order of 1 face, 1 back, 1 face, and the ends in the order of 1 face, 1 wadding, 1 face. As before, the weave marks on the face ends are exactly the same as in the weft-backed design, and the wadding ends are marked down on the face picks. The section through the weft given at J, which represents the interlacing of the first two ends of I, may be compared with the warp section indicated at F; both diagrams show how the wadding ends lie between the face fabric and the backing weft.

**Warp-Backed and Weft-Wadded Designs.**—The system of constructing warp-backed and weft-wadded designs is illustrated by the examples given in Fig. 19, in which the weave marks indicate warp up. The illustrations lettered K to P respec-

tively correspond with those lettered A to G in Fig. 18. The design L in Fig. 19 shows the 4-and-4 twill K arranged on the ordinary warp-backed principle, while M and N represent different stages in the construction of the wadded design. The arrangement of the threads is 1 face, 1 back in the warp, and 1 face, 1 wadding in the weft, the positions of the backing ends and wadding picks being indicated by the shaded spaces in M. The solid marks in M, which are inserted where the face ends and picks intersect, show the lifts of the face weave; while the crosses, which are placed between face warp floats, represent the backing-warp stitches. It will be seen that the marks on the odd horizontal spaces of M correspond with the marks of the design L. In the complete design given at N the face ends are lifted on the wadding picks, as shown by the dots, whereas the backing ends are left down. The wadding picks therefore lie between the face fabric and the backing ends, as shown in

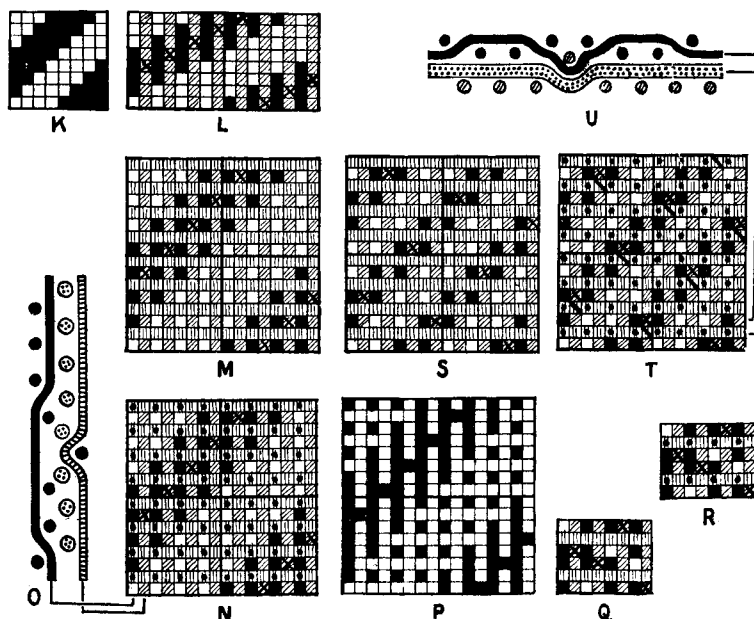


Fig. 19.

the diagram given at O, which represents the interlacing of the first and second ends of N. P represents the appearance of the design N assuming that only one kind of mark is used to indicate warp up. The drafting of the design is the same as for the warp-backed design L.

Q and R in Fig. 19 show two stages in the construction of a wet-wadded modification of the reversible 4-thread warp sateen given at J in Fig. 12 (p. 13). In this case there are two face picks to each wadding pick. In Q the weave marks of the design J in Fig. 12 are indicated on the face picks, while R shows the wadded design completed by lifting the face ends on the wadding picks.

The weave marks on the face picks of the plan S in Fig. 19 correspond with those indicated in the design S in Fig. 13 (p. 14), which shows a 2-and-2 twill backed with warp in sateen order. The complete weft-wadded design to correspond is given at T in Fig. 19, but in this example a method of interweaving the wadding picks with

the backing ends, which is sometimes practised, is illustrated. The diagonal strokes which precede the crosses in T, Fig. 19, indicate the lifts of the backing ends over the wadding picks; it is necessary for these lifts to be made either immediately before or immediately after the backing-warp stitches, in order to avoid breaking the backing-warp floats on the underside of the cloth. The diagram given at U, which represents the interlacing of the picks 2 and 3 of T, shows how the wadding picks lie between the face fabric and the backing ends, except where they pass under the latter at a stitching place. In the design T the wadding picks and backing ends interweave in 8-sateen order with each other and really form a loosely-woven fabric below the face fabric; the former being united to the latter where the backing ends are raised over the face picks.

## CHAPTER II

### DOUBLE CLOTHS

Double-Cloth Structure—Relative Proportions and Thicknesses of the Face and Backing Threads—Origination or Selection of the Face and Backing Weaves—Tying or Stitching—Construction of the Point-Paper Design—Construction of Double-Cloth Designs for Looms with Changing Boxes at one End only—Double-Cloth Beaming, Drafting, and Pegging—Effect of the System of Tying upon the Number of Healds—Special Features in Double-Cloth Designing—Position of the Backing Weave—Systematic Construction of Double-Cloth Designs—Reversible Double Weaves—Double-Cloths with Compound Face Weaves.

**Double-Cloth Structure.**—The simplest type of double-cloth is composed of two series of weft and two series of warp threads; one series of each kind forming an upper or face fabric, and the other, an under or back fabric. It is necessary for the face picks to be arranged in definite order with the backing picks, and the face ends with the backing ends. The two series of ends require to be drawn through the healds or harness in such a manner that one series may be operated quite independently of the other series. Separate weaves are required for the two fabrics, which, however, may be either alike or different from each other. Then by interweaving the face picks only with the face ends according to the face weave, and the backing picks only with the backing ends according to the backing weave, two distinct fabrics are formed one above the other. The method in which this is accomplished is illustrated in Fig. 20.

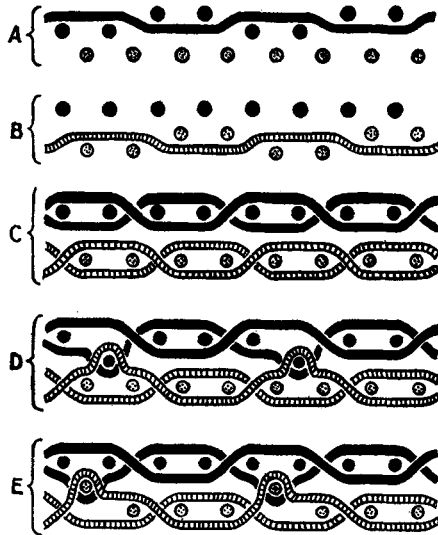


Fig. 20.

The threads are arranged 1 face, 1 back in warp and weft, and a 2-and-2

weft rib weave is employed for both the face and back textures. A represents the position of the warp threads when the first face pick is inserted. All the backing ends are left down in order that they will be out of the way of the face weft, and half the face ends are raised in forming the face weave. B shows the position of the warp threads when the first backing pick is inserted. In this instance all the face ends are raised in order that they will be clear of the backing weft; also half the backing ends are raised in forming the backing weave. By allowing each series of weft picks to thus interweave only with its own series of warp threads, two fabrics are produced which are quite separate and detached from each other, as shown at C. If, however, a proportion of the face warp threads be left down when a backing pick is inserted, as shown at D in Fig. 20, or if a proportion of the backing warp threads be raised when a face pick is inserted, as indicated at E, the threads of one fabric interweave with the threads of the other fabric; and although there are still two distinct fabrics formed one above the other, they may be so closely united that only one cloth is produced which

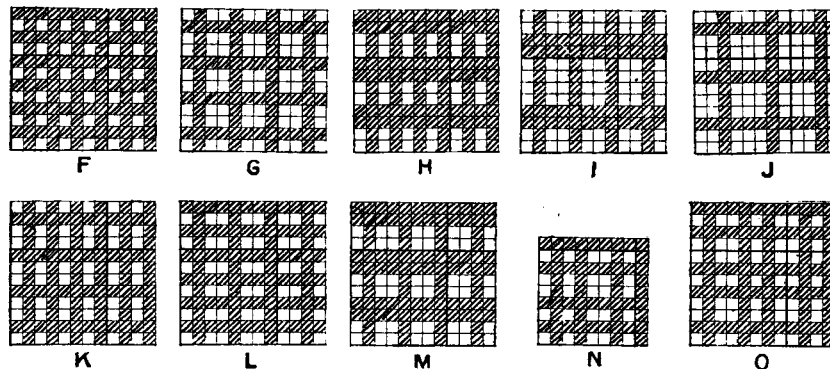


Fig. 21.

is equal in thickness and weight to the two single fabrics. The tying or stitching together of the two fabrics forms one of the principal features of ordinary double-cloth designing. If a cloth is not soundly stitched, the two fabrics are liable to become separated from each other during wear, particularly if the back fabric is heavier than the face. Diversity of design and colouring can be applied to both sides of a double-cloth, and at the same time a more perfect structure is obtained than in the case of single fancy cloths or backed cloths.

The construction of double cloths may be considered under the following heads: The relative proportions and thicknesses of the face and backing threads; the origination or the selection of the face and backing weaves; the tying or stitching together of the two fabrics so as to form one cloth; the construction of the point-paper design; the beaming, the drafting, and the construction of the pegging plan.

**Relative Proportions and Thicknesses of the Face and Backing Threads.**—These are decided mainly by the weight to be added to the face texture, but the order of arrangement of the threads is determined partly by the boxing capacity of the loom. The most common varieties of double cloths are arranged in warp and weft 1 face, 1 back, as shown at F in Fig. 21, and 2 face, 1 back, as shown at G. For looms with boxes at one end only, and when the backing weft is different from the face weft,

similar effects may be obtained in many weaves by changing the wefting to 2 face, 2 back and 4 face, 2 back, respectively, as shown at H and I. Cloths which require a very fine face are sometimes arranged 3 face, 1 back in warp and weft, as shown at J. The threads may also be arranged in a mixed order, as, for example, 1 face, 1 back in the warp, and 2 face, 1 back in the weft, and *vice versa*, as shown at K and L respectively, or 2 face, 1 back in the warp, and 2 face, 2 back in the weft, as shown at M. Irregular arrangements such as 5 face to 4 back (shown at N), and 7 face to 5 back (shown at O), are also employed, and these are useful as they admit of relative proportions of face and backing threads being used which cannot be obtained in any of the regular bases. In addition, special arrangements of threads are employed in the construction of cut double cloths, double plain styles, wadded double cloths, and centre stitched double cloths.

In deciding on the relative thicknesses of the face and backing yarns, a good rule to follow is to have the relative counts about proportionate to the relative numbers of the threads per unit space. Thus, in a 1-and-1 double cloth the backing yarn should be similar to, or not much thicker than the face yarn; the finest qualities of the structures being usually made the same on both sides. If arranged 2 face to 1 back, the backing yarn may be proportionately thicker, or say, from two-thirds to one-half the corresponding counts of the face yarn; the back being made coarser than the face, particularly when worsted yarns are used for the latter, and woollen yarns for the former. The proportionate counts of the threads, however, depend upon the relative firmness of the face and backing weaves, and the preceding proportions apply to the 2-and-1 arrangement when the backing weave is firmer than the face weave, as described in the next paragraph. If the same weave is used on both sides of the cloth the backing threads may be three or four times as heavy as the face threads in the 2-and-1 arrangement, especially when centre threads are employed for stitching.

**Origination or Selection of the Face and Backing Weaves.**—When the threads are arranged in equal proportions the backing weave is usually the same as the face weave, or contains about the same relative number of intersections, as, for instance, the 2-and-2 twill is suitable for backing the 3-2-1-and-2 twill. In other arrangements the backing weave is, as a rule, made with a relatively greater number of intersections than the face weave in order to compensate for the reduced number of threads. Thus, in the 2-face, 1 back arrangement, the plain weave is suitable for backing the 2-and-2 twill and the 2-and-2 hopsack; the 2-and-1 twill for backing the 3-and-3 twill; and the 2-and-2 twill for backing the 4-and-4 twill. However, in the making of cloths with a fine, smart face and soft back, the same weave may be used, in the 2-and-1 arrangement, for both the face and back textures; while for a similar type of cloth in a 1-and-1 arrangement of the threads, a looser back than face weave may be employed. The most regular effect is obtained by having the repeats of the face and backing weaves equal, or one a multiple of the other. For example, the 1-and-3 twill is unsuitable for backing the 2-and-3 twill unless the threads are arranged irregularly in the proportion of 5 face threads to 4 backing threads.

**Tying or Stitching.**—The main principles involved in tying or stitching are described and illustrated in pp. 2-7, but in stitching double cloths, certain conditions are different as compared with backed cloths. In backed cloths, as previously stated, the order of stitching the backing threads to the face fabric gives the weave on the

underside. In ordinary double cloths, on the other hand, the stitches simply join the two fabrics together, and, if correctly placed, have no effect on the appearance of either the face or the underside of the cloth. In backed cloths the stitches can only be made by the weft or warp threads (as the case may be) which form the underside, whereas in double cloths there are two methods of tying, since either the backing ends or the backing picks may be employed. Tying with the backing warp, which is termed warp tying, is illustrated by the section given at E in Fig. 20, in which it will be seen that the backing warp interweaves with the face fabric, and the face weft with the back fabric. When the backing picks are inserted, all the face ends are raised, and when the face picks are inserted, all the backing ends are left down, with the exception of the tying ends.

The section given at D in Fig. 20, illustrates the method of tying with the backing weft, which is termed weft tying; in this method the backing weft interweaves with the face fabric, and the face warp with the back fabric. When the face picks are inserted, all the backing ends are left down; and when the backing picks are inserted, all the face ends are raised, with the exception of the tying ends.

The method of tying which is the more suitable is, in some cases, determined by the character of the face weave. If a warp sateen, or a warp twill weave be employed for the face fabric, tying with the backing warp only is suitable; while in the case of a weft sateen or a weft twill weave, it is only advantageous to tie with the backing weft. When there is a choice of the two methods, other things being equal, warp tying is usually preferable, as the warp is less liable to show on the face than the weft. This is because the backing warp, as a rule, is a finer and smarter yarn than the backing weft, and ordinary woollen and worsted cloths contract in finishing more in width than

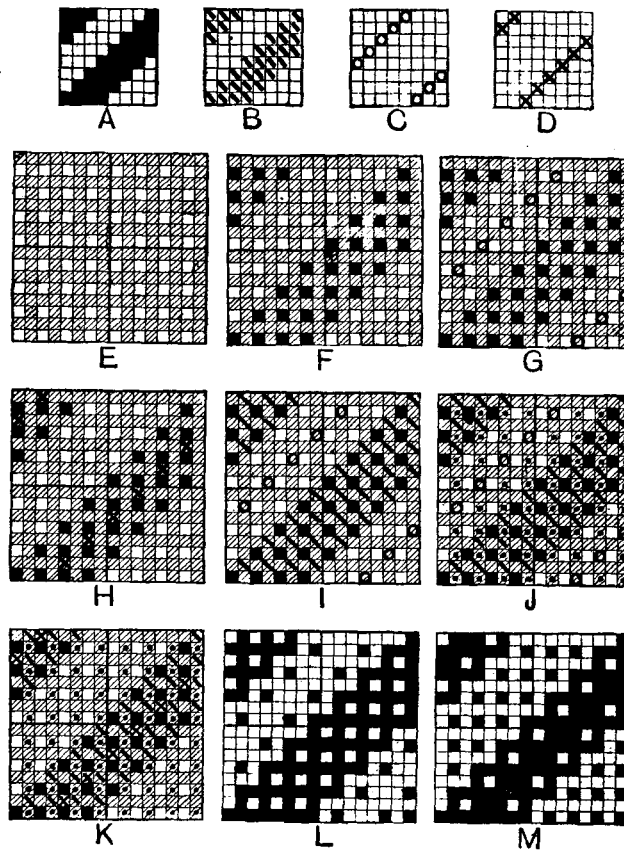


Fig. 22.

in length. In some cases both methods of tying are employed in combination, as previously explained (p. 4), the cloth being then termed double-stitched.

**Construction of the Point-Paper Design.**—In constructing backed designs it is clearly advantageous to indicate weft in weft-backing and warp in warp-backing, but in double cloths either weft or warp may be marked with equal facility, and in the following examples both methods are illustrated. Figs. 22 to 33 simply show the construction of designs from given particulars; various factors, which require to be considered before a double weave is commenced, are fully dealt with in reference to subsequent examples. It is sufficient at this stage to assume that in each example the face weave, the backing weave, and the ties, are placed in such positions relative to one another as will ensure that the ties are covered on each side of the cloth as effectively as possible by the adjacent floats.

In order to prevent confusion the different stages in working out a double-cloth design should be represented by different kinds of marks, as shown in Fig. 22, which illustrates, step by step, the construction of a double 4-and-4 twill structure in which the ends and picks are arranged 1 face, 1 back. In this example *marking for weft* is illustrated, and both the warp and the weft method of tying are shown. A is the plan of the face weave, B of the backing weave, C of the warp ties (the circles indicating the order in which the backing ends are raised over the face picks), and D of the weft ties (the crosses indicating the order in which the backing picks are passed over the face ends). The ties are distributed in 8-thread twill order to correspond with the face and backing weaves. The different stages in the construction of the double-cloth plan are shown separately at E to K.

E shows the arrangement of the backing threads with the face threads, the backing ends and picks being represented by the shaded lines. In practice, transparent colour or pencil may be employed.

F shows the face weave inserted. The weave marks are copied from A, and are indicated in the prescribed order on the squares where the face ends intersect with the face picks, as shown by the solid marks.

G shows the insertion of the ties, assuming that warp tying is employed. Each mark (a circle) is placed where a backing end intersects a face pick, and between two blanks alongside each other—*i.e.*, two face warp floats—in the face weave.

H shows the insertion of the ties, assuming that weft tying is employed. In this case each mark (a cross) is placed where a backing pick intersects a face end, and between two marks, one above the other—*i.e.*, two face weft floats—in the face weave.

I shows the backing weave inserted (the warp method of tying being employed). The weave marks are copied from B, and are indicated on the squares where the backing ends intersect with the backing picks—as shown by the diagonal strokes.

J shows the completion of the point-paper plan for warp tying. Backing ends are marked down on face picks (except those which are raised for tying) in order that they will be out of the way when face picks are inserted, as shown by the dots. All the face ends are left blank on the backing picks in order that they will be raised out of the way when the backing picks are inserted.

K shows the completion of the point-paper plan for weft tying. In this case all the backing ends are marked down on the face picks, and all the face ends are left blank on the backing picks, except where the ties occur.

L shows the appearance of the design J when only one kind of mark is used to indicate the weft floats. The marks correspond with those given in J, except that the circles, which indicate the warp ties in the latter, are represented by blanks, as they show warp up.

M is constructed in the same manner as L, but in this case the marks correspond with those given in the design K.

The flat view given at Q in Fig. 23 corresponds with the design shown at J in Fig. 22. The interlacings of both the face and the backing series of threads are shown, and the positions of the warp ties are indicated in solid black. For convenience each solid mark also includes a portion of the backing warp where it floats over the backing weft. By comparing the plan shown at J, or that shown at L in Fig. 22 with the diagram Q, it will be observed that the weave marks coincide

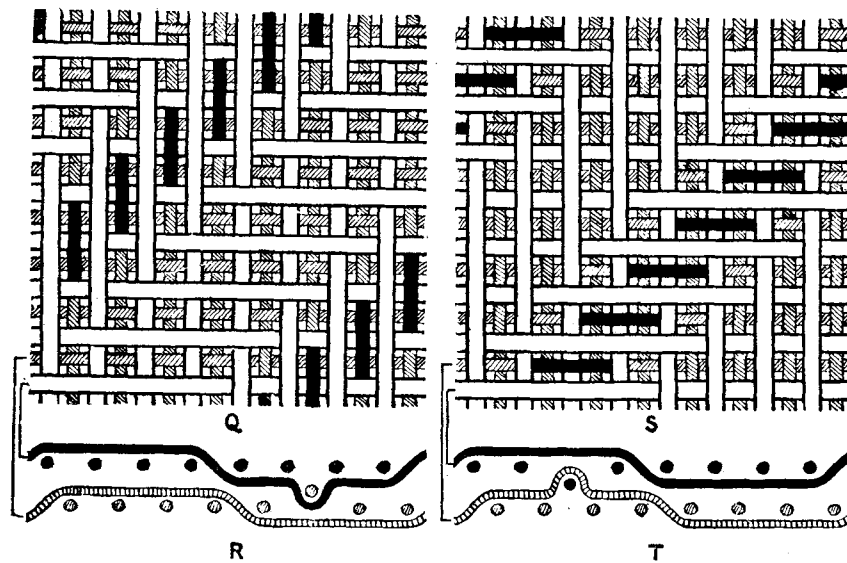


Fig. 23.

with the weft floats, the blanks with the warp floats, and the circles in J with the warp ties. For example, the first face pick passes over the first four and under the last four face ends. It also passes over all the backing ends with the exception of the sixth, which is raised on this pick for tying. The first backing pick passes under all the face ends, but it interweaves with the backing ends by passing over the first four and then under the last four.

The section given at R in Fig. 23 shows how the first face and the first backing pick of Q interlace, and represents in another form the order in which each weft interweaves with its own warp, and how the two fabrics are united by the backing warp entering the face fabric, and the face weft the back fabric.

From a careful examination of Q and R in Fig. 23 it will also be seen that not only will the backing warp ties be covered on the face of the cloth by the adjacent face warp floats, but in addition that where the face weft enters the back fabric for tying it will be concealed on the underside of the cloth by the adjacent backing weft floats. This is evident, because where a backing end is raised over a face pick for



tying, it is also raised over the backing picks which precede and succeed the tie, and the lifting of the backing warp gives a corresponding backing weft float on each side of the face weft stitch, on the underside of the cloth.

S in Fig. 23 shows a flat view of the weave given at K in Fig. 22, the positions of the weft ties being indicated in solid black. In this case each solid mark also includes a portion of the backing weft where it floats over the backing warp. By comparing the drawing with K or with M it will be observed that the interlacings of the threads coincide with the marks and blanks on the point-paper. Thus, the first pick passes over the first four face ends and under the last four, while it also passes

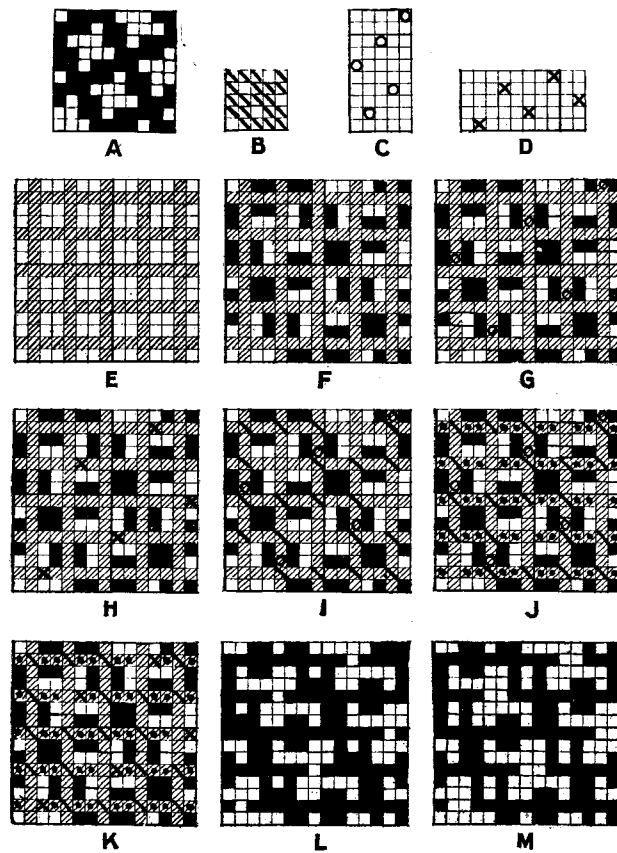


Fig. 24.

over all the backing ends. The first backing pick passes over the first four and under the last four backing ends, but it affects the tying by passing in addition over the third face end. A section representing the interlacing of the first face and the first backing pick of S, is given at T in Fig. 23, which shows that the two fabrics are united by the backing weft entering the face fabric, and the face warp the back fabric. On the face of the cloth the backing weft ties will be covered by adjacent face weft floats, while on the back the face warp ties will be covered by adjacent backing warp floats, because where the backing weft floats over the face warp for tying it also passes over the backing ends on each side of the tie, and a corresponding backing warp float on the underside of the cloth results on each side of the face warp stitch.

The method of constructing the plan of a double cloth, in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft, is shown in Fig. 24. As thicker yarn may be employed for the back fabric than is possible in the 1-and-1 order, this arrangement may be used conveniently in the manufacture of fine face cloths in which the underside is composed of heavy yarns. The 10-thread

over all the backing ends. The first backing pick passes over the first four and under the last four backing ends, but it affects the tying by passing in addition over the third face end. A section representing the interlacing of the first face and the first backing pick of S, is given at T in Fig. 23, which shows that the two fabrics are united by the backing weft entering the face fabric, and the face warp the back fabric. On the face of the cloth the backing weft ties will be covered by adjacent face weft floats, while on the back the face warp ties will be covered by adjacent backing warp floats, because where the backing weft floats over the face warp for tying it also passes over the backing ends on each side of the tie, and a

fancy weave given at A in Fig. 24 is used for the face fabric, and the 5-thread sateen (with weft surface on the underside), shown at B, for the back fabric. Both the backing warp and the backing weft method of tying are shown, the warp ties being formed by raising the backing ends in 5-sateen order over alternate face picks, as indicated at C, and the weft ties by passing the backing picks over alternate face ends in a similar order, as represented at D.

In Fig. 24 the different stages of working are indicated separately in the same manner as in Fig. 22, and corresponding stages are similarly lettered in the two figures, but in Fig. 24 *marking for warp* is illustrated. E shows the arrangement of the face and backing threads; the face weave is inserted at F; the circles in G indicate the positions of the warp ties, and the crosses in H the positions of the weft ties; the backing weave is inserted at I; while the complete design for warp tying is given at J, and for weft tying at K.

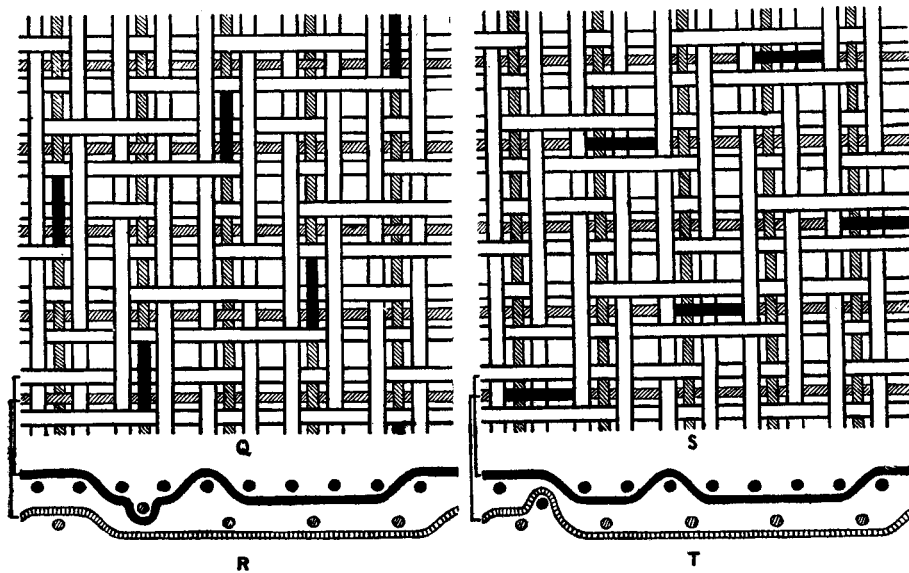


Fig. 25.

It will be seen, from a comparison of Figs. 22 and 24, that in marking for warp the warp stitches are placed between face weave marks (instead of blanks), and the backing weft stitches between blanks in the face weave (instead of marks); while dots are inserted to lift the face ends on the backing picks, except where backing weft stitches are indicated (instead of marking backing ends down on face picks, except where there are warp stitches). L and M in Fig. 24 respectively show the appearance of J and K when only one kind of mark is used to indicate the warp floats, marks being omitted in M to correspond with the crosses in K which represent weft float.

In the flat view given at Q in Fig. 25 the interlacings of the face and backing series of threads and the positions of the warp ties correspond with the marks and blanks in the point-paper plan shown at J or L in Fig. 24. The section R in Fig. 25 shows the interlacing of the first backing pick and the second face pick of S. It

will be seen that where the backing warp enters the face cloth for tying it will be concealed by the face warp floats; also, as each backing end (where raised over a face pick for tying) is also raised on the backing pick which precedes and succeeds the tie, the face-weft tie will be covered on the underside of the cloth by the backing-weft floats.

S and T in Fig. 25 respectively show the flat view, and the order of interlacing

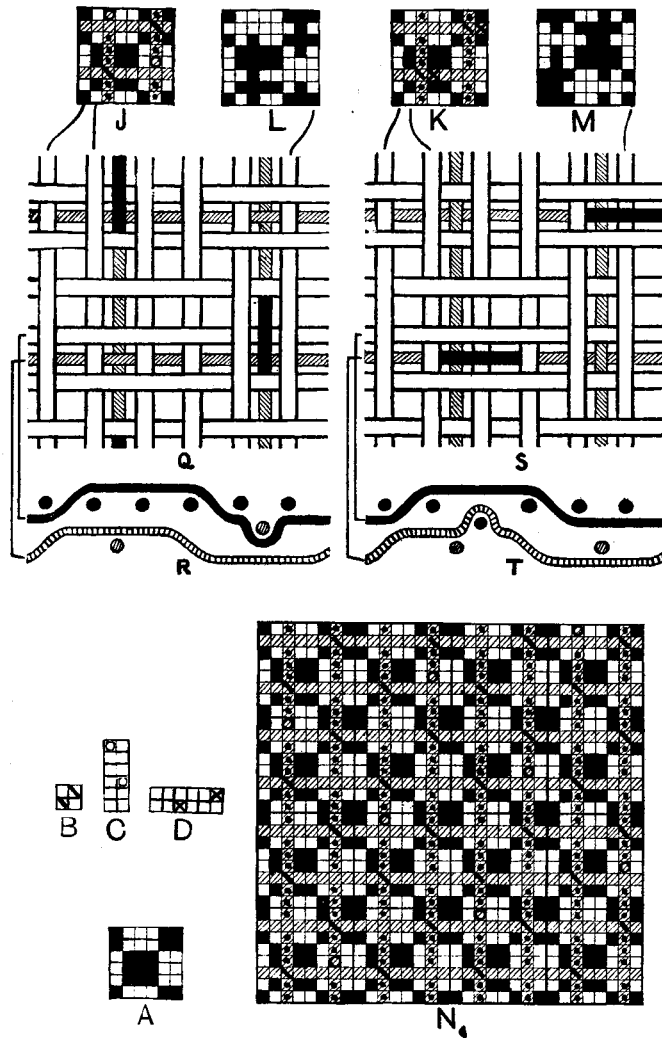


Fig. 26.

of the first backing pick and the second face pick of the weave given at K, or M in Fig. 24, in which weft tying is employed. The tie will be concealed on the face of the cloth by the face picks which precede and succeed it, but on the back of the cloth the face warp tie will be covered on one side only by the backing warp. This cannot

be avoided, because, on the underside there is only a warp float of one at a place in the backing weave.

In the following examples (Figs. 26 to 33) the different stages of working are not shown separately, but illustrations which correspond with those given in Figs. 22 and 23, or Figs. 24 and 25, are lettered the same. Thus the face weave is given at A, and the backing weave at B, while C shows the order in which the backing ends are raised over the face picks in warp tying, and D the order in which the backing picks are passed over the face ends in weft tying. The complete double-cloth design

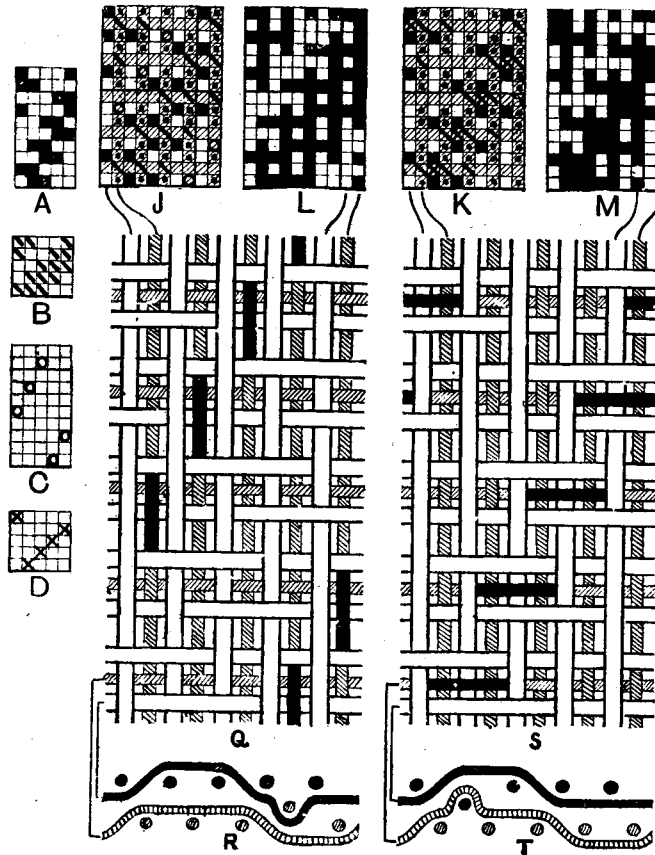


Fig. 27.

showing warp tying, is given at J, and showing weft tying at K, the different stages of working being indicated by the different marks in the following order:—The position of the backing threads is shown by the shaded squares; the face weave is represented by the full squares; the ties are indicated by the circles and crosses for warp and weft tying respectively; the backing weave is shown by the diagonal strokes; and finally the dots indicate backing ends down on face picks if the weave marks represent weft, or face ends up on backing picks in cases where the weave marks indicate warp. The plans L and M show the appearance of J and K respec-

tively when only one kind of mark is used to indicate the floats. A flat view and section to correspond with warp tying are given at Q and R, and to correspond with weft tying at S and T.

In Fig. 26 the threads are arranged in the proportion of three face threads to one backing thread. This order of arrangement is useful for cloths in which the face fabric is very fine, as, for instance, when face yarns of higher counts than 2/48's worsted are employed; and, usually, the backing weft is thicker than the backing warp and soft spun, in order that softness of handle will be obtained on the underside of the cloth. As shown at A and B respectively in Fig. 26, 3-and-3 hopsack

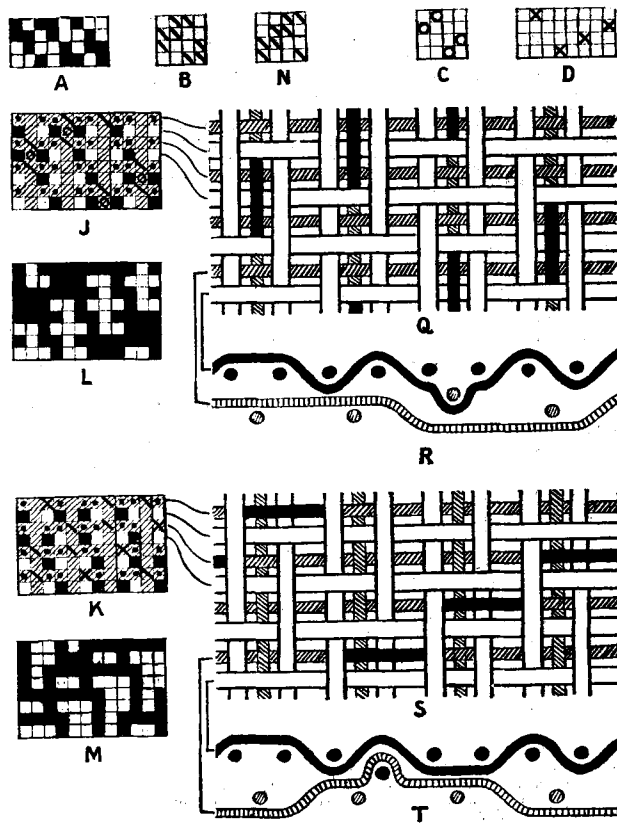


Fig. 28.

In Fig. 26 the weave marks, with the exception of the circles, indicate *weft*. The sections R and T represent the interlacing of the third face pick and the first backing pick of the respective flat views. In both methods of tying the stitches are effectively covered on the face of the cloth but only partially on the underside.

The design N in Fig. 26 is introduced, in addition to J and K, in order to show how the ties (warp tying is illustrated) may be distributed in 8-sateen order. This arrangement of the ties may be employed with advantage for a cloth in which the two fabrics do not require to be so firmly united as is the case with the alternate order of

weave is employed for the face fabric, and plain weave for the back fabric, while the warp ties are distributed in plain order on the third and sixth face picks, as indicated at C, and the weft ties in plain order on the third and sixth face ends, as represented at D. With a face weave of this character it is necessary to take into consideration that there will be a tendency for the face ends to run in groups of three. Therefore, they are arranged in the order of 2 face, 1 back, 1 face, and the face weave is inserted in such a position that by denting four or eight ends (including the backing ends) through each split of the reed, the grouping of the ends is neutralised, and the face of the cloth is made as uniform as possible.

tying. The distribution of the ties over the surface of the fabric is perfectly uniform in the design N.

Fig. 27 shows the construction of the plan for a double cloth, the threads of which are arranged in mixed order, the proportion being 1 face to 1 back in the warp, and 2 face to 1 back in the weft. The arrangement is specially suitable for a cloth in which fine warp yarns, closely set, are required for both the face and back fabrics, and thicker weft yarns (particularly on the underside), with less picks than ends per inch. The repeats of the face and backing weaves (A and B respectively) fit with the arrangement of the threads. The backing warp ties (indicated at C) are placed only on alternate face picks, whereas the backing weft ties (shown at D) engage all the face

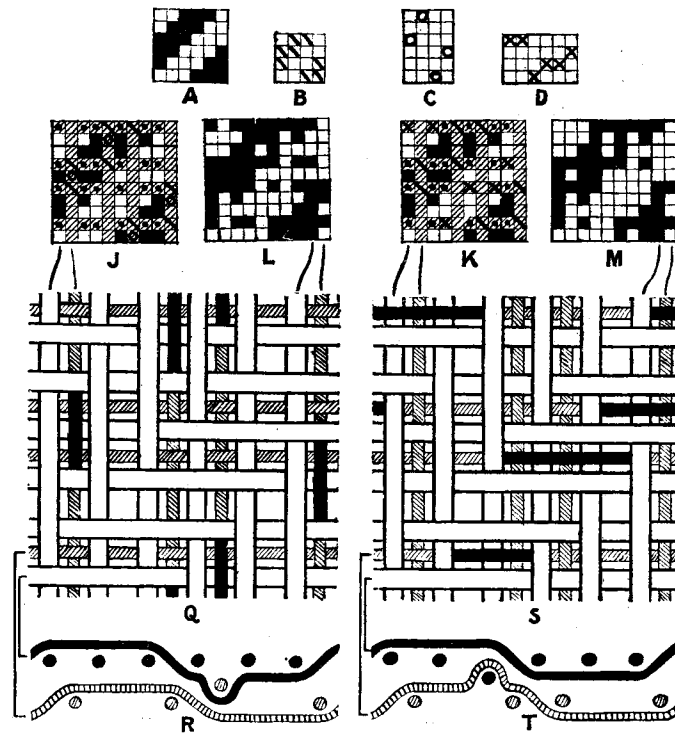


Fig. 29.

ends. The weave marks indicate *weft*, with the exception of the circles. The sections R and T show how the first face pick and the first backing pick of the corresponding flat views interlace. The face and backing weaves are so placed in relation to each other that the ties are in the best position for being concealed on both sides of the cloth by the adjacent floats.

In Fig. 28 the working out of the point-paper plan is shown for a double cloth, in which the threads are again arranged in mixed order, the proportion in this case being 2 face to 1 back in the warp, and 1 face to 1 back in the weft. This order of arrangement is specially applicable to face weaves which repeat on twice as many ends as picks. The 2-and-2 twill, cut every two ends, is employed for the face fabric, 2-and-2 twill for the back fabric, and the tying is effected in 4-thread twill order.

The weave marks indicate *warp*, with the exception of the crosses which represent backing weft stitches. This is an example in which the back weave is looser than the face weave, taking into account that there are fewer ends on the underside than on the face. In order to enable suitable positions to be selected for warp tying, the face weave is so placed that a backing end comes between the two ends which twill with each other, and not between two which cut. In warp tying the ties are effectively covered on both sides of the cloth by the adjacent floats, but in weft tying, in order that the ties will be perfectly covered on the back of the cloth as well as on the face, it has been necessary to change the position of the backing weave to that shown at N in Fig. 28.

Fig. 29 shows the working out of the plan of a double cloth, in which the threads are arranged irregularly in the proportion of 6 face ends and picks to 4 backing ends and picks. In this principle the face fabric may be made finer than the back fabric in almost any required proportion. The chief point to note is that suitable weaves are selected for the face and back fabrics respectively. Thus, if the threads are arranged 5 face to 4 back, a 5-shaft face weave should be combined with a 4-shaft backing weave; if 4-face to 3 back, a 4-shaft weave with a 3-shaft weave, or an 8 shaft weave with a 6-shaft weave; if 9 face to 7 back, a 9-shaft weave with a 7-shaft weave, etc. In the example 3-and-3 twill is employed for the face fabric, and 2-and-2 twill for the back fabric, and as the face fabric is finer than the back fabric in the proportion of 6 threads to 4, the 3-and-3 twill face will be similar in appearance to the 2-and-2 twill back. The cloth will therefore have the semblance of a double 2-and-2 twill, but its wearing property will be superior on account of the greater fineness of the face fabric. In the warp method of tying, illustrated in Fig. 29, no tie is placed on the second and fifth face pick, but in the weft method a slight deviation from the ordinary system is illustrated. The even backing picks pass over two face ends, while the odd backing picks only pass over one. They are arranged in this way in order that all the face ends will be intersected by the backing picks, and to show one method of obviating the difficulty which frequently arises in weaving when only a portion of one series of ends is employed for tying. If, however, there is any liability of the ties showing on the surface of the cloth, such a method should not be employed.

**Construction of Double-Cloth Designs for Looms with Changing Boxes at One End Only.**—If the same kind of weft yarn be used for both the face and back fabrics, the method of constructing the point-paper plan is not affected by the limitation in the boxing capacity of the loom, even though, as is sometimes the case, two or more shuttles are employed for the purpose of obtaining a more regular cloth. If, however, the backing weft is different from the face weft, it is necessary for the face and backing picks to be arranged on the point-paper to alternate with each other in even numbers according to the relative proportions required. The arrangement of the face and backing ends may be the same as in ordinary double-cloths, and it is better that it should be the same, for if the backing warp be employed for tying, the placing of the ties is then not influenced by the order in which the picks are inserted, so far as the face of the cloth is concerned. The covering of the corresponding face weft ties on the underside of the cloth is, however, not so easily effected when the picks are arranged in even numbers. The backing weft should only be employed for tying when absolutely necessary, as the insertion of the picks in even numbers not only renders it more difficult for suitable tying positions to be selected in the majority

of face weaves, but the interweaving of the backing weft with the face warp at intervals of 2 or 4 face picks, increases the tendency of the latter to group in 2's or 4's.

The system of construction is exactly the same as in the foregoing designs. In Fig. 30 the face and backing threads are arranged in equal proportions, the ends in the order of 1 face 1 back, and the picks in the order of 2 face 2 back. The weave marks in Fig. 30 indicate weft with the exception of the circles which represent the

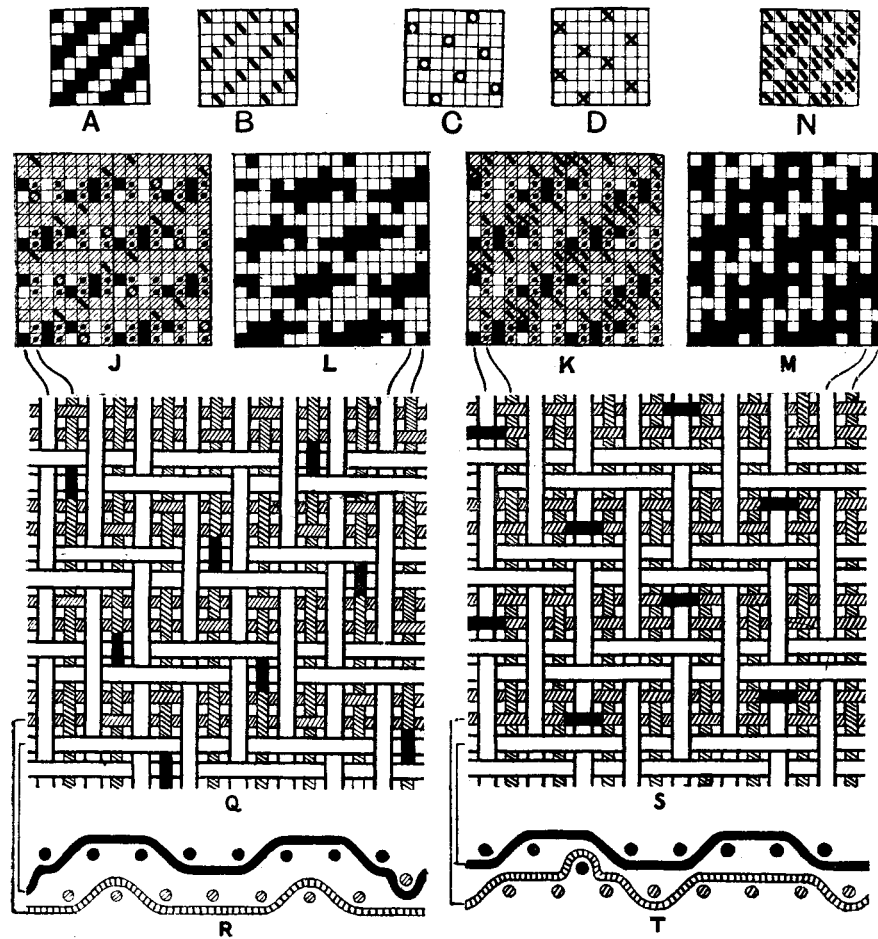


Fig. 30.

backing-warp stitches. The 2-and-2 twill weave is employed for the face fabric, but for the back fabric the 1-and-3 warp twill, shown at B, is used for warp tying, and the 1-and-3 weft twill, shown at N, for weft tying. Hence with the design J or L the underside of the cloth will have a weft surface, and with the design K or M a warp surface.

In the flat view given at Q the warp ties are shown arranged in 8-thread sateen order, as indicated at C, and it will be observed that on the face side of the cloth



each tie is placed between two face warp floats. Also each backing end is raised on the backing picks which precede and succeed a tie, hence on the underside of the cloth each face weft tie occurs between two backing-weft floats. R in Fig. 30 represents the interlacing of the second face pick and the first backing pick, from which it will be seen that the face ends and the backing picks are quite separate and distinct from each other, while the face picks interweave at intervals with the backing ends (in this case the eighth backing end) for the purpose of uniting the two fabrics.

In the weft method of tying, illustrated in the flat view S in Fig. 30, on account of the picks being inserted in pairs, there are no positions available for passing the backing picks over the even face ends with a face weft float on both sides. The ties can therefore only be placed on the odd face ends, and though they are equally as well covered on both sides of the cloth a comparison with Q will show that the distribution is less perfect in this system than when the backing warp is employed for tying. Because of the difference in the arrangement of the ties the design J repeats upon twice as many picks as the design K, of which two repeats are shown. In the section given at T the face picks and the backing ends are shown quite separate from each other, the union of the two fabrics being effected by the backing weft interweaving at intervals with the face ends.

The threads in Fig. 31 are arranged in the proportion of 2 face to 1 back in warp and weft, the ends in the order of 1 face, 1 back, 1 face, and the picks in the order of 4 face, 2 back. In this case also weft is indicated, and for the face fabric the 5-thread weft Venetian weave A is employed for both warp and weft tying. For the back fabric the 5-thread twill given at B is employed for warp tying, and the 5-thread Venetian (with the warp on the underside) given at N for weft tying. The former backing weave is firmer than the latter, and also than the face weave, and may therefore be used when the back fabric is composed of fine yarns. On the other hand, the fewer intersections of the backing weave shown at N render it suitable for a cloth in which thicker backing than face yarns are employed. It should be noted that on account of the backing picks being inserted in pairs it is necessary for the 5-pick backing weave to extend over 10 backing picks, hence 20 face picks are required. The complete design therefore repeats on 30 picks. In both methods of tying, the ties are placed between corresponding face floats, but on the underside of the cloth some of the ties have a corresponding float on one side only. Thus, from an examination of the flat view S in Fig. 31, it will be seen that the face ends, which are passed over by the even backing picks, have a backing warp float on one side, and a backing weft float on the other side.

In Fig. 32 the threads are arranged in mixed order, the proportions being 2 face to 1 back in the warp, and 2 face to 2 back in the weft. Warp is indicated in the plans, and the 5-thread warp-face Venetian weave A is employed for the face fabric, and the 5-thread sateen, with the weft on the underside, for the back fabric. Weft tying is not illustrated in the figure, but two methods of distributing the warp ties are given at C and N. The corresponding complete plans are shown at J and O, while the design given at L corresponds with J. With the ties distributed as shown at C and J, the alternate face picks only are passed over by the backing ends, and although this is a standard method of distributing the ties for cloths in which the face and backing ends are in the proportion of 2 to 1, in many cases it is found that a more even cloth is formed if all the face picks are employed for tying, as then the shrinkage of each is the same. The diagrams Q and R correspond with the design J.

The diagram P in Fig. 32 corresponds with the design O and is similar to Q

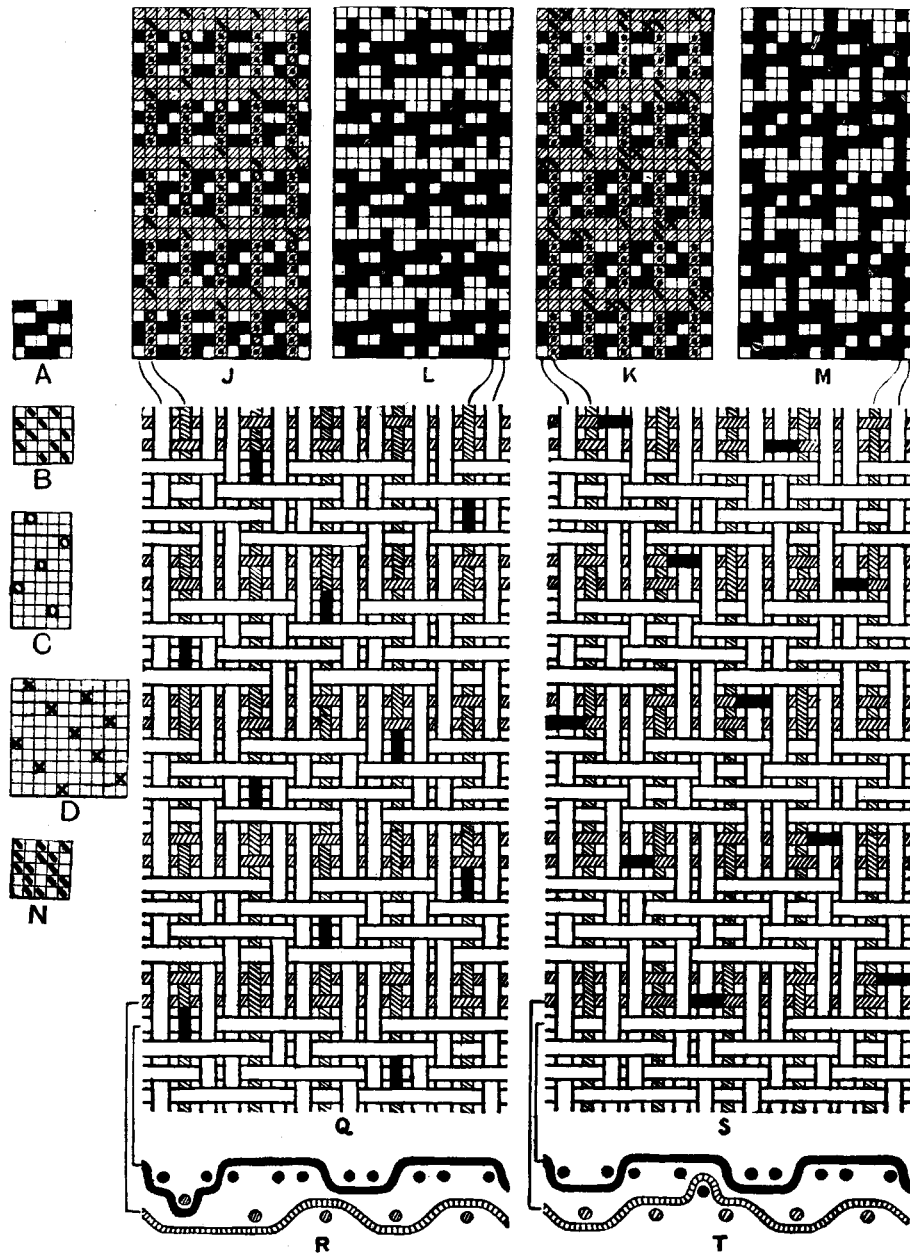


Fig. 31.

except that in this case all the face picks are passed over by the backing ends. With the latter order of tying the two fabrics will not only be more firmly united, but the

shrinkage of the weft picks will be uniform. The distribution of the ties in this order will, however, be liable to produce an indistinct twill running in the opposite direction to the face warp twill, which, by detracting from the clearness of the latter, may be a source of defect.

Although it is not advisable for the face and backing ends to be arranged with each other in even numbers, as the difficulty of tying the two fabrics satisfactorily

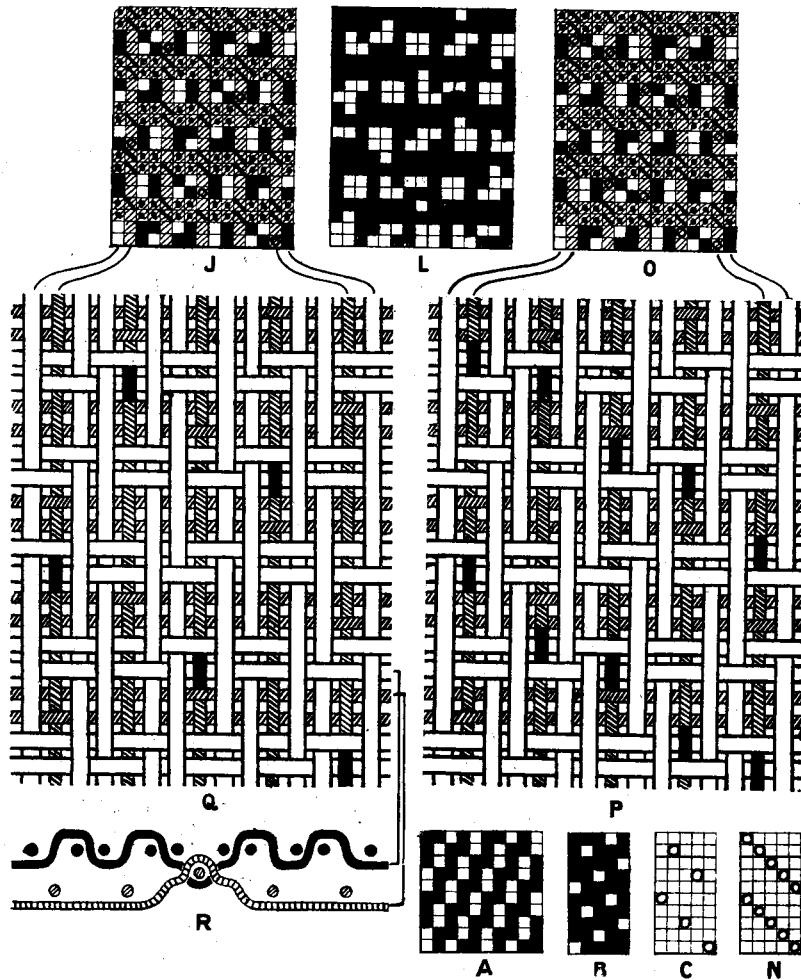


Fig. 32.

together is thereby increased, circumstances sometimes arise which render the arrangement necessary, hence for the purpose of illustration, an example is given in Fig. 33 in which the threads are in the order of 2 face, 2 back, in both warp and weft. The 2-weft, 3-warp twill is employed for both the face and back fabrics. In both the warp and weft methods of tying the ties are distributed regularly in such a manner that the same number is placed on each thread, while each tie is con-

cealed on both sides of the cloth by the adjacent floats. It is due to the weave which is used for the face and back repeating on an odd number of threads that such a correct distribution of the ties is possible; a twill weave repeating on an even number of threads can not be tied so satisfactorily in the 2-and-2 arrangement. The weave marks in Fig. 33 represent weft with the exception of the circles.

**Double-Cloth Beaming, Drafting, and Pegging.**—As in warp-backed cloths (see p. 15), if the yarns for the face fabric are similar to those for the back fabric, and

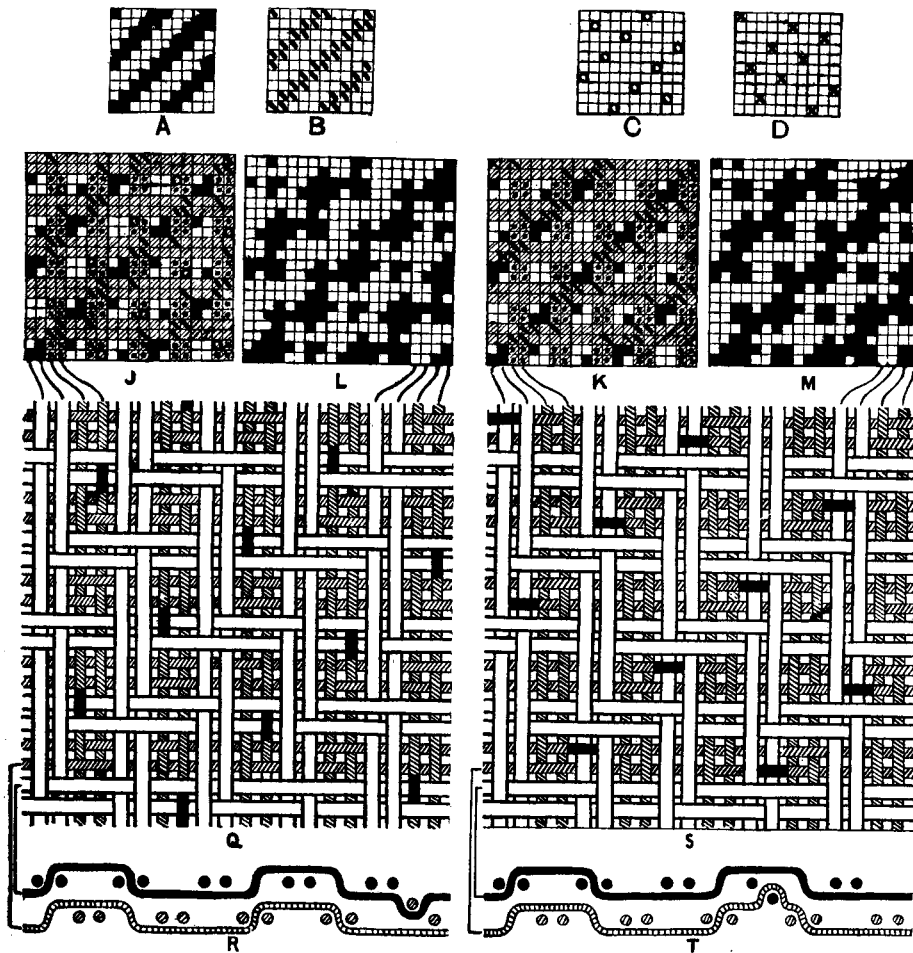


Fig. 33.

the intersections of the weaves are relatively the same, it is possible for a perfect double-cloth to be woven with only one warp beam. An example of such a double weave is illustrated in Fig. 34, in which the same weave—shown at A and B—is used for the face and back fabrics, while both series of threads are used for tying, as indicated at C. In the plan C the circles denote backing ends passing over face picks, and the crosses backing picks passing over face ends, the cloth being double-stitched.

In the complete design, given at D, the weave marks indicate warp, with the exception of the crosses. The corresponding flat view is shown at E, while F represents the interlacing of the first face and the first backing end. It will be seen that the relative number of intersections is the same for each thread; hence, if the yarns in each fabric are similar, the contraction of the warp threads in weaving will be uniform, and the equal tension required for each series will be better obtained by using only one beam. If, however, the face yarns in a cloth are different from the backing yarns, or, on the other hand, if the weaves are different as regards the relative number of intersections, it is better for two warp beams to be used, in order that the two series of threads may be separately tensioned.

As a general rule two beams are employed, and the proper tensioning of the two warps is then of great importance, because if the backing warp is held tighter than the face warp the backing warp stitches are liable to impair the softness of handle of the cloth, while if it is slacker the cloth is deficient in soundness. Normally, the two warps should be held at about the same tension.

In the drafting of double-cloths the conditions are very much the same as in warp-backed cloths (see p. 15). Thus, the double 2-and-2 twill design given at D in Fig. 35 (the face weave of which is shown at A, the backing weave at B, and the order of warp stitching at C) may be drafted in one of the methods illustrated at E, F, and G. At E the backing healds are shown intermingled with the face healds, whereas

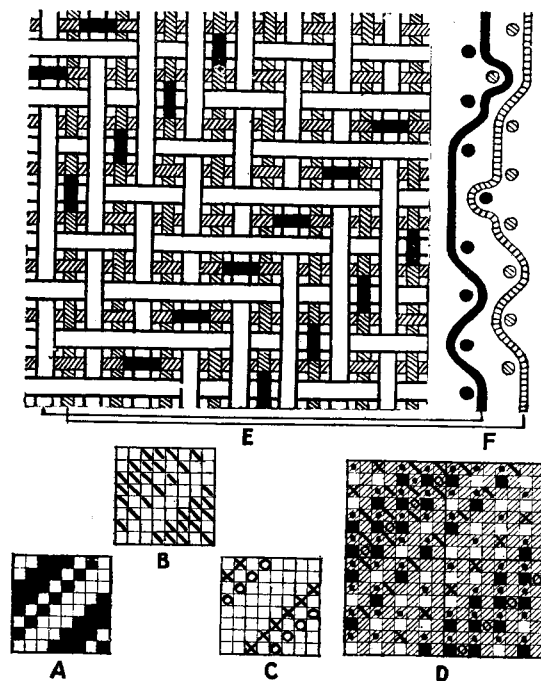


Fig. 34.

at F they are shown in front of, and at G behind the face healds.

With the exception that a set of healds is required for each fabric, the ordinary method of constructing a draft may be employed—*i.e.*, the threads in each fabric which work alike may be drawn on the same heald. Therefore the minimum number of healds in each set is decided by the number of threads in each fabric, which work different from each other. Thus, the design D in Fig. 35 requires eight backing healds, although the backing weave is on four threads, because the backing ends must be raised for tying independently of each other in the 8-thread sateen order given at C. Only four face healds are required, because the working of every fourth face end is the same. This will be understood from an examination of the flat view given at M in Fig. 36, which corresponds with the design D in Fig. 35, and the section, shown at N, which represents how the first face and the first backing end interlace.

The face ends work regularly in 2-and-2 order with the face picks, whereas the backing ends, in addition to working in 2-and-2 order with the backing picks, are raised for tying in 7-and-1 order with the face picks.

H, I, and J in Fig. 35, in which different marks are used to distinguish the face

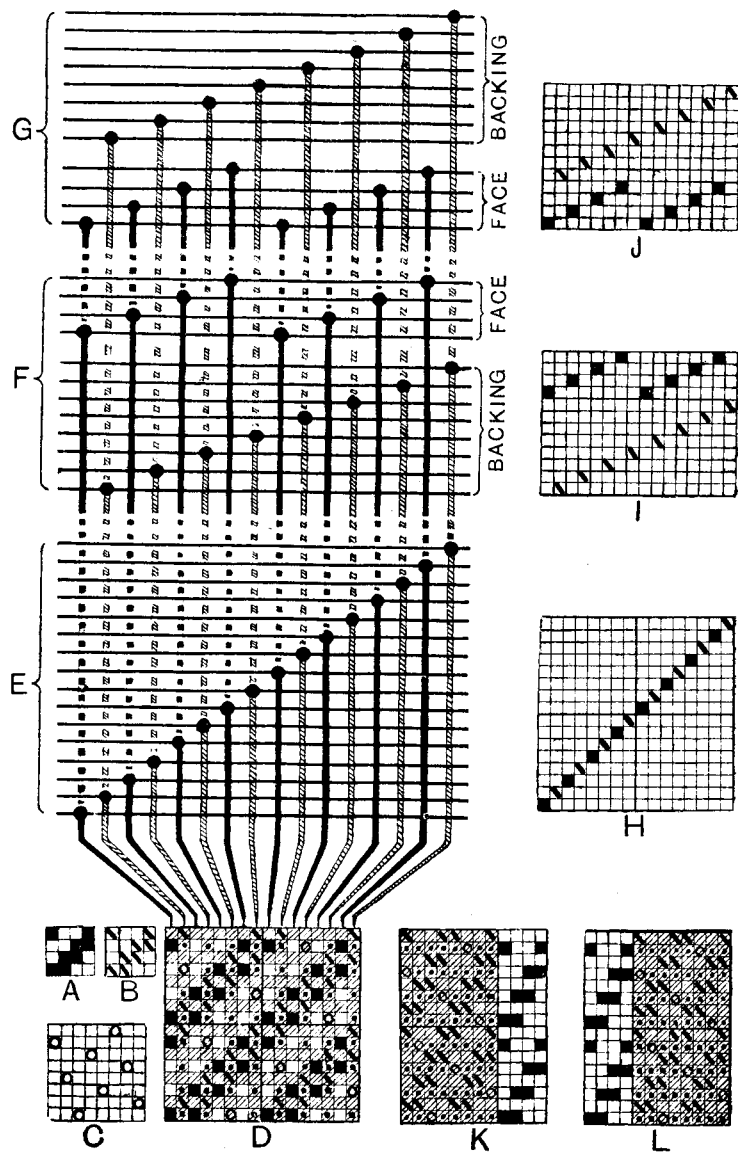


Fig. 35.

ends from the backing ends, respectively show the more convenient method of indicating the drafts given at E, F, and G on point-paper. When the face and backing healds are intermingled it is convenient to employ as many healds as there

are ends in the repeat of the design, as shown at E and H. Also, when a special draft such as I or J is used, the draft may be made upon the same number of face as backing healds (see G in Fig. 13, p. 14), in order to give more scope in

varying the weaves, and so that the healds will all be equal in fineness.

The pegging plan may be made in the ordinary manner by copying from the double weave the working of the healds, commencing with the first and taking them in consecutive order. The number of squares in the repeat on the point-paper is equal in one direction to the number of healds, and in the other direction to the number of picks in the double weave. In Fig. 35, D is not only the design, but also the pegging plan for the straight draft given at E, while K and L are the pegging plans for producing weave D on the drafts shown at F and G respectively. In each case the working of the backing healds is indicated on the shaded squares which, it will be seen, coincide in position in the pegging plans with the position which the backing healds occupy in the draft. Thus, in plan K they precede and in plan L follow the vertical spaces on which the working of the face healds is indicated. Weft is represented in the design D, so that the marks in the pegging plans (with the exception of the circles) indicate healds down.

Sometimes it is convenient for the healds which have been used for the back fabric in a

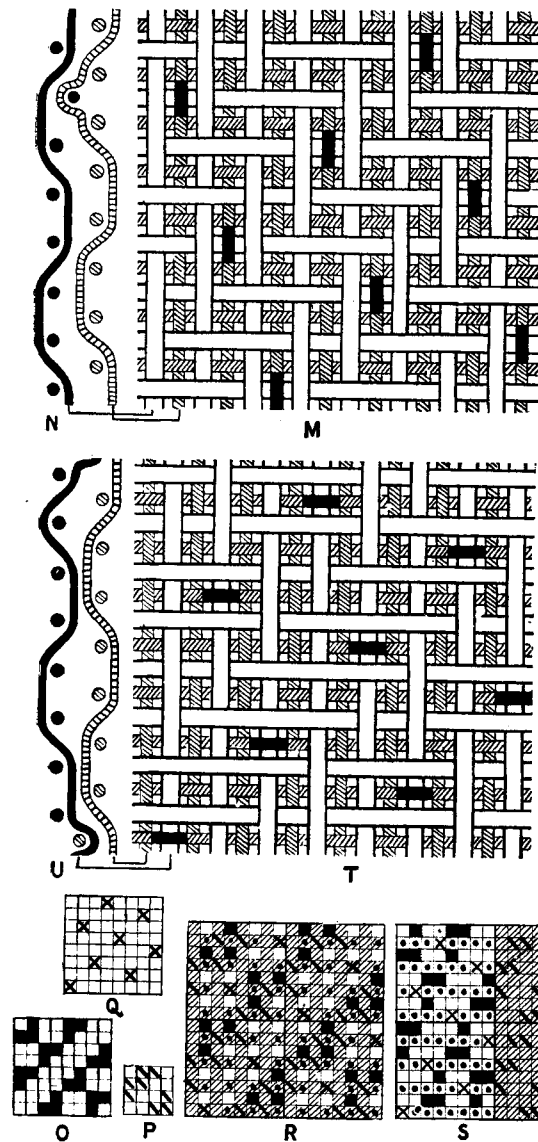


Fig. 36.

design to be subsequently employed as the face healds, and *vice versa*, in order that a change in the weave, or in the method of tying may be made without re-drawing the warp. For example, if a face end be twisted to a backing end, the drafts given at F and G in Fig. 35 may be employed for a double-cloth in which the eight-

shaft face weave shown at O in Fig. 36 is combined with the 4-shaft backing weave given at P. As, however, there will then be only four backing healds, it is impossible to effect the tying in 8-end order by means of the backing warp; but as there are eight face healds, the face ends may be depressed for tying independently of each other in the 8-end sateen order given at Q in Fig. 36. The complete double weave is shown at R, and S is the pegging plan for producing R on the draft given at F in Fig. 35, the front eight healds of which are now used for the face ends, and the four back healds for the backing ends. In this example warp is indicated so that the marks in S (with the exception of the crosses) represent healds raised. The flat view and a section showing the interlacing of the first backing and the first face end are given at T and U in Fig. 36. A comparison of M and N with T and

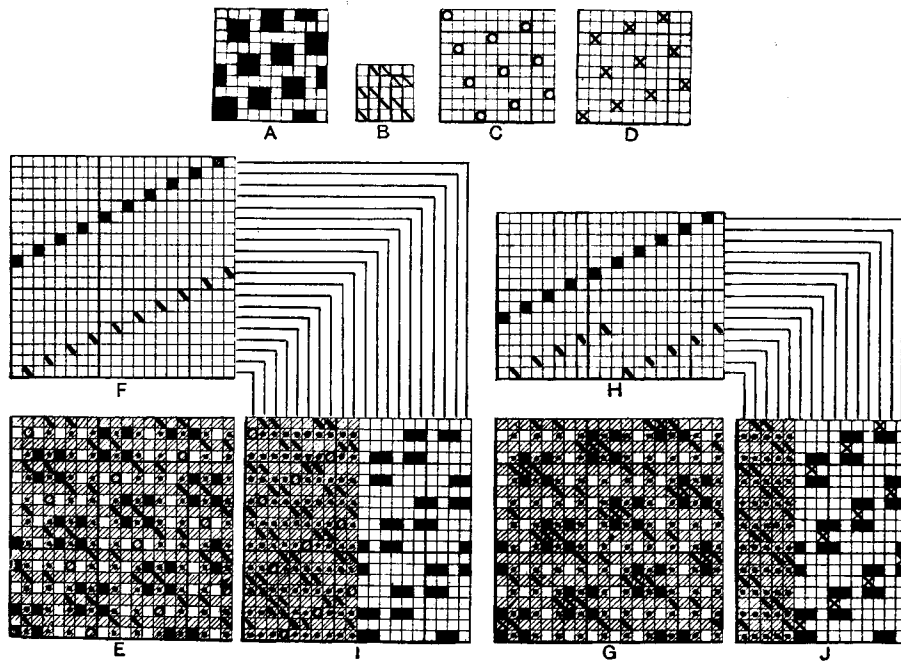


Fig. 37.

U in Fig. 36 will show that when warp tying is employed, the backing ends are affected, so that the number of backing healds must be at least equal to the number of different tying positions in one repeat of the tying plan; while in the case of weft tying, the face ends are affected, hence the minimum number of face healds is indicated in the same way.

**Effect of the System of Tying upon the Number of Healds.**—When a fancy weave is employed for the face fabric, and a smaller weave for the back fabric, it will frequently be found that fewer healds are required for weft tying than for warp tying. For example, assuming that in a 1-and-1 double-cloth the weave shown at A in Fig. 37 is employed for the face fabric, and that shown at B for the back fabric, ten healds will be required for the face weave, and five healds for the backing weave, without taking the question of tying into consideration. With weave A either warp or weft



tying may be employed, but the ties can only be distributed satisfactorily in the 10-thread sateen order shown at C or D in Fig. 37. For warp tying E is the double weave, and F the draft, ten backing healds being required in order that the backing ends may be raised for tying in the order given at C. For weft tying, G is the double weave and H the draft, only five backing healds being required in this case, while the ten healds which are required for the face weave enable the face ends to be depressed for tying in the 10-thread sateen order given at D. Hence, as a total of twenty healds is necessary for warp tying, compared with fifteen healds for weft tying, the latter is the more economical method so far as the number of healds is concerned. The pegging plans for E and G are given at I and J respectively in Fig. 37

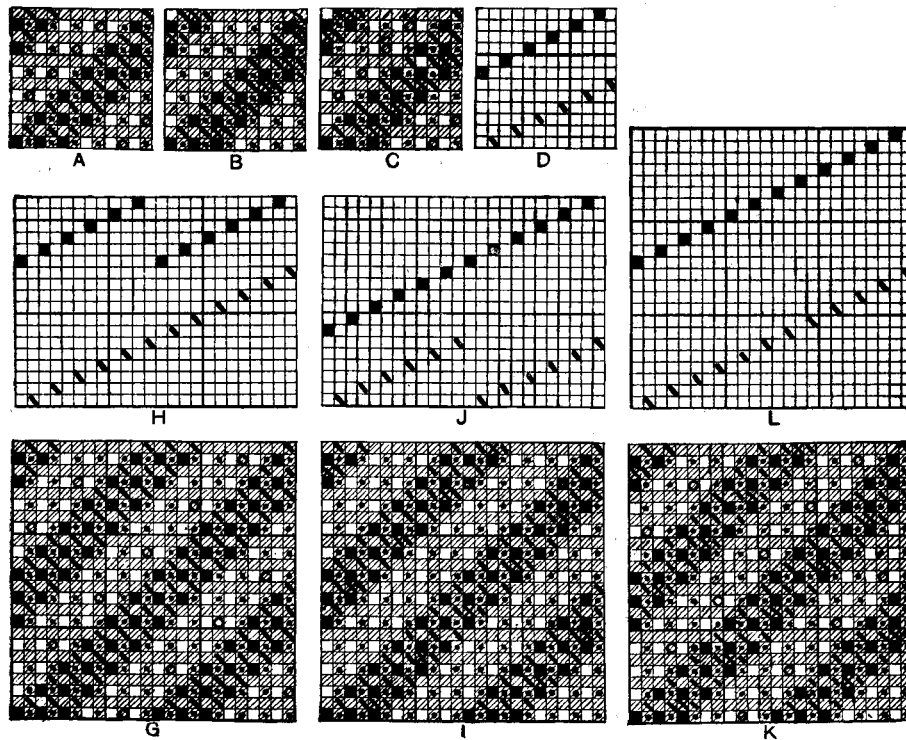


Fig 38.

and as weft is indicated in the designs the marks in I and J (with the exception of the circles in I) represent healds down.

Fig. 38 illustrates the effect that the system of tying has on the total number of healds, and also on the relative number of face and backing healds when simple weaves are used for both fabrics. The 3-and-3 twill weave is employed for the face and back, and the threads are arranged one face one back in warp and weft—weft is indicated in the plans. If the ties are distributed in twill order, six face and six backing healds will be required, as shown in the draft given at D, for either warp tying, shown at A, weft tying, shown at B, or double tying, shown at C. If, however, the ties are distributed in 12-thread sateen order—for warp tying, shown at G, six face

and twelve backing healds will be required, as drafted at H ; for weft tying, shown at I, twelve face and six backing healds, as drafted at J ; while for double tying, shown at K, it will be necessary to employ twelve face and twelve backing healds, as drafted at L. The double 3-and-3 twill may thus require a total of twelve, eighteen, or twenty-four healds, according to the system of tying which is employed.

A further illustration of the effect of the system of tying on the draft is given in Fig. 39. In this case the threads are arranged in the proportion of two face to

one back in warp and weft, while the 2-and-2 twill weave is employed for the face fabric, and plain weave for the back fabric. Weft is indicated in these examples also. The plain order of tying by means of the backing warp is given at M, and by means of the backing weft at N, for either of which four face and two backing healds are required, as shown in the draft given at O. The pegging plans for M and N are given at P and Q respectively. With the 8-thread sateen order of tying by means of the backing warp, shown at R, four face and eight backing healds are required, as indicated at S; while with the same order of tying by means of the backing weft, as shown at T, ten face and two backing healds are necessary, as represented at U. The latter order of drawing in the threads is, however, more complicated than the former.

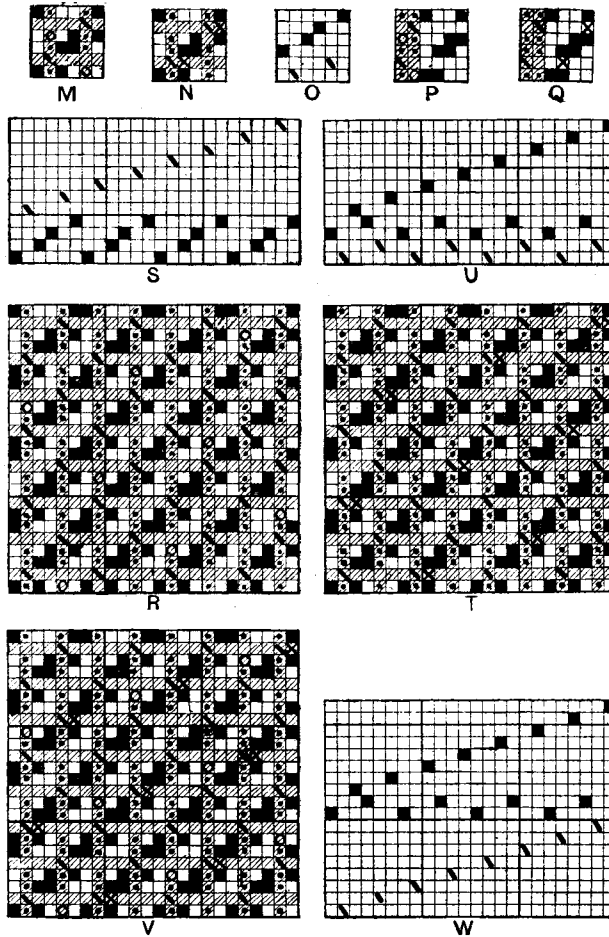


Fig. 39

If the tying is affected in 8-thread sateen order by means of both warp and weft, as shown at V, ten face and eight backing healds are required, as drafted at W. The system of tying may thus render it necessary to employ a total of either six, twelve, or eighteen healds in this case.

**Special Features in Double-Cloth Designing.**—In arranging the order of the ties it is important that the same number be placed, whenever possible, on each end and each pick of the series which is employed for tying. Tying with the backing

warp is equivalent to tying with the face weft, while tying with the backing weft is equivalent to tying with the face warp. In the former case the best results are obtained if the backing ends are raised equally over every face pick, and in the latter if the backing picks are passed equally over every face end. In the 1-face 1-back arrangement of the threads this can usually be accomplished without much difficulty, except that all the ties cannot be perfectly concealed in the case of such a face weave as the one shown at A in Fig. 40. The complete cut which occurs in the weave between the second and third and the sixth and seventh ends and picks makes it impossible for the second and sixth backing ends or picks to be passed over the face picks or ends with a corresponding face float on both sides. In

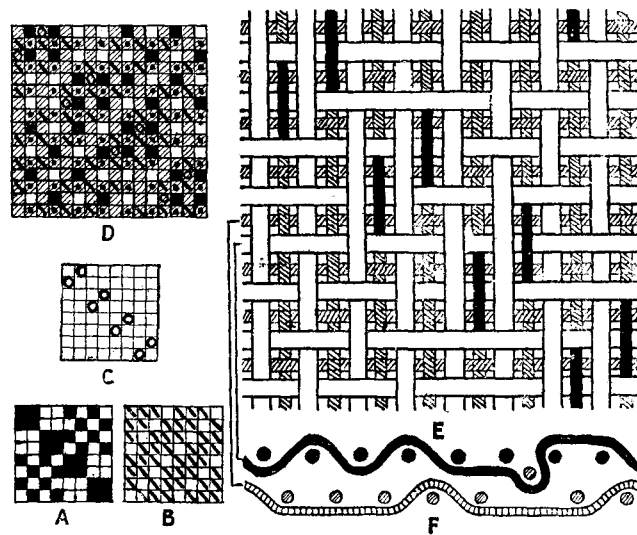


Fig. 40.

an example such as this, however, unless there is a considerable degree of contrast between the face and backing yarns, it is better for a tie to fall on each thread of the series which is employed for tying rather than to select only those positions where the ties will be covered on both sides. C in Fig. 60 shows how the ties may be arranged for warp tying, while at D the complete double weave is shown, the 4-thread twill given at B being used for the back fabric. The weave marks indicate warp. The flat view of the structure is represented at E in Fig. 40, and the interlacing of the fourth face and the fourth backing pick at F. It will be seen that the ties on the fourth and eighth face picks are only covered on one side by the face warp. However, as there is the same number of ties on each backing end and each face pick, the take up in weaving will be the same for each end, and the contraction in width the same for each pick. A more regular cloth will therefore be produced than would be the case if no ties were placed on the second and sixth backing ends.

When the threads are arranged in unequal proportions it is frequently impossible for the same number of ties to be placed on each face thread, although it is usually an easy matter to place the same number on each backing thread. Thus, in the

standard methods of tying the 2-face to 1-back arrangement, usually only half the face picks are passed over when the backing warp is employed, and only half the face ends in the case of the backing weft. For instance, the warp ties for the Mayo weave, given at G in Fig. 41, are usually distributed as shown at I, the alternate face picks only being passed over by the backing ends. J shows the complete design with the 2-and-2 twill, given at H, as the back weave, the marks indicating warp. The corresponding flat view of the structure is represented at K in Fig. 41. However, by changing the position of the face weave to that shown at L, so that it is situated in relation to the backing threads, as indicated at O in Fig. 41, it is possible for the ties to be distributed as represented at N. In this case, as shown in the design O (for which M is the backing weave) and the corresponding flat view given at P, a tie is placed upon each face pick. In the repeat of the double weave, however, each backing end is stitched twice to the face texture.

The flat view given at V in Fig. 42 shows the standard method of distributing the ties in the 2-and-1 arrangement when weft tying is employed. The corresponding face weave is given at Q, the backing weave at R, and the order of tying at S. When the even ends only are passed over by the backing picks, they will, in ordinary weaves, be liable

to take up in weaving more rapidly than the odd ends. This weave, however, is exceptional in the fact that the odd face ends interweave more frequently with the face picks than the even face ends, there being four intersections in eight picks in the former, compared with two intersections in the latter. This is shown in the section given at W in Fig. 42, in which the dotted line shows the interweaving of the first face end, the solid black line of the second face end, and the shaded line of the first backing end. The placing of the ties on the looser woven ends will tend to neutralise the variation in the take-up caused by the difference in the number of

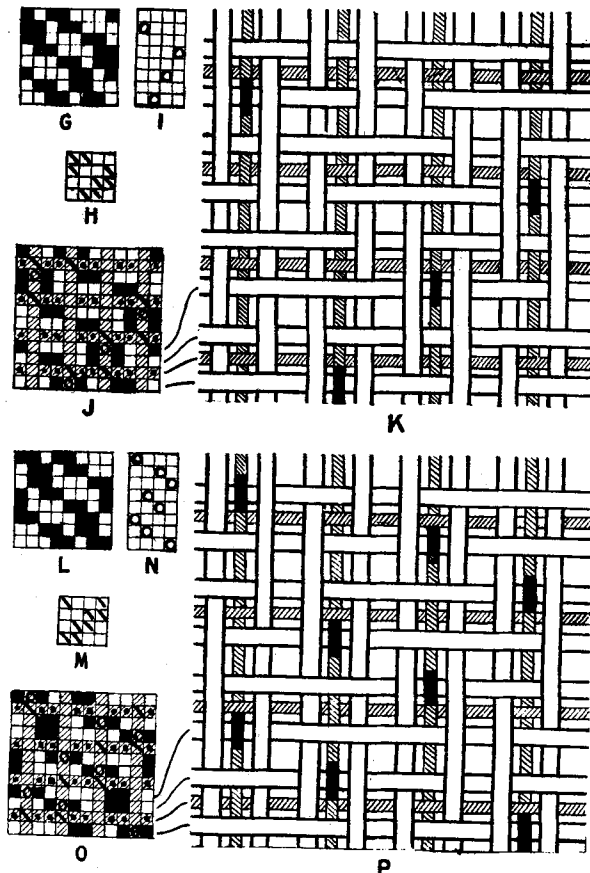


Fig. 41.

intersections between the odd and even ends. The distribution given at V in Fig. 42 will therefore yield the best results in weaves of this character. However, in order to illustrate a method of stitching on every face end, the flat view is extended to another repeat of the weave, as shown at X in Fig. 42, the ties being placed on the odd ends in the second repeat in order to balance those which are placed on the even ends in the first repeat. The plan of the ties for the two portions lettered V and X is given at T in Fig. 42, while the complete double weave is shown at U.

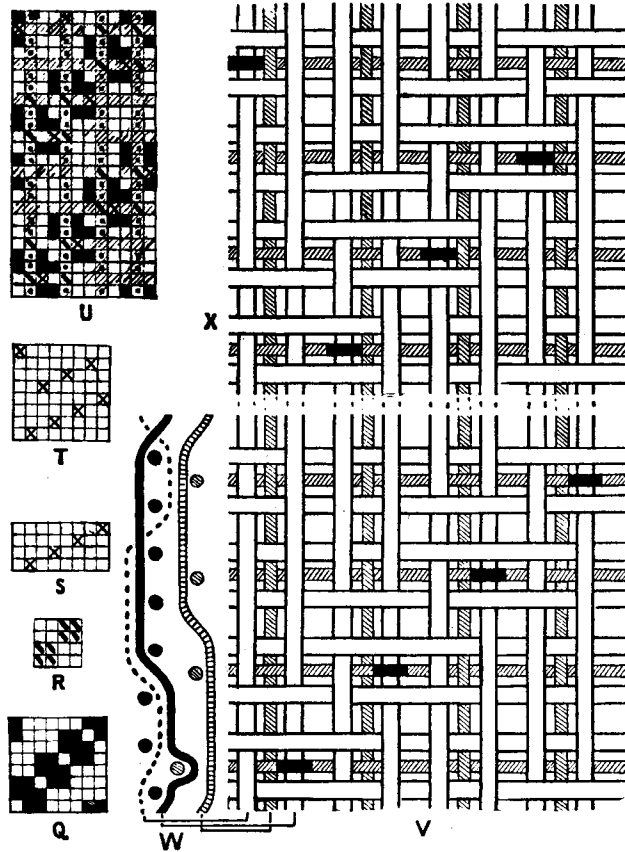


Fig. 42.

When the floats of the face weave permit it, this method of distributing the ties may be adopted with advantage for ordinary weaves. The difficulty which is frequently found in the 2-and-1 arrangement, of placing a tie on each face end, is one reason why tying with the backing weft is usually not so suitable as tying with the backing warp. It is better to have the ties unevenly distributed on the face picks than on the face ends, so far as the weaving of the cloth is concerned.

In order that a regular cloth may be obtained, the backing weave should be suitable for the back fabric, and similar to the face weave. Thus, the loose face weave given at Q in Fig. 42 is backed with the 2-and-2 hopsack weave shown at R.

This combination will permit of the use of thick backing yarns and yield a soft under texture.

When a twill weave is employed for the face fabric and the ties are distributed in twill order, they should fall equally on each face warp twill in the case of warp tying, or each face weft twill in the case of weft tying. If they fall on alternate twills only, as shown in the double-cloth design given at A in Fig. 43, and the corresponding flat view represented at B, adjacent twill lines are liable to appear different from each other. The example is a double 1-weft-and-2 warp twill structure, in which

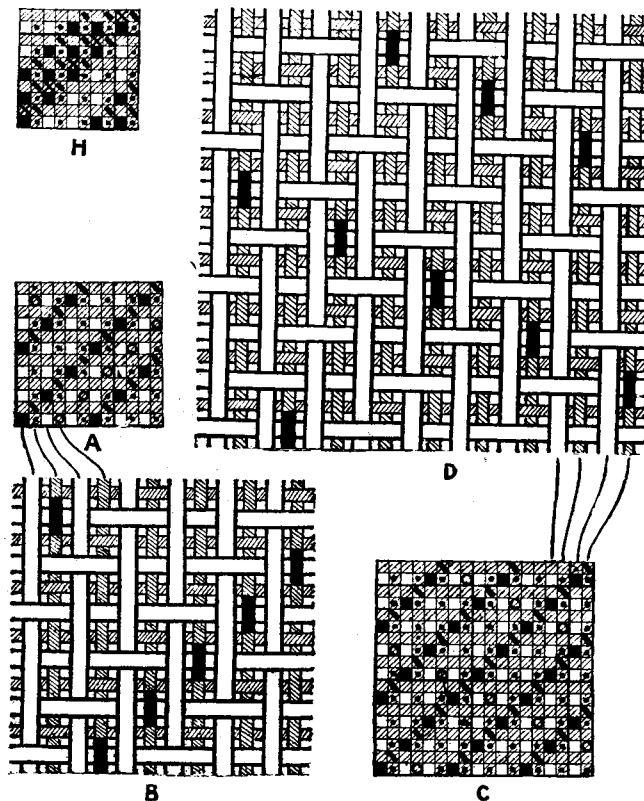


Fig. 43.

the threads are arranged in the order of 1 face, 1 back in warp and weft, the tying being effected by means of the backing warp. By distributing the ties in 9-sateen order, as shown in the design C and the corresponding flat view given at D in Fig. 43, the ties will fall equally on each face warp twill line. In C and D, however, the ties run somewhat distinctly in the opposite direction to the twill of the face fabric, and there is, therefore, a liability of a cross-twill showing in the cloth. (For further reference to this defect see p. 6.)

The design H in Fig. 43 illustrates that in backing weft tying if there is a choice of two consecutive positions for a tie in the face weave, it is, as a rule, better to select that which will be covered by the greater number of following face picks. The

corresponding flat view is given in Fig. 44, on the right of which a section, representing the interweaving of the first face and the first backing pick, is shown. The example is a double 3-weft, 2-warp twill, and the threads are arranged 1 face, 1 back. It will be seen that the weft tie on the first face end may be placed either between the first and second face picks, or the second and third. The former position is shown in the illustrations, and is preferable to the latter, because the beating up of two succeeding face covering picks gives a better opportunity of the tie being concealed.

**Position of the Backing Weave.**—In the construction of a perfect double-cloth it is necessary for similar conditions to be obtained in the weave of the under-fabric as have been described and illustrated with reference to the weave of the face fabric. The ties form the connection between the two fabrics, and are thus common to both weaves. Therefore, since it is first necessary for the ties to be placed according to the positions of suitable binding places in the face weave, the backing weave should afterwards be suitably placed in accordance with the position of the ties.

There are three positions which a face warp or weft tie may occupy in relation to the floats on the underside of the cloth—viz., between two corresponding floats; with a corresponding float on one side, and an opposite float on the other; and between two opposite floats. Each position is illustrated in Figs. 46 and 47 which

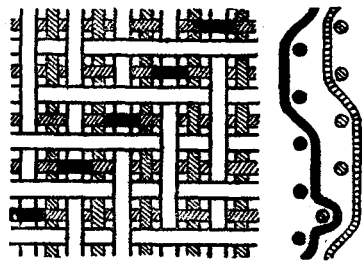


Fig. 44

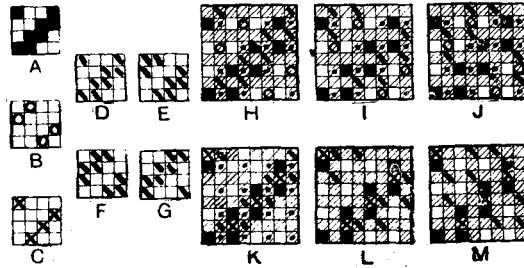


Fig. 45.

correspond with each other in every respect except that the backing warp is employed for tying in Fig. 46, while the backing weft is employed in Fig. 47. The threads are arranged 1-and-1 in warp and weft, and the 2-and-2 twill weave is employed for both the face and the back of the cloth. The weave marks indicate weft, and in the face fabric the 2-and-2 twill is placed throughout as shown at A in Fig. 45, while the ties are placed to suit the face weave as at B for Fig. 46, and as at C for Fig. 47. The backing weave, however, is placed in the three different positions given at D, E, and F in Fig. 45. Thus N in Figs. 46 and 47 shows the flat view of the structure from the face side of the cloth, with the backing weave placed as at D; R with the backing weave placed as at E; and V, with the backing weave placed as at F. Sections O, S, and W respectively show the interlacings of the first face and the first backing pick of N, R, and V. The flat views P, T, and X in each figure correspond with N, R, and V, and show the appearance of the underside when the cloth is turned over horizontally, as indicated by the numbers above the warp threads. Sections Q, U, and Y respectively show the interlacing with their respective picks of the first face, and the first backing end (numbered 1 and 2) of P, T, and X.

It will be noted that in each arrangement the ties will be correctly covered on the face of the cloth by the corresponding face floats between which they are

placed. By comparing the flat view N and the section O in each figure with the flat view P and the section Q, it will be seen that with the backing weave placed as at D in Fig. 45, the back of the cloth will be as perfect as the face, because the ties occupy positions between corresponding backing floats. A comparison of R and S with T and U, however, shows that with the backing weave placed as at E,

the back fabric will not be so perfect as in the former case, because the position occupied by each tie on the underside is between a corresponding and an opposite backing float. This kind of defect frequently cannot be avoided, as, for example, when a plain backing weave is employed. Although in well-set-up cloths the defect is practically invisible, it should only be allowed to occur when absolutely necessary. A comparison of V and W with X and Y in which the backing weave is placed as at F, shows the most serious defect which can occur in the back fabric. In this case the position occupied by each tie on the underside is between two opposite backing floats. When the backing warp is employed for tying, this causes the warp floats in the underside to be broken by the face weft ties, as shown at Y in Fig. 46, while when the backing weft is employed, the weft floats on the underside are broken by the face warp ties, as shown at W in Fig. 47. This not only results in the ties showing prominently on the underside, but as the intersections of the backing threads are correspondingly increased, the back fabric is made firmer and harder woven than it should be.

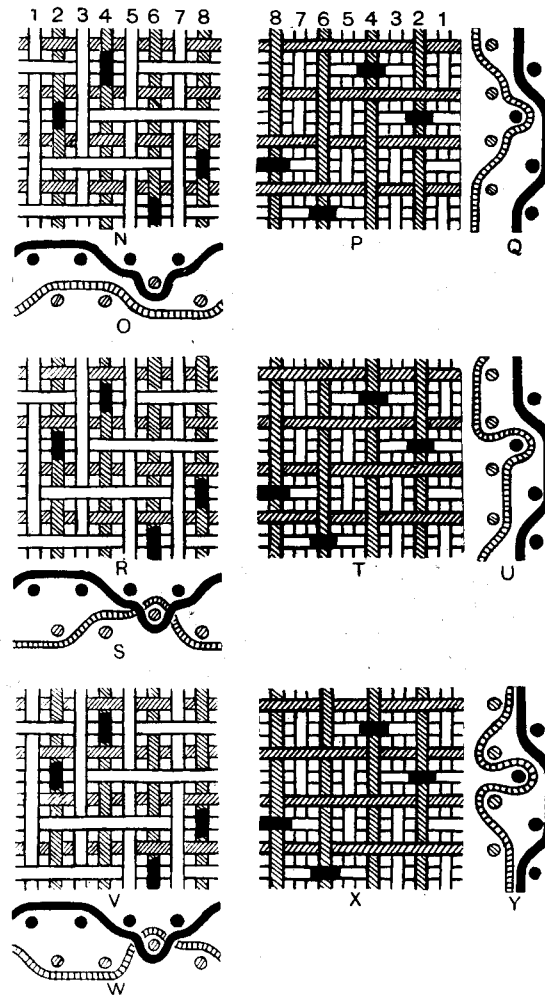


Fig. 46.

The complete plans for the drawings given in Fig. 46 are shown respectively at H, I, and J in Fig. 45, the marks—with the exception of the circles—indicating weft. A comparative examination shows that in warp tying the most perfect back fabric is obtained when each backing end is raised on the backing picks which



precede and succeed the face pick on which the tie is placed. In the same way a comparison of the plans given at K, L, and M in Fig. 45, with the corresponding diagrams in Fig. 47, shows that in weft tying the most regular back fabrics results when each backing pick passes over the backing end on each side of the face end on which the tie is placed. (All the marks in K, L, and M indicate weft, but the dots which are shown in L and M.)

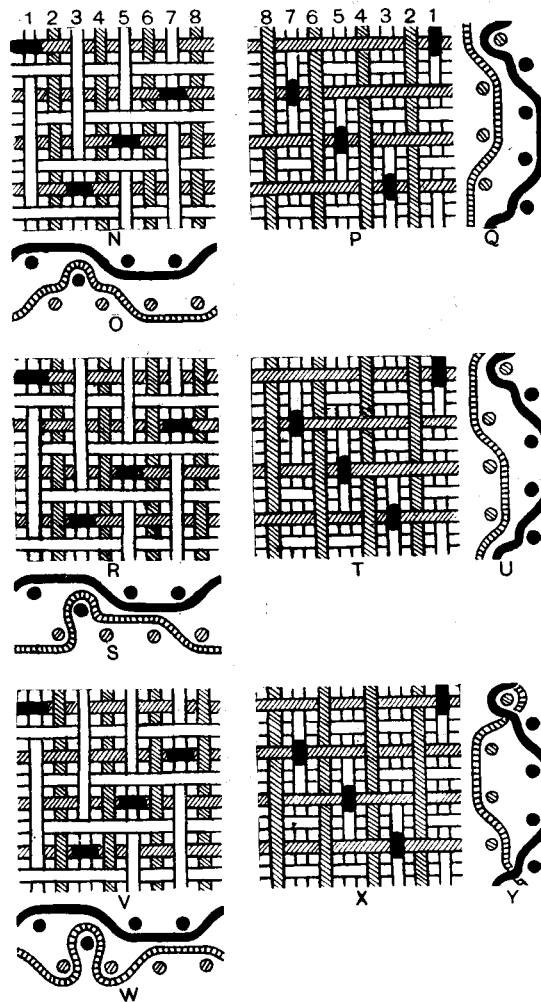


Fig. 47.

the same weave in a similar position, as shown at B; while in a 2-and-1 arrangement it may be backed with the 2-and-2 twill in the position shown at C. If the threads are arranged in the proportion of 7 face to 5 back, the 3-and-4 twill in the position shown at D may be backed with the 2-and-3 twill in the position shown at E.

In only the simplest cases, however, may it be safely assumed, without experi-

The backing weave may also be placed as shown at G in Fig. 45, but this will produce a similar defect to that produced by placing it as at E.

For some of the simpler standard makes of double-cloths, in which the ties are distributed in regular order, the position of the backing weave in relation to the ties can be reasoned out without difficulty. Thus, in the foregoing example the best result is obtained with the face and backing weaves occupying corresponding positions, as shown at A and D in Fig. 45. A weft or warp float on the surface of the upper fabric should be above a similar float on the top side of the under fabric, so that where the two fabrics are in contact, a warp float of one is against a weft float of the other. The best conditions are thereby obtained for the interweaving of the warp threads of one cloth with the weft threads of the other cloth. For example, in a 1-and-1 arrangement of the threads, the 4-and-4 twill, shown at A in Fig. 48, may be backed with

ment, that the best position of the backing weave has been obtained. Thus, taking F in Fig. 48 as the weave for both the face and the back of a 1-and-1 double-cloth—the marks indicating weft—the warp ties may be either placed as shown in the plan G, or with the same result, so far as the face of the cloth is concerned, they may be placed one pick lower, as shown at H, the marks indicating backing ends raised over face picks. With the ties placed as at G, the most perfect under-fabric will be obtained by commencing the backing weave exactly like the face weave, as shown at I, but with the ties placed as at H, it will be necessary for the backing weave to be changed to the position shown at J in order to secure the best results. In the same way assuming that the weave F is required to be backed with a 2-and-2 twill, K shows the best position of the weave for tying as at G, while L is the best for tying as at H. It is evident, therefore, that the positions of the face weave, the ties, and the backing weave, cannot be decided upon haphazardly, but that they should bear a definite relationship to each other.

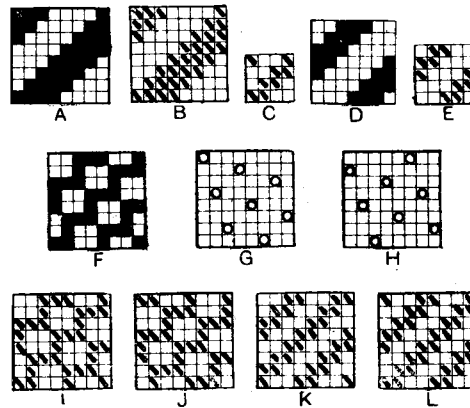


Fig. 48.

**Systematic Construction of Double-Cloth Designs.**—The example given in Fig. 49 illustrates step by step a convenient method of procedure in constructing double-cloth designs, by which it is possible to ensure that the best conditions will result both on the face and the back of the cloth. It is applicable to any type of face or backing weave, and to any arrangement of the threads. A is the plan of the face weave, which, it may be assumed, is required for a cloth in which the threads are arranged in the order of 1 face, 1 back in warp and weft, with a 2-and-2 twill backing weave. The weave marks are taken to indicate weft float. As the chief object should be the production of as perfect a face texture as is possible, the tying should be considered first in relation to the order in which the face warp and weft threads interweave with each other. The point-paper plan of the face weave enables the interweaving of the face threads to be seen at a glance, and thus affords a convenient means of reasoning out experimentally which is the better method, warp tying or weft tying, and also which is the best order of distributing the ties. Therefore, one or more repeats of the face weave are inserted lightly on the point-paper, as shown at A. In order to ascertain if warp tying can be employed, the positions of the backing ends are indicated between the face ends along the bottom of the plan, as shown at B, a face thread being arranged to precede a backing thread, in accordance with the order of warping. As the weave marks indicate weft float, two blanks alongside each other on the same face pick indicate that two consecutive face ends are raised at the same time, and therefore show a suitable position for raising a backing end between them over the pick. Thus on the first pick of the weave shown at B, the second and third squares are blank, therefore the second backing end may be

raised over the first face pick. On the second face pick the seventh and eighth squares are blank, therefore the seventh backing end may be raised over it, and so on. The positions of the warp ties may be conveniently indicated on the face weave by inserting marks where required between the blank squares, as shown at C. The selection of such a position for each tie ensures that one condition of warp tying will be fulfilled—viz., that where the backing warp enters the face cloth it will be covered on both sides by the adjacent face warp floats.

In order to ascertain if weft tying can be employed, the positions of the backing

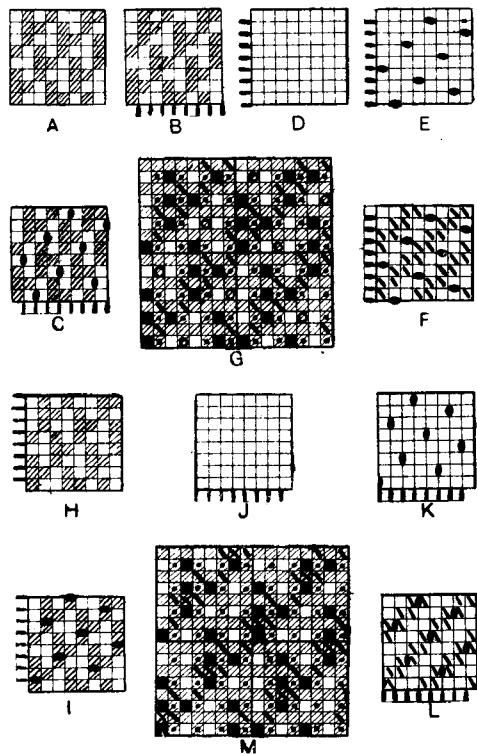


Fig. 49.

picks are indicated between the face picks at the side of the face plan, as shown at H in Fig. 49. In this case, two marks, one above the other, on the same end of the face weave indicate that a face end is passed over by two consecutive face picks, and therefore show a suitable position for passing a backing pick between them over the face end. Thus, on the first end of the weave H marks are inserted on the first, second, and third squares; therefore either the first or the second backing pick may be passed over the first face end, the former being preferable, as the tie will then be covered by two succeeding face picks. The positions of the ties may be conveniently indicated by inserting marks where required between the face weave marks, as shown at I. The selection of such positions ensures that where the backing weft enters the face cloth it will be covered on both sides by the adjacent face weft floats. After the positions of the ties have been indicated, the plan should be examined in order to ascertain if the

best distribution has been obtained, the arrangement being modified if necessary.

The next process is to find the best position of the backing weave in relation to the ties. A space is reserved for the backing weave, and taking warp tying first, the positions of the face picks are indicated between the backing picks at the side of the space, as shown at D in Fig. 49. (It is necessary to remember that a face thread precedes a backing thread, and that for each backing warp tie in the face fabric there is a face weft tie in the back fabric.) The positions of the ties are then copied from the face weave C on to the reserved space, as shown at E, the marks of the ties necessarily falling on the ends and between the picks of the backing plan. At C the tying marks indicate that backing ends pass over face picks, while at E they indicate that face picks pass under backing ends, which is the same thing. Thus

C and E show that on the first face pick the second backing end is raised ; on the second face pick, the seventh backing end ; on the third face pick, the fourth backing end, etc. With practice the ties are readily transferred from one plan to the other. In inserting the backing weave (the marks indicating weft), if possible, a square should be left blank above and below each tying mark, as shown at F. This ensures that each backing end will be raised on the backing picks which precede and succeed the tie ; or, in other words, that each face weft tie on the underside of the cloth will occupy a position between two backing weft floats.

In the case of weft tying, the positions of the face ends are indicated between the backing ends along the bottom of the space reserved for the backing weave, as shown at J in Fig. 49. The positions of the ties are then copied from the face weave I, the marks being placed on the picks and between the ends of the backing plan, as shown at K. In I the tying marks indicate that backing picks pass over face ends, and, what is equivalent, in K they indicate that face ends are down on backing picks. Thus, the first backing pick passes over the first face end, the second backing pick over the sixth face end, and so on. In inserting the backing weave, if possible, a weave mark should be placed on both sides of each tying mark, as shown at L. This ensures that the backing ends on both sides of the tie are down—that is, each face warp tie on the underside of the cloth will occupy a position between two backing warp floats.

By thus carrying out the weaves, the double plan may afterwards be constructed from them in the most advantageous manner, or if the complete weave is not required, as is frequently the case in heald work, the draft and pegging plan may be constructed directly. G in Fig. 49 is the double weave from the face weave C and the backing weave F, the circles which indicate the warp ties corresponding in position with the tying marks in both weaves. M is constructed from the face weave I and backing weave L, the weft ties being indicated by the crosses, which correspond in position with the tying marks in the two weaves.

While the foregoing method may be employed with advantage for a simple arrangement, it is particularly useful in the construction of designs in which the backing weave is different from the face weave and in which, because of the irregular construction of the face weave, the ties require to be distributed in irregular order. The working out of an irregular type is illustrated in stages in Fig. 50, in which, it may be assumed, the face weave A is required to be backed with 2-and-2 hopsack weave in a 1 face, 1 back arrangement of the threads. In this instance the weave marks are taken to indicate warp, but the system of working is exactly the same as when weft is indicated if the marks in the face and back weaves are taken for blanks and *vice versa*. In order to ascertain if warp tying can be employed, the positions of the backing ends are indicated between the face ends, as shown at B in Fig. 50, then each pair of face ends between which a backing end is indicated is examined in turn. So far as regards the covering of the tie on the face of the cloth, in this case a suitable position is shown where marks are indicated on both ends of a pair. Thus in B the second and third squares are marked on the first and sixth face picks ; therefore the second backing end may be raised on either of these picks. It is, however, not only necessary for a suitable position to be found in the face weave for each tie, but the distribution must also be considered—that is, there should, if possible, be the same number on each backing end and on each face pick, while the distribution should be as regular as possible. When, as is frequently the

case with weaves of an irregular character, there are two or more positions in the face weave for tying some of the backing threads, and only one position for tying others, the latter should be dealt with first. Thus in weave B there is only one position available for each of the backing ends 1, 3, 5, and 7. Therefore, tying marks are first inserted at these places between the face ends, as shown at C. Then, as indicated at D, the remaining ties can be readily added to the plan with due regard to the order of distribution.

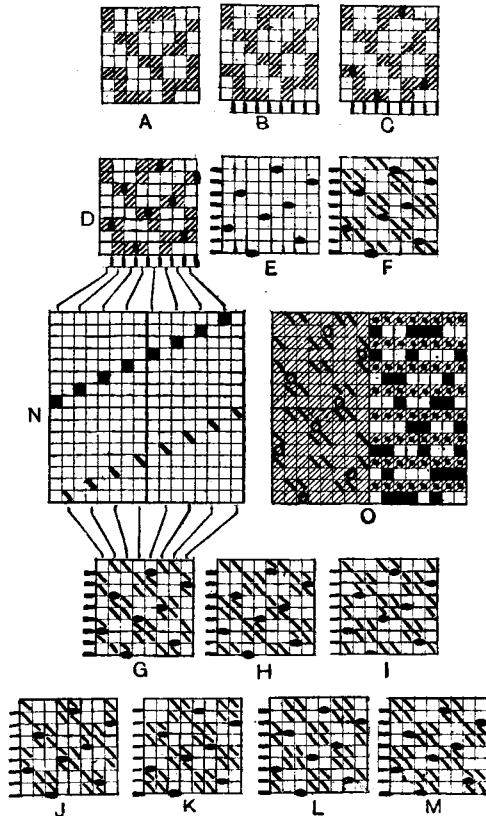


Fig. 50.

P is a flat view from the face side, while R shows the appearance of the underside when the cloth is turned over horizontally, as indicated by the numbers above the warp threads. The positions of the ties are shown by the solid marks, and it will be seen that they correspond with the marks between the squares of D and G in Fig. 50. Q in Fig. 51 represents the interlacing of the threads 1 and 2, and S of the threads 3 and 4. The diagrams show how a face weft tie on the underside of the cloth corresponds with a backing warp tie on the face. The ties on threads 2, 6, 12, and 16 (which in G are indicated between two marks) are covered between two backing weft floats. Thus, in the section Q, the third face pick is shown entering the back fabric between the second and third backing picks. The ties on threads 4, 8, 10, and 14 (which in G have a mark on one side, and a blank on the other) have a backing warp float on one

E in Fig. 50 represents the space reserved for the backing weave, the marks at the side of which show the order in which the face picks are inserted between the backing picks. The marks between the squares of E correspond with those indicated in D, and represent the positions where the face picks pass under the backing ends. The plans F to M show all the different positions in which it is possible to place the 2-and-2 hopsack backing weave in relation to the ties. As the weave marks indicate warp, the chief thing to avoid is the occurrence of a blank space above and below a tying mark, and it will be seen that all the plans, with the exception of G and J, are defective in this respect, as regards a proportion of the ties. In G and J the relation of the backing weave to the ties is not perfect, as it is impossible for the weave to be placed with a mark above and below every tying mark.

In the diagrams given in Fig. 51, in which the shaded lines represent the backing threads, the face weave D is shown backed with the 2-and-2 hopsack placed as indicated at G in Fig. 50.

side and a backing weft float on the other. The position is clearly shown in section S, where the sixth face pick enters the back fabric between the fifth and sixth backing picks. The effect of placing the backing weave with a mark above and below a tying mark is shown by the dotted lines in Q and S. In Q the dotted line shows the interweaving of the backing end numbered 2, assuming that the backing weave has been placed as shown at H or I in Fig. 50, the float being broken by the tie on the third face pick. Similarly, the dotted line in S shows how the float of the backing end numbered 4 would have been broken by the sixth face pick if the backing weave had been placed at L or M.

N and O in Fig. 50 respectively illustrate the construction of the draft and pegging plan directly from the face weave D, and the backing weave G. From an examination of D and G the number of healds that are required can be readily ascertained. Thus, D requires eight face healds because all the ends in the repeat work differently from each other, while G requires eight backing healds on account of the backing ends being raised for tying in 8-thread order. It is therefore only necessary to decide on the positions of the healds in order to construct the draft directly, as shown at N, in which the backing healds are placed in front of the face healds. The pegging plan O may then be constructed directly from D and G as follows:—(1) The positions of the backing healds and the backing picks are indicated lightly, as shown by the shaded squares. (2) The face weave is copied from D on to the face picks of the face healds, as shown by the full squares. (3) The backing weave is copied from G on to the backing picks of the backing healds, as shown by the diagonal marks. (4) The warp ties are copied on to the face picks of the backing healds from either D or G, as shown by the circles. (5) The face healds are marked up on the backing picks, as indicated by the dots. All the marks in O indicate healds raised.

In Fig. 52 the method of working is shown for a double-cloth in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft, assuming that the face weave given at A is required to be backed with 2-and-2 twill. The weave

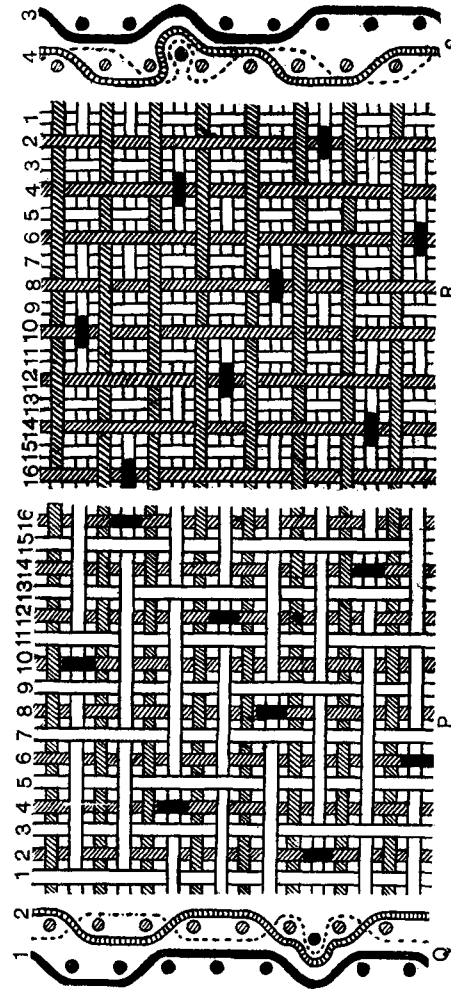


Fig. 51.

marks are taken to indicate weft. An examination of A shows that weft tying is more suitable than warp tying so far as regards the covering of the ties on the surface of the cloth. Therefore the positions of the backing picks are indicated between the face picks in the order of 1 face, 1 back, 1 face, as shown at B. Each pair of face picks between which a backing pick is indicated is then examined in turn, and experiments are made until the best possible arrangement of the ties is obtained. This is shown by the marks between the picks of the plan C. D shows the positions of the face ends between the backing ends on the space reserved for the backing weave two face ends being indicated between each pair of backing ends. The method of transferring the ties from the face weave to the reserved space is similar to that already described in reference to the 1-and-1 arrangement of the threads, except that a tie on either (or both) of the face threads will be indicated between the same pair of backing threads. Thus the tying marks between the ends of the plan E correspond in position with those between the picks of C. Plans F, G, H, and I show the different positions in which the backing weave

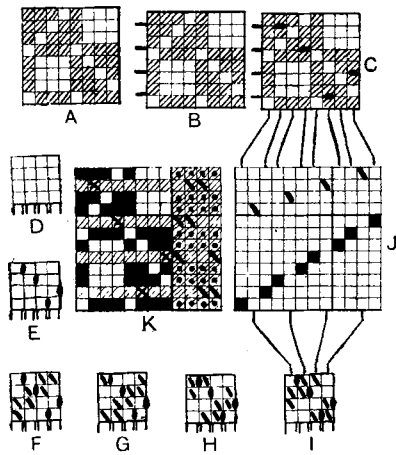


Fig. 52.

may be placed in relation to the ties. In this case while the best conditions are obtained when weave marks are placed on both sides of each tying mark, the chief thing to avoid is having a blank square on both sides. Plans F, G, and H are therefore defective, the only possible position of the backing weave being shown at I.

In the diagrams given in Fig. 53 the interlacings of the threads and the positions

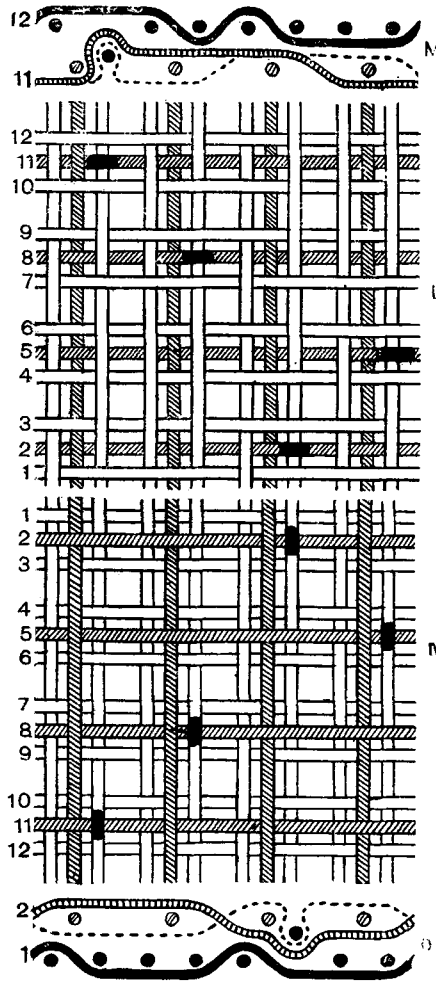


Fig. 53.

of the ties correspond with the weave marks and blanks, and the tying marks of plans C and I in Fig. 52. The structure, as viewed from the face side, is represented at L, and from the underside at N, assuming that the cloth is turned over from top to bottom, as indicated by the numbers alongside the weft picks. M shows the interweaving of picks 11 and 12 with their respective ends, and O of picks 1 and 2. From an examination of L it will be seen that each backing weft tie is perfectly covered on the surface of the cloth. N enables the relation of the ties to the backing weave to be observed; thus, a face warp tie on the underside corresponds with a backing weft tie on the surface. The ties on the picks 2 and 5 (which in I have a mark on both sides) are covered between two backing warp floats. This is also shown in section O, where the sixth face end enters the back fabric between the third and fourth backing ends. The ties on picks 8 and 11 (which in I have a mark on one side and a blank on the other) have a backing warp float on one side, and a backing weft float on the other, the position being also shown in section M, where the second face end enters the back fabric between the first and second backing ends. The dotted lines in M and O show the effect of placing the backing weave with a blank square on each side of a tying mark. In M the dotted line shows how the float of the backing pick 11 would have been broken by the tie on the second face end if the backing weave had been placed as at F in Fig. 52; while the dotted line in O shows how the float of backing pick 2 would have been similarly broken by the sixth face end if the weave had been placed as at G.

J and K in Fig. 52, respectively show how the draft and pegging plan may be constructed directly from the face and backing weaves, the backing healds, for the purpose of illustration, being placed behind the face healds. In this case, the backing weft ties are marked on the backing picks of the face healds, as shown by the crosses in K, while dots are inserted on the face picks of the backing healds, all the marks indicating healds down.

**Reversible Double Weaves.**—In no type is the correct placing of the backing weave in relation to the ties of greater importance than in the construction of reversible double weaves, such as are used for fine woollen and worsted overcoatings, in which the same effect is produced on both sides. Plans A to G in Fig. 54—in which weft is indicated—illustrate the construction of a reversible 7-shaft whipcord, in which the threads are arranged in the order of 1 face, 1 back, in warp and weft. As the back of the cloth is warp surface, the same as the face, the backing weave is exactly the opposite of the face weave. So far as regards the face of the cloth, the position of the backing warp ties may be varied, as shown in the plans A, B, and C, in each of which the tying places are indicated by the marks between the ends. The corresponding positions of the face weft ties are indicated by the marks between the picks of the plans D, E, and F respectively, in which it will be noted that the position of the backing weave is changed to accord with the position of the ties. Section H in Fig. 55 shows the interweaving of the first face and the first backing end with the weaves and ties placed as at A and D; section I, as at B and E; and section J, as at C and F. In each case the back of the cloth is as perfect as the face, the weaves being the same except that the twill runs in the reverse direction. G in Fig. 54 shows the complete double design with A as the face weave and D the backing weave.

**Double-Cloths with Compound Face Weaves.**—If warp tying be employed for a compound face weave, such as that shown at K in Fig. 54, an important principle



to note is, if possible, to distribute the ties in the same order throughout the complete repeat. This is particularly necessary when a simple backing weave is employed. For example, assuming that the threads are arranged 1 face, 1 back, in warp and weft the best order of distribution for the twilled hopsack in the first section of K is the 8-sateen order. The same order may be employed for the 2-and-2 twill section, therefore the 8-sateen distribution may be used regularly throughout the repeat, as shown by the marks between the ends of K. Then if a simple backing weave, such as the 2-and-2 twill shown at L, be employed, the backing ends may be drafted in

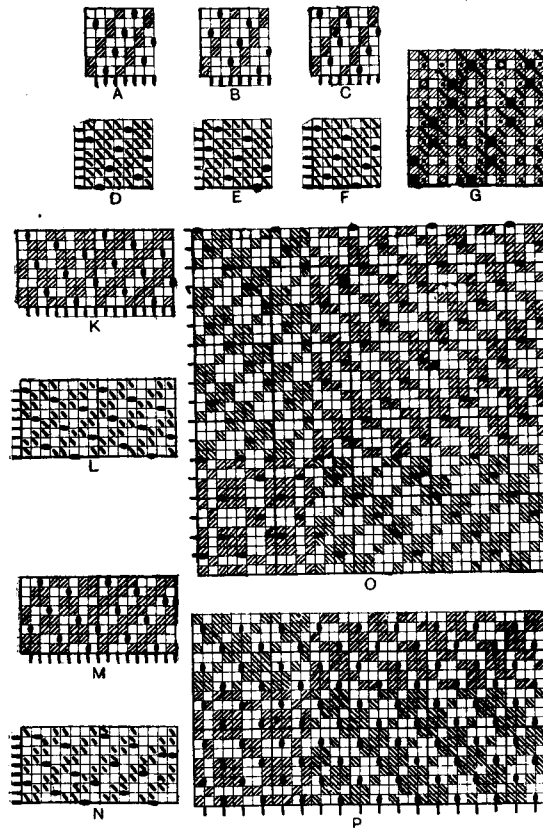


Fig. 54

straight order on to eight healds. If, however, the ties for the twilled hopsack section are placed as shown by the marks between the ends of M, it is necessary for a break to be made in the order of distribution where the weave changes. An irregularity of this kind may not only complicate the drafting of the backing ends, but in this case for a 2-and-2 twill backing weave, 16 backing healds are required, because as shown at

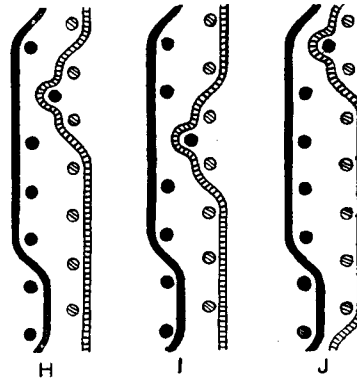


Fig. 55.

N, the ties are in a different position relative to the backing weave in the two sections of the design.

In the production of compound face weaves which require a large number of healds, tying with the backing weft gives more scope for variety of effect in dobby weaving than tying with the backing warp. For example, in a 2-and-1 arrangement of the threads, the ends of the face weave given at O in Fig. 54 may be depressed for tying in the order indicated by the marks between the picks, and 20 face healds are required, while if a plain backing weave be used, only two backing healds are necessary. The weave marks of O indicate weft. On the other hand, stitching

with the backing warp would necessitate the use of a large number of backing healds if the ties were as effectively concealed as in weft tying. In some cases, however, the cheaper classes of piece-dyed cloths, in which compound face weaves are employed, are tied by means of the backing ends, which are raised for tying in regular order. Thus, if the weave given at O in Fig. 54 is backed with plain weave, and the ties distributed in plain order, only two backing healds are necessary, the same as in weft tying. The backing healds, in this system, are raised alternately for tying, as shown by the marks between the ends of P, irrespective of the face weave, except that care is taken to so plan the weave that the defective ties are reduced to the lowest possible number. In a piece-dyed cloth the defects on the face are not so apparent as when there is a difference in colour between the face and backing yarns.

### CHAPTER III

#### SPECIAL CLASSES OF DOUBLE CLOTHS

*Double Cloths in which the Threads Interchange.* *Cut Double Cloths*—Cut Effects produced by Interchanging the Threads—Designs in which the Cut is produced by interweaving the Threads in 3-and-3 order. *Double Plain Cloths*—Styles arranged 1-and-1 as to Colour—Correct Joining of Double Plain Weaves—Double Plain Horizontal Hairline—Intermingled Double Plain Effects—Specially arranged Double Plain Stripes—Double Plain Spotting—Broad Double Plain Stripes—Double Plain Cloths Specially Coloured in the Warp—Comparison with the First System—Cutting and Joining the Weaves—Methods of Colouring the Backing Ends—Method of Designing Stripe Patterns—Construction of Double Plain Check Patterns—Double Plain Effects in Three or Four Colours—Four-Shade Effects Coloured 1-and-1 in the Warp—Three-Colour Patterns arranged 1 Face, 1 Back in the Warp—Four-Colour Patterns arranged 1 Face, 1 Back in the Warp. *Double Twill and Sateen Stripe Designs.*

#### DOUBLE CLOTHS IN WHICH THE THREADS INTERCHANGE

THE method of interchanging the threads, illustrated by the plans A and B in Fig. 56, and the drawings in Fig. 57, is employed for reversible cloths in which very loose weaves are required on the face and back. The odd ends and picks, which in the example form the 10-thread hopsack pattern A on both sides of the cloth, are alternately above and below a plain fabric formed by the even ends and picks. A weft float formed on the surface by the odd picks has a corresponding warp float on the underside formed by the odd ends, and *vice versa*; each odd end and pick thus floating loosely on one side or the other without interweaving with the other threads, except where the interchange is made. The necessary firmness of structure is secured by the plain weaving of the even threads which form a centre fabric, and by the interchanging of the loosely woven threads through it. In the complete plan given at B in Fig. 56, the positions of the threads which are in the centre are indicated by the shaded lines. After the plain weave of the centre threads has been inserted over the repeat, as indicated by the diagonal marks, it is only necessary to insert marks on the odd ends and picks (as shown by the full squares) in the sections where the weft is required on the surface. (The marks in Fig. 56 represent weft.) The odd picks thus float over all the ends, and the odd ends are down on all

the picks ; while in the remaining sections, where the warp is required on the surface the odd picks pass under all the ends, and the odd ends are raised on all the picks. This is clearly shown in the flat view of the structure given in the upper portion of

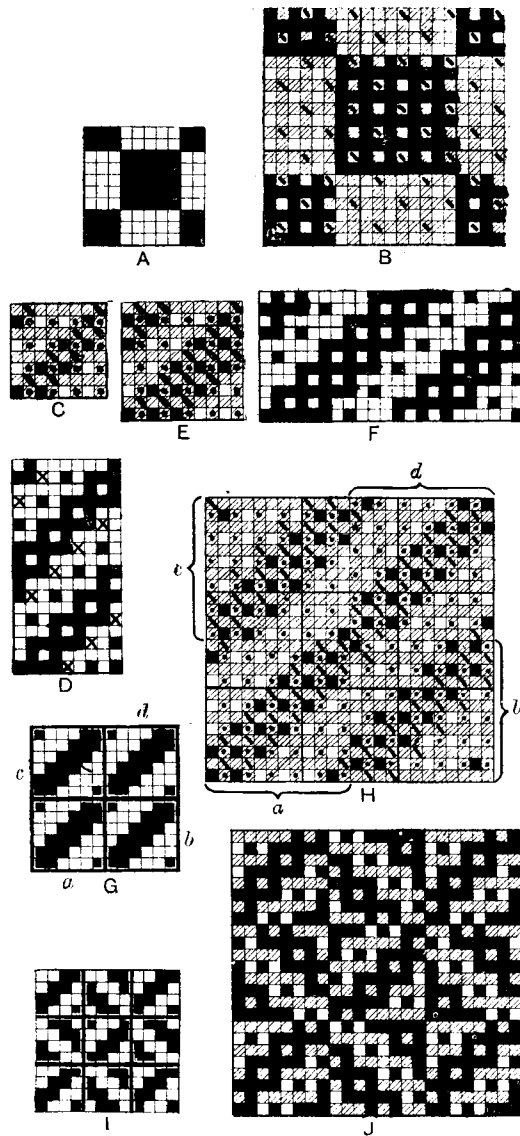


Fig 56.

one end more than the number of ends in the repeat of the original weave C, and the weave C is inserted in the manner illustrated by the full squares in D. Because the weave C is a 1-and-1 arrangement while the repeat of D contains

Fig. 57. The section on the right of the flat view shows the interweaving of the ends 1 and 2, and that below of the picks 1 and 2. The diagrams indicate the method in which the ends and picks respectively change from one side to the other of the plain centre fabric. The threads which form the centre fabric require to be much finer than those which float on the face and back.

All ordinary double weaves constructed for 1-and-1 warping and wefting may be readily rearranged to interchange on the principle illustrated by the plans C, D, E, and F in Fig. 56. In this system one series of threads, either warp or weft, enters about equally into the face and back fabrics, passing alternately from face to back, and from back to face. Usually it is better to interchange the warp threads, as the cloth can then be woven from one warp beam. Also, a lower quality of weft can be used for the under than for the face fabric, while fewer healds are required than when the interchange is in the weft threads.

C in Fig. 56 shows an ordinary double 2-and-2 twill weave from which the ties are omitted ; the threads are arranged 1 face, 1 back in warp and weft, and the repeat occupies eight ends and picks. For the warp interchange the repeat is made either one end less, or, as shown at D,

an odd number of ends, it is necessary for two repeats of the twill to be run in before the repeat for the picks is complete. This causes the odd ends to enter the face fabric and the even ends the back fabric in one twill, while in the other twill the positions of the ends are reversed. The picks, however, are always retained in their respective positions, the odd picks being on the face and the even picks on the back throughout; hence the backing weft may be different from the face weft, as in the ordinary type of double cloth. The additional float, indicated by the cross on each face pick of D, may be in either weft or warp, although in this case weft is preferable, as the face twill is thus made more definite. An effect similar in appearance to a double 2-and-2 twill is obtained, but the weave is really between a 2-and-2 and a 3-and-2 twill.

The flat view, to correspond with the design D (in which the marks represent weft), is given in Fig. 58, the shaded lines indicating where the threads are on the underside. The section on the right of the flat view shows the interweaving of the first two ends, and

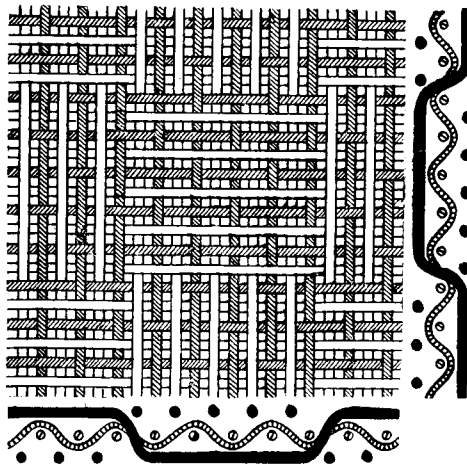


Fig. 57.

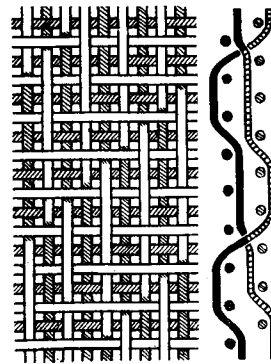


Fig. 58.

enables the method in which the ends change from one fabric to the other to be readily seen. The interchange is so frequent that a firm, solid structure results without the ordinary system of tying being employed.

E in Fig. 56 shows an ordinary double 3-and-2 twill with the ties omitted; while F shows the weave arranged to interchange in the weft. In this case the repeat for the picks is made an odd number by increasing it by one, the two lines of the twill thus occupying 22 ends. The odd ends are always on the face, and the even ends on the back, which renders it possible for a lower quality of warp to be used for the back than for the face. The effect which is obtained is between a 3-and-2 and a 3-and-3 twill. If the repeat had been made on 9 picks and 18 ends the weave would have produced an effect between a 3-and-2 and a 2-and-2 twill.

### CUT DOUBLE CLOTHS

In these a division of the face weave is obtained by means of fine lines which may run in the direction of the warp, of the weft, or of both warp and weft. If the lines are near together, tying on the ordinary principle is not necessary, as the cuts

serve to unite the two fabrics. When, however, there is a rather large space between the cuts, say more than one-fifth of an inch, extra tying places are required in order to produce a firm structure.

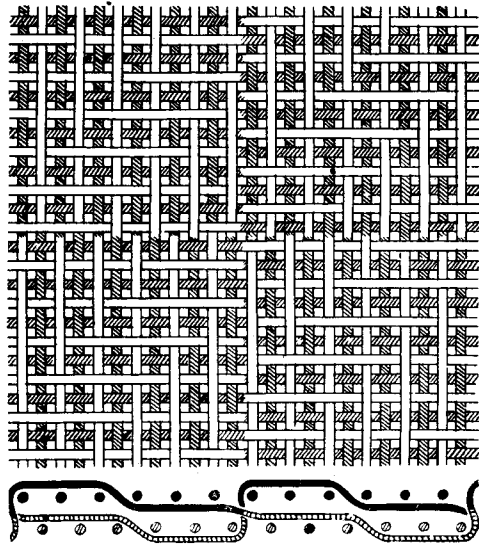


Fig. 59.

double weave given at H indicate the positions of the backing threads in the

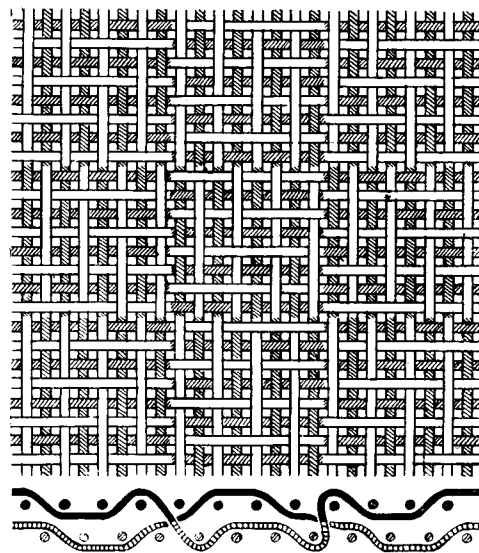


Fig. 60.

alternately from face to back and from back to face, it will be clear that

to produce a firm structure.

The cut or line effect can be produced in either of the following methods:—

- (1) By interchanging the threads.
- (2) By interweaving the face and back threads together in 3-and-3 order.

**Cut Effects produced by Interchanging the Threads.**—

This system is employed in well-set-up cloths in which the threads are arranged in the proportion of 1 face to 1 back in warp and weft, neat designs resulting from reversing the ends and picks in sections, according to the form of pattern required.

For example, G in Fig. 56 shows the positions of the lines for the production of a cut check of equal spaces on the face and back in a double 3-and-3 twill, while the shaded squares in the complete

double weave given at H indicate the positions of the backing threads in the various sections. The cuts between *a* and *b*, and between *c* and *d*, are obtained by reversing the picks; and between *a* and *c*, and *b* and *d*, by reversing the ends. Thus, although every portion of the cloth is double in structure, each end and pick forms part of both the face and the back fabric, and a perfectly regular structure can be obtained with only one warp beam. In H the face weave is indicated by the full squares, and the backing weave by the diagonal marks, the dots showing where the backing ends are down on the face picks.

The flat view, to correspond with the design H in Fig. 56, is given in the upper portion of Fig. 59, and a section showing the interweaving of picks 3 and 4 in the lower portion. As the threads pass

additional variety of effect may be obtained by arranging the threads as to colour in different orders. For example, with a 1-dark, 1-light order of warping and wefting, a solid dark surface would be formed in section *a* of the design H, where the odd ends interweave with the odd picks. In section *b*, where the odd ends interweave with the even picks, an intermingled colour effect would be produced on the surface, while a similar effect would be formed in section *c*, where the even ends interweave with the odd picks. In section *d* the interweaving of the even ends with the even picks would form a solid light surface. The colour effect on the underside would be exactly the reverse of the face in the solid portions.

Although with the weave H a line is produced on both sides of the cloth by the interchanging of the threads, the 3-and-3 twill is really continuous throughout in both fabrics. A better defined and deeper cut is obtained if the face and backing weaves are arranged on the principle shown at I in Fig. 56. In this case the face weave also cuts along the line where the threads interchange, and the direction of the twill is reversed in alternate sections. The arrangement causes a similar cut to be formed in the double weave given at J, in which only one kind of weave mark is shown, in order that it may be more clearly seen how the weft opposes the warp where the interchange takes place. This is also shown in the corresponding flat view given in the upper portion of Fig. 60, and in the section showing the interweaving of picks 1 and 2 in the lower portion. From an examination it will be seen that

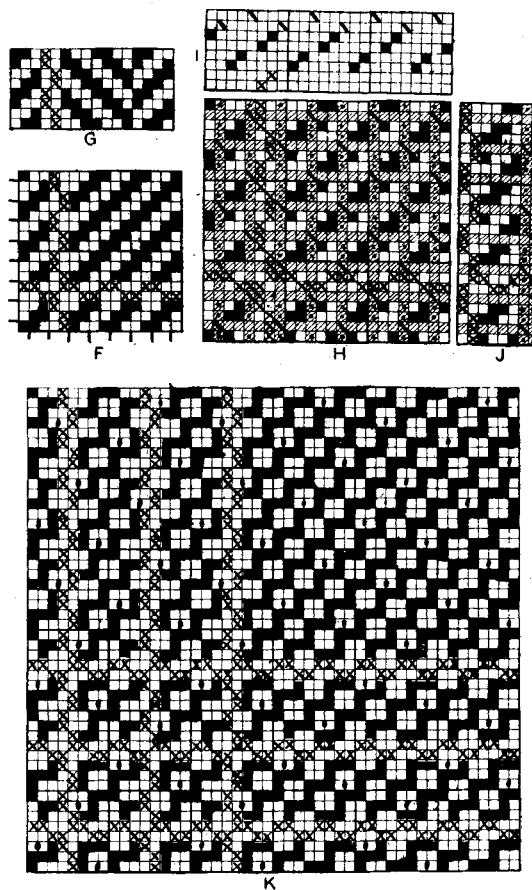


Fig. 61.

a thread which floats on the surface of the upper fabric interchanges directly to the underside of the lower fabric, and *vice versa*. This is not the case with all the threads when the weave is arranged as indicated in Fig. 59. The reversing of the twill, as shown in Fig. 60, assists in bringing out the cutting line sharp and clear.

**Designs in which the Cut is produced by interweaving the Threads in 3-and-3 order.**—This is the more common method of producing the cut or sunk effect, and it is usually employed in cloths in which the threads are arranged in the proportion

of 2 face to 1 back in warp and weft. In this system both the face and the backing threads assist in forming the line, and it is necessary for the weaves to be arranged in precise order in relation to the threads to obtain the best results. In the first place at each cut two face threads between a pair of backing threads are arranged to weave in 2-and-2 order with the face picks, and to oppose each other with their floats, as shown by the crosses on the fourth and fifth ends and picks of the face plan given at F in Fig. 61. Also each face float of 2 is arranged to include a face end or pick on each side of a backing end or pick. The face weave is then placed, as far as possible, to support the cutting threads. Thus in F the float of one cutting thread is a continuation of the twill, while that of the other increases the float of the face weave. If the face weave is placed so as to oppose the cutting threads, as shown at G in Fig. 61, which illustrates a defective plan, the line is made more open and not so distinct.

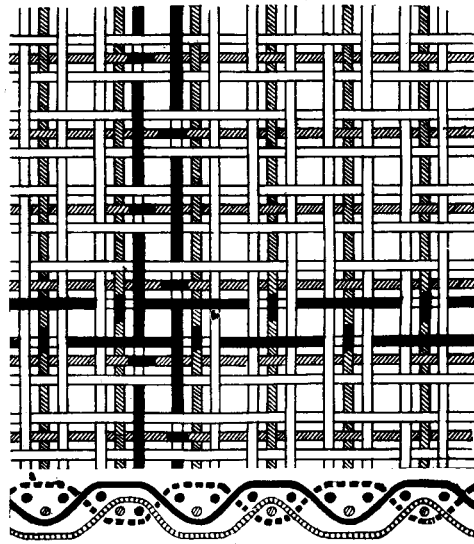


Fig. 62.

Under ordinary circumstances, however, these ends weave tighter than the rest, and it is usual to draw them through the healds near the front in order that, in shedding, they will be subjected to the least possible strain. The draft for H, on the lowest possible number of healds, is given at I, and the pegging plan at J, in which the marks indicate healds down.

The flat view given in the upper portion of Fig. 62 shows the interweaving of the ends and picks 1 to 18 of the weave H in Fig. 61, the threads which assist in forming the cut being indicated in solid black. The solid line in the section given in the lower portion of Fig. 62 shows the interweaving of the first face cutting pick, the dotted line of the second, and the shaded line of the backing pick which precedes them. The method of interweaving not only forms the sunk effect between the face cutting threads, but the face and back fabrics are tied very firmly together along the cuts.

In constructing elaborate designs, the positions and the order of interweaving of the cutting threads may, with advantage, be first indicated on the space

In constructing the complete design, which is given at H in Fig. 61, the backing thread between each face float of two is given a corresponding float, the cutting threads thus interweaving in 3-and-3 order, as shown by the crosses on the sixth and seventh ends and picks of H. Each 3-float passes under, or over, 1 face thread, 1 backing thread, and 1 face thread. The plain backing weave also requires to be placed to support the cutting threads, as shown by the diagonal marks which are inserted against the crosses. In some cases, in order to increase the sunk effect, the cutting ends are woven as tightly as possible from a separate beam. Under ordinary circumstances, however, these ends weave tighter than the rest, and it is usual to draw

occupied by the face weave, as shown by the crosses in K, Fig. 62. The face weave—in this case the twilled hopsack—may then be arranged in the best position for supporting the cutting threads, and if the space between the lines is so great that extra stitching is necessary, the positions of the additional ties can be indicated, as shown in K, in which the marks between the blank squares represent backing warp ties. The complete double-cloth design is readily constructed from a face plan arranged as shown at K.

DOUBLE PLAIN CLOTHS

Double plain weaves which are tied by means of the backing warp, as shown at A and B in Fig. 63, are employed for solid coloured dress-face cloths, which require to be very firm in structure. In the design A the threads are arranged 1 face, 1 back in warp and weft, and in B in the proportion of 2 face to 1 back ; the marks indicate weft. In double-plain weaving, however, the object is usually to produce cloths

in which patterns are obtained which are due (a) to the combination of differently arranged double-plain weaves, and (b) to the method of arranging the threads as to colour.

Two opposite double-plain weaves are given at C and D in Fig. 63. With the weave C (taking the marks to indicate weft) the odd ends and picks form the upper, and the even ends and

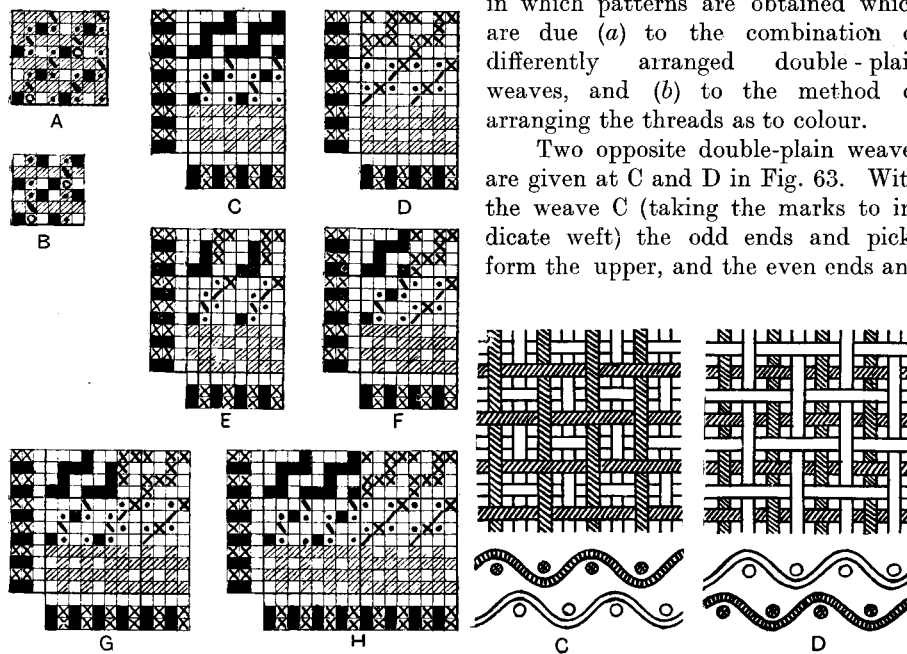


Fig. 63.

Fig. 64.

picks the lower plain fabric. This is illustrated by the corresponding flat view, and the section which shows the interweaving of the first and second picks, given at C in Fig. 64. With the weave D in Fig. 63 the threads are in the reverse positions, the upper fabric being formed by the even ends and picks, and the lower fabric by the odd ends and picks, as represented at D in Fig. 64. In each case the two plain fabrics are quite separate from each other, but by combining the weaves C and D the threads are caused to interchange, and a firm compact structure is formed, so long as neither weave extends for more than about eight threads.



There are two principles upon which the threads may be arranged as to colour, viz. :—(a) In the order throughout of 1-and-1 in warp and weft; (b) in regular order in the weft, but with the warp colour order varied according to the form of pattern which is required. The first arrangement is used in the production of spotted vestings and figured fabrics, and in stripe patterns for suitings and trouserings. The

second method is chiefly limited to the production of stripe effects, for which, however, it has certain advantages over the first method. In the following both systems of constructing double-plain stripe patterns, for suitings, trouserings, and costume fabrics, are described and illustrated.

**Styles arranged 1-and-1 as to Colour.**—In this method, with the threads arranged 1 dark, 1 light in warp and weft, the weave C (Fig. 63) produces a dark over a light surface, and the weave D a light over a dark surface, as shown by the drawings given at C and D respectively in Fig. 64, in which the dark threads are represented by the shaded lines. By combining the weaves in sections, therefore, any form of pattern in two colours may be obtained. This is illustrated by the plans E, F, G, and H in Fig. 63, and by the corresponding drawings, similarly lettered, given in Fig. 65. In E the ends 1 and 2 of C are combined with the ends 3 and 4

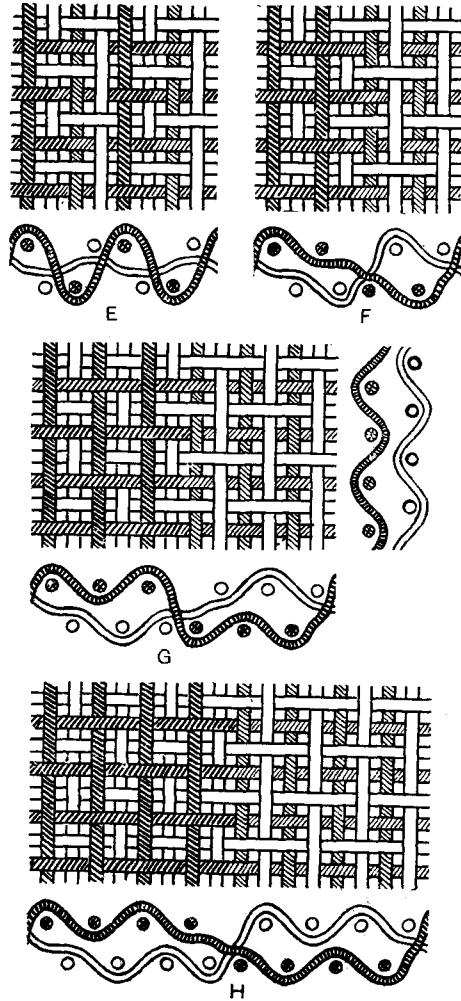


Fig. 65.

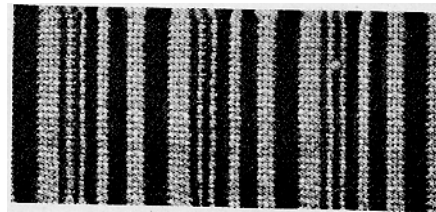


Fig. 66.

of D, a single-thread hairline stripe lengthwise of the cloth being formed. In F, 4 ends of C are combined with 4 ends of D, a stripe pattern in 2 dark, 2 light colouring being obtained. In G, 6 ends of C are combined with 6 ends of D, and in H 8 ends of C with 8 ends of D, the former producing a stripe effect in 3 dark, 3 light, and the latter in 4 dark 4 light colouring on the surface. The effect produced by combining the plans E, F, G, and H, Fig. 63, in stripe form

is shown in Fig. 66, the colour pattern on the surface of the cloth being 1 dark, 1 light, 1 dark, 1 light, 2 dark, 2 light, 3 dark, 3 light, 4 dark, 4 light.

In order to produce a pattern in which each section is in solid colour, it is necessary for the warp and weft colours to be alike, and for each colour of weft to interweave only with its own colour of warp. An examination will show that this is the case in the examples E, F, G, and H in Figs. 63 and 65; and further, that the colour pattern on the underside of the cloth is in each exactly the reverse of that on the face.

In the flat views the odd ends and picks are shaded to represent the dark threads; but in order to show a distinction where these threads are on the underside, the shading is somewhat lighter than where they are on the surface. The section below each flat view shows the interweaving of the picks 1 and 2. The picks pass alternately from face to back and from back to face, a firm structure thus being formed. The section on the right of the flat view, given at G, shows the interweaving of the ends 1 and 2. No interchange takes place in the warp threads in stripe patterns of this character, each end being retained on the face or back continuously.

In order that the method of construction may be conveniently analysed, the plans C to H in Fig. 63, and also the designs in Fig. 67, are each shown in three portions.

In the bottom portion the shaded squares indicate the backing ends and picks, hence the blank squares show where the face ends intersect the face picks. In the centre portion the weaves are shown in different marks; thus for the face weave the full squares indicate where the dark face picks pass over the dark face ends, and the crosses where the light face picks pass over the light face ends; for the backing weave, the diagonal marks inclined to the left show where the light backing picks pass over the light backing ends, and the diagonal marks inclined to

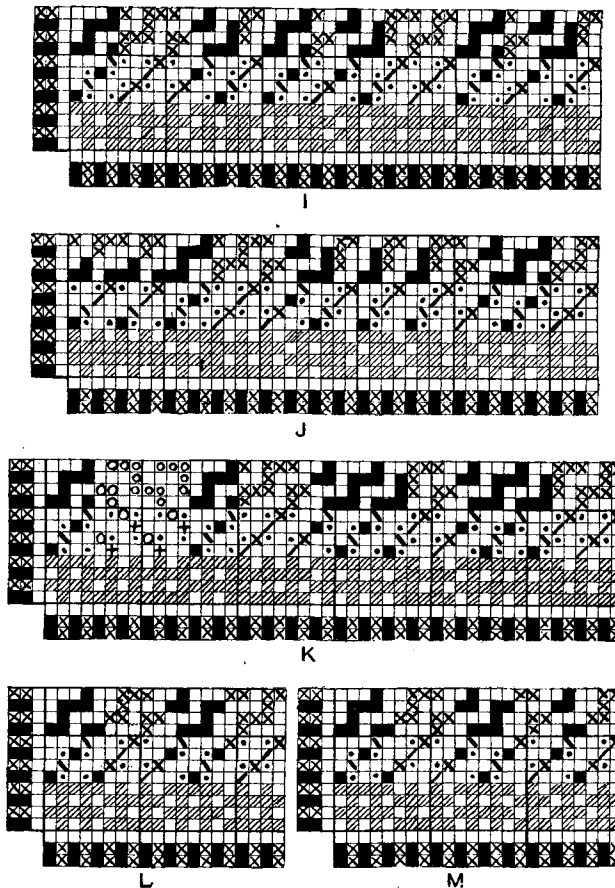
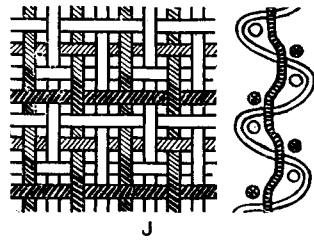
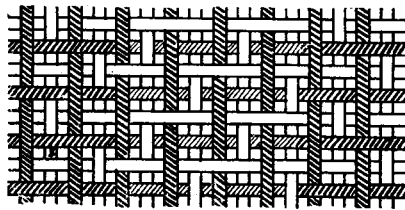


Fig. 67.

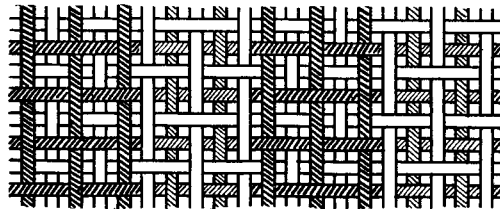
the right where the dark backing picks pass over the dark backing ends; while the dots denote the backing ends down on the face picks. In the top portion, the full squares indicate the sections where the odd or dark threads are on the surface, and the crosses the even or light threads. The arrangement of the threads as to colour is indicated along the bottom and at the side of each plan, the solid marks denoting the dark ends and picks, and the crosses the light ends and picks. The patterns



J



K



L

Fig. 68.

above and below the twill marks on those ends which are required on the underside. (If marking for warp is practised, marks are added above and below the 3-and-1 twill marks on the ends which are required on the surface.) As the face colour pattern of I repeats on an odd number of ends (11) it has been necessary to extend the design over two repeats (22 face and 22 backing ends).

Again as each weave C and D in Fig. 63 repeats on four threads, a correct junction is obtained if one weave commences with the thread which is next in number to the thread with which the other weave finished. Thus, in the design I the first

represented in Fig. 69 correspond with the designs that are similarly lettered in Fig. 67.

*Correct Joining of Double Plain*

*Weaves.*—In combining the weaves it is necessary for care to be taken that not more than a float of three is made in a design where the interchange is made. In the 1-and-1 order of colouring the threads, a correct junction is assured if the face and backing weaves are placed in the same relation to each other in every section of the pattern. For example, if the centre four picks of I, Fig. 67, be examined, it will be seen that the full squares and crosses which are used for the face weave are always in the same relation to the diagonal marks which are used for the backing weave, a continuous line in 1-and-3 twill being formed. The pattern produced on the surface of the cloth by design I is 2 dark, 3 light, 2 dark, 1 light, 2 dark, 1 light, as shown at I in Fig. 69. Designs in which each section requires to be in solid colour may therefore be readily constructed by first dividing the repeat into sections according to the desired pattern, and inserting the 1-and-3 twill over the given surface. Marks are then added

section finishes with the fourth end of C, while the second section commences with the first of D. The second section finishes with the second end of D, which is followed by the third of C, and so on.

*Double Plain Horizontal Hairline.*

—If the picks 1 and 2 of C, Fig. 63, are combined with the picks 3 and 4 of D, a hairline effect across the piece is formed. The horizontal hairline, however, is seldom used except in small spaces in combination with other effects in the manner shown at J in Fig. 69. The pattern on the surface of this example is 4 horizontal hairline, 2 dark, 3 light, 2 dark, 1 light, 1 dark, 1 light, 1 dark, 2 light, 3 dark, 2 light. In the complete design given at J in Fig. 67, the horizontal effect is produced by the weave shown on the first 8 ends. The corresponding flat view of this portion of the design, and a section showing the interweaving of the ends 1 and 2, are given at J in Fig. 68, in which it will be noted that the horizontal hairline is produced by the interchanging of the ends.

*Intermingled Double Plain Effects.*

—In the pattern shown at K in Fig. 69, variety of effect is obtained by the introduction of a stripe in which the colours are intermingled. The effect on the surface of the cloth is 2 dark, 4 mixed, 2 dark, 3 light, 4 dark, 2 light, 4 dark, 3 light. The design is given at K in Fig. 67, the mixed effect being produced by the section shown in circles in the top portion. An examination of the centre four picks of K, in which the circles indicate where the face weft passes over the face warp, shows that in the mixed effect the light picks interweave with the dark ends on the surface of the cloth. This is more convenient in this case because, as

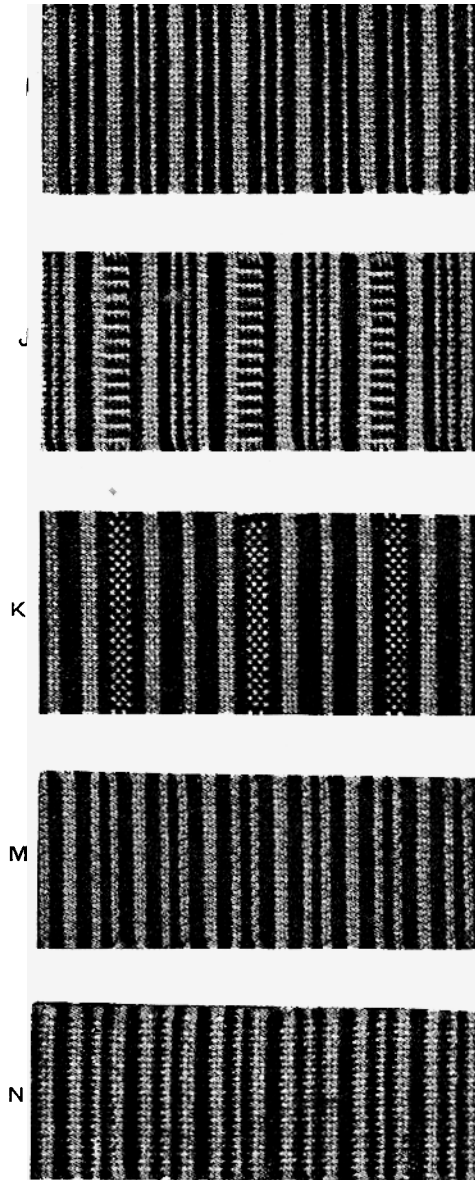


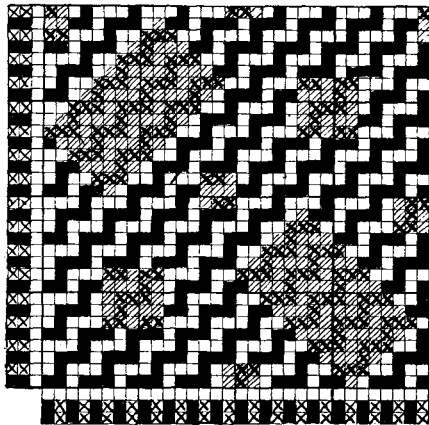
Fig. 69.

shown in the bottom portion of K, the ends may be arranged 1 face, 1 back in continuation of the order in which they are arranged for the two dark stripes

between which the mixed effect is placed. This makes it possible, by reversing the weave as shown, to place it to cut with the weave on each side, a better defined stripe thus being formed.

The method in which the ends 1 to 16 of the design K in Fig. 67 interweave is illustrated by the flat view given at K in Fig. 68, and the section showing the interlacing of the first and second picks. On the underside of the cloth a similar intermingled effect is produced by the dark weft interweaving with the light warp, which is a suitable arrangement when the mixed effect is introduced between two light stripes.

*Specially arranged Double Plain Stripes.* — In the foregoing stripe designs it will be noted that 2 face or 2 backing ends are brought together where the change from one colour to the other is made. It is sometimes feasible, however, with the same order of colouring, to avoid having 2 backing ends together by arranging the weaves on the principle shown at L in Fig. 67. In this case, as shown in the bottom portion of



N  
Fig. 70.

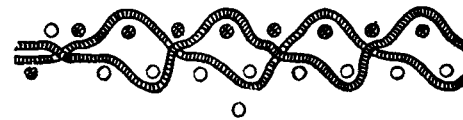
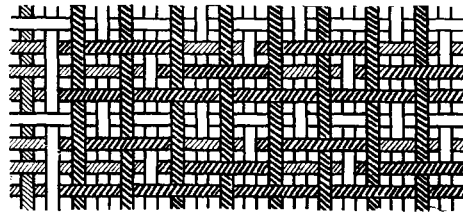
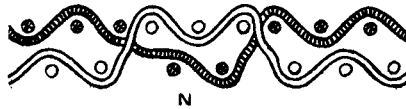
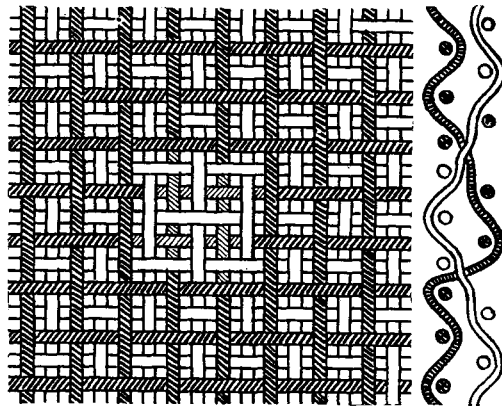


Fig. 71.

the plan, each section contains an odd number of ends, so arranged that the two ends which are brought together where the interchange is effected are face ends. This, necessarily, causes more ends to be brought to the face than to the back, although the picks are equal on both sides. The flat view of the design L, and a section showing the interweaving of the picks 1 and 2, are given at L in Fig. 68. There are 3 face ends to 2 backing ends, the pattern formed on the surface of the cloth being 3 dark, 3 light, and on the back 2 light, 2 dark. In this principle of construction each section contains one backing end less than the

number of face ends. Thus, for a pattern in 2 dark, 2 light on the face, there will be 2 face ends to 1 backing end, and the effect on the underside will be 1 light, 1 dark; while for a 4 dark, 4 light face pattern there will be 4 face ends to 3 backing ends, and the effect on the back will be 3 light, 3 dark. More elaborate stripes may be constructed on the same principle. For example, M in Fig. 67 shows the design for the pattern represented at M in Fig. 69, the effect on the face being 3 dark, 3 light, 3 dark, 2 light, 2 dark, 2 light. In the repeat of the design there are 15 face ends to 9 backing ends. N in Fig. 69 shows the appearance of the cloth on the underside, the pattern being 1 dark, 1 light, 1 dark, 2 light, 2 dark, 2 light. It is necessary for care to be taken that the same number of face ends is sleyed through each split of the reed.

*Double Plain Spotting.*—In the construction of stripe patterns the interchange is usually in the weft only, the warp threads being retained on the face or back continuously. The exception is when a section of the horizontal hairline is introduced. In spotted patterns, such as are employed in vesting styles, however, the interchange is in both warp and weft. An example is given at N in Fig. 70, in which the shaded portions indicate where light spots are brought up on a dark ground. In constructing the design the weave D, Fig. 63, is inserted in the spotted sections, and the weave C in the ground. The flat view showing the interweaving of the ends and picks 1 to 16 of the design N in Fig. 70 is given at N in Fig. 71. The sections below and alongside the flat view, which respectively show the interweaving of the picks 6 and 7, and the ends 6 and 7, illustrate the method in which both the warp and weft threads change from one side to the other.

*Broad Double Plain Stripes.*—A broad, solid - coloured, double - plain stripe can be produced in the 1-and-1 order of warp colouring, by changing the weft colour plan to 3-and-1, and by arranging the weaves on the principle illustrated at O in Fig. 72. The limitation of the arrangement is that

only one thread of one of the colours can be brought to the surface at a place. In this case the wefting is 3 dark, 1 light, and the pattern formed on the face of the cloth is 1 light, 11 dark, 1 light, 3 dark, 1 light, 3 dark, as shown in Fig. 73. The flat view of the ends 1 to 18 of Fig. 72 and a section showing the interweaving of the picks 2 and 3 are given at O in Fig. 71. An examination and comparison with the design will show that the light pick is always on the underside, and the first dark pick always on the surface, except where the single thread lines in light colour are formed. In the broad stripe the second and third dark picks alternately pass from one side to the other every

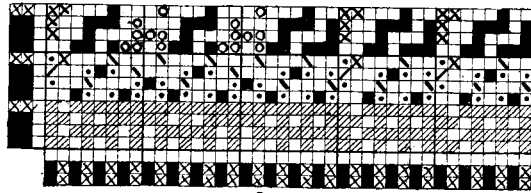


Fig. 72.

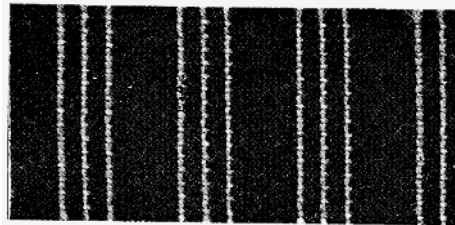


Fig. 73.

four ends, effectively binding the stripe and preventing the cockling of the cloth, which would otherwise have resulted on account of the fabrics being separated for too wide a space.

**Double Plain Cloths specially Coloured in the Warp.**—This, the second method of producing double plain stripe patterns, is illustrated by the designs given in Fig. 74, and the diagrams shown in Figs. 75, 76, and 77.

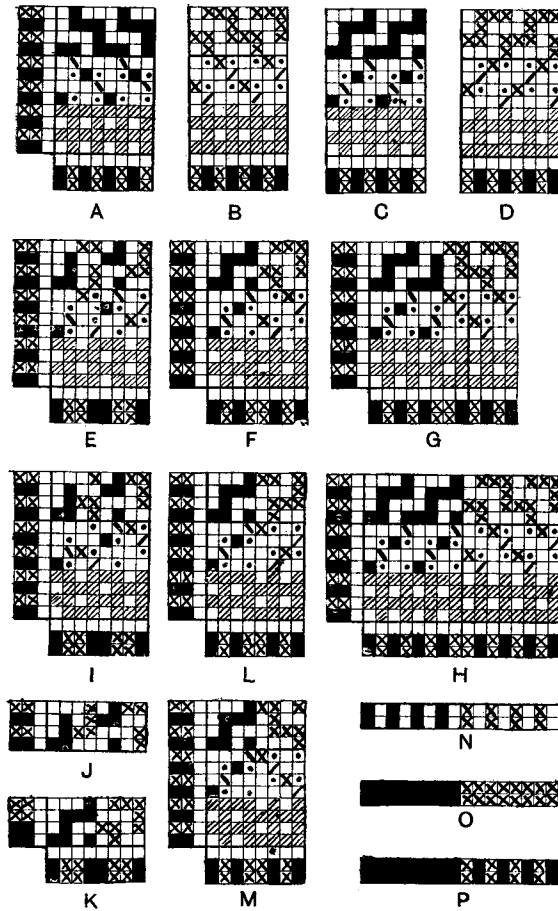


Fig. 74.

coloured over a dark fabric is formed, as shown at D in Fig. 75. In the plans A and B in Fig. 74 the twill lines formed by the weave marks run in the opposite direction, but they produce exactly the same effects as to colour as the plans C and D, as will be seen by comparing the corresponding drawings A and B with the drawings C and D in Fig. 75. The weave A or C may therefore be combined with either the weave B or D, so that more latitude in joining the weaves is found in this than in the first system.

*Comparison with the First System.*—In order that this system of construction

the plans are shown in three portions, with the order of colouring indicated along the bottom and at the side; while in the drawings, the shaded lines represent the dark threads, the shading being lighter where they are on the underside. In this method the ends are arranged 1-and-1 throughout as to their positions on the face and back, and the picks usually 1-and-1 as to colour, but a change is made in the order of colouring the ends at each change of the pattern.

In the two opposite double-plain weaves given at C and D in Fig. 74, the ends are arranged 1 face, 1 back, and the picks 1 dark, 1 light. With the ends also arranged 1 dark, 1 light, the weave C produces a dark over a light surface, as shown at C in Fig. 75. The ends of the weave D are arranged 1 light, 1 dark. On the surface the odd (light) ends interweave with the even (light) picks, and on the underside the even (dark) ends with the odd (dark) picks. Thus a light-

may be readily compared with the previous system, the designs and orders of colouring are given at E, F, G, and H in Fig. 74, which will respectively produce in the second system the same colour patterns as the plans E, F, G, and H in Fig. 63 (p. 69). The combination in stripe form of the designs E, F, G, and H, Fig. 74, will therefore also produce the pattern shown in Fig. 66. The flat views given in Fig. 76 respectively correspond with the designs similarly lettered in Fig. 74, while the section below each flat view shows the interweaving of the picks 1 and 2. As the drawings given in Fig. 65 correspond in the same manner with the designs E, F, G, and H in Fig. 63, the two Figs. 65 and 76 also afford a means of comparing the two systems. It will be noted that in both cases the order of wetting—viz., 1 dark, 1 light—and the positions of the backing picks are the same. The difference is in the arrangement, first of the ends, and second of the weaves; the latter necessarily requiring to conform with the arrangement of the ends. In the first system the order of warping is 1 dark, 1 light throughout, and 2 face or 2 backing ends are brought together where a change in the pattern is made. In the second system, on the other hand, the order in the warp is 1 face, 1 back throughout, and 2 dark or 2 light ends are brought together at each change of the pattern. Thus, in producing a pattern in 4 dark, 4 light colouring on both sides of the cloth, in the first system the ends in the order of 1 dark, 1 light are arranged 1 face, 1 back for 4 times, and 1 back, 1 face for 4 times, as shown at H in Figs. 63 and 65; while in the second system the ends in the order of 1 face, 1 back are arranged 1 dark, 1 light for 4 times, and 1 light, 1 dark for 4 times, as shown at H in Figs. 74 and 76.

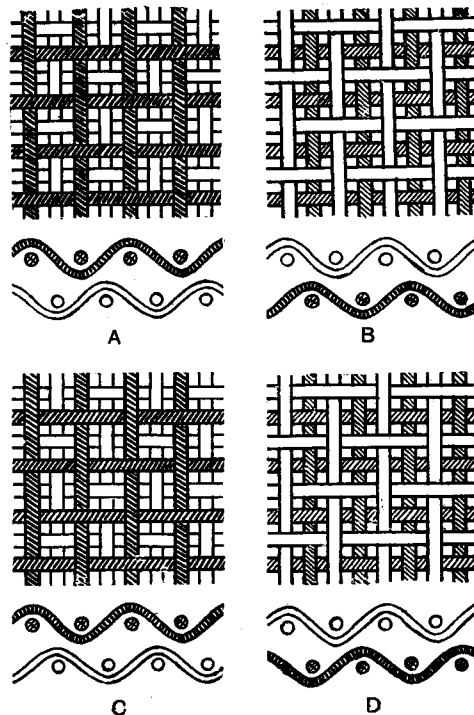
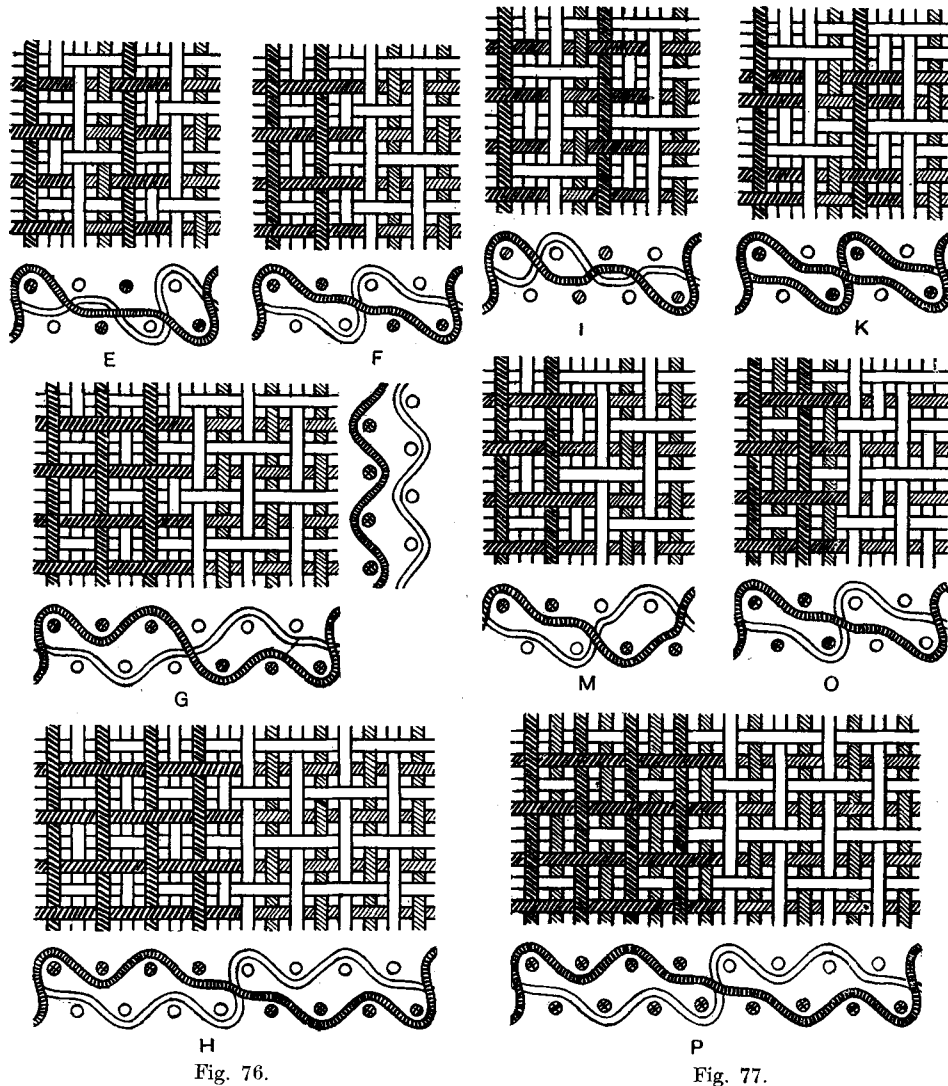


Fig. 75.

The advantages of the second system of constructing stripe patterns are:—(1) A more even cloth results, because the bringing of 2 face or 2 backing ends together is avoided. (2) The production of more than a float of three where the weaves join is impossible if each pick, when on the surface, interweaves only with its own colour of warp. (3) If necessary the weaves can be arranged to cut where the interchange takes place. For worsted cloths this is a better method than joining the weaves, so long as the cutting does not occur too frequently, as the pattern is thus brought out smart and definite. Cutting in small sections and several times in succession, however, should usually be avoided, as it is liable to produce a ribbed cloth and to cause hardness of handle, this being particularly the case in woollen cloths.



*Cutting and Joining the Weaves.*—In E, F, G, and H, Fig. 74, the weaves are arranged to cut at each change of the pattern, as is distinctly shown in the top portions of the designs. In each case, however, the weaves may be arranged without the cutting, or to cut at one change and not at another. Thus the design I shows



how the vertical hairline may be obtained with the weaves cutting every 4 ends, instead of every 2, as in the design E; while J shows how the same effect may be formed without the weaves cutting. The flat view given at I in Fig. 77 corresponds with the design I, while the section below shows the interweaving of the picks 1 and 2. The most common method of producing the single-thread vertical hairline, with the

weaves cutting every four ends, is illustrated by the design K in Fig. 74, and the drawings shown at K in Fig. 77. In this case, while the arrangement of the warp colouring is the same as that for the designs E, I, and J, the threads interlace in the same order as in the design F. The wefting, however, is changed to 2 dark, 2 light, hence the pattern may be produced in looms with changing boxes at one end only. Design L in Fig. 74 shows how the two-thread stripe pattern may be formed with the weaves cutting every 8 ends, and M without the weaves cutting, the colour effect in each case being the same as that produced by the design F. The flat view and the section showing the interweaving of the picks 1 and 2, given at M in Fig. 77, correspond with the design M in Fig. 74.

*Methods of Colouring the Backing Ends.*—If the plans E to M in Fig. 74 are carefully analysed and compared with the corresponding drawings, it will be seen that each colour of weft interweaves only with its own colour of warp, and solid lines of colour are formed on both sides of the cloth. It will also be seen that with the warp colours arranged on the principle indicated below the designs E to M, the pattern on the underside of the cloth is exactly the reverse of that on the face, which in many cases is a distinct advantage. If, however, the colour pattern on the underside is of little or no importance, the backing ends may be in either dark or light, or practically any colour, since these ends remain on the back all the time, while the face ends are continuously on the face, as shown in the section alongside the flat view given at G in Fig. 76. In such a case, therefore, so long as the face ends are arranged as to colour in accordance with the form of the pattern which is required on the surface, the order of warping may be materially simplified by colouring the backing warp in sections to conform with the face order of colouring. For example, the design given at H in Fig. 74 will produce the pattern 4 dark, 4 light on the surface, if the face ends are arranged in the order of 4 dark, 4 light, as shown at N. So far as regards the face of the cloth, the complete warping plan may therefore be 8 dark, 8 light, as shown at O, which is a simpler arrangement than the warping order which is necessary in order that the face and back will be alike. In the same manner the warping plan for the 2-dark, 2-light stripe produced by the design F may be 4 dark, 4 light, and for the 3-dark, 3-light stripe produced by the design G, 6 dark, 6 light. Again, assuming that the dark shade of warp is cheaper than the light shade, the warping plan for the design H may be as indicated at P, the more expensive yarn thus being used economically. The backing warp may also be in a different colour from either of the face warp colours, and it may be different in thickness. The weft, however, should be in the same colours as the face warp, and similar in thickness, and it is usually an advantage to insert more picks than ends per inch, as greater solidity of colouring is thereby obtained. The flat view of the design F, with the warp colours arranged 4 dark, 4 light, is given at O in Fig. 77, while the section shows the interweaving of the picks 1 and 2. In the same manner the drawings given at P in Fig. 77, correspond with the design H in Fig. 74, the warp colours being arranged in the order shown at P. If the drawings given at F and H in Fig. 76 are compared with O and P in Fig. 77, it will be noted that on the face the patterns are respectively the same, the change in the warping plan simply affecting the underside, where an intermingled colour effect is produced.

*Method of Designing Stripe Patterns.*—The method of constructing a stripe design is illustrated at Q, R, S, T, U, and V in Fig. 78. It is assumed that the ends are

arranged 1 face, 1 back, the picks 1 dark, 1 light, and that the pattern to be formed on the surface of the cloth is 3 dark, 2 light, 3 dark, 1 light, 2 dark, 1 light. The position of the backing ends, the order of wefting at the side, and the face warping plan below the ends, are first indicated, as shown at Q. The complete order of colouring the ends may afterwards be arranged, as described with reference to the weave H,

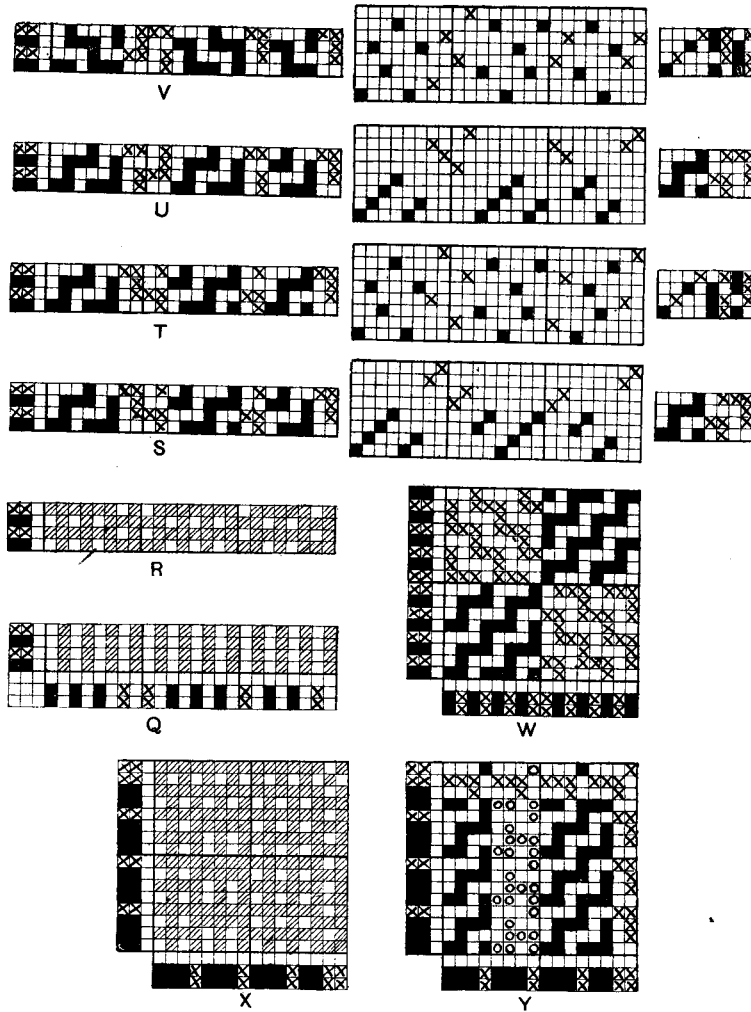


Fig. 78.

Fig. 74, according to the effect which is required on the underside. R shows the positions of the backing picks which are indicated—in the dark sections on the light picks, and in the light sections on the dark picks. The blank squares show where the face ends and face picks intersect, and it will be noted that a dark end intersects a dark pick, and a light end a light pick. Each colour of weft is thus arranged to interweave on the face only with its own colour of warp; and, if the

weave A or C, Fig. 74, is inserted on the dark sections, and the weave B or D on the light, the required colour pattern will be formed on the surface of the cloth, although, as experiment will show, the weaves may be combined in many different ways. S shows the weaves arranged to cut at each change of the pattern, while in T a cut is made only at each side of the 3's of dark colour. U shows another arrangement with the weaves cutting at each change, and V with the cutting as at T. Other combinations may be made which will produce the same colour pattern on the surface, but one of the chief objects to note in arranging the weaves is the simplification of the drafting.

The respective drafts are given alongside the designs S, T, U, and V, and the weaving or pegging plans on the right of the drafts, the marks indicating healds down. Two sets, of four healds each, are required in each case, but while in the drafts for S and U the front four healds produce the dark sections of the pattern, and the back four healds the light sections, the drafts for T and V are arranged with the face threads drawn on the front four healds, and the backing threads on the back four healds. The draft for S is the simplest arrangement, because not only are the mails per unit space of the healds in each set the same, but the order in which the threads are drawn in can be readily followed. The order of drafting is 1, 2, 3, 4, throughout, a change from one set of healds to the other being made at each change of colour. In the draft for the design T a definite system is also employed for the simplification of the drawing-in. Thus, the dark face ends are on the odd healds, and the light face ends on the even healds of the front set. The first heald of the front set is followed by the first heald of the back set, the second by the second, and so on. Further, in the case of tappet shedding, the design and the draft may, with care, be made to conform with any given weaving plan. For example, if the threads 19 to 22 of the draft for the design S are drafted 1, 2, 3, 4, instead of 3, 4, 1, 2, the lifting plan for S will produce the design T. The design U may be taken to illustrate a defective combination of the weaves to fit a given weaving plan. In this case with the lifting plan the same as for S the draft is unsatisfactory, because not only is it difficult to follow, but there is an extreme variation in the setts of the healds.

*Construction of Double Plain Check Patterns.*—The method of arranging the colours and the weaves for producing a *check* pattern in sections of 4 dark, 4 light colouring on both sides of the cloth is illustrated by the design W in Fig. 78. The order of colouring in the weft is the same as that in the warp—viz., 1 dark, 1 light for 4 times, and 1 light, 1 dark for 4 times. The pattern is obtained by the interchanging of both the warp and the weft threads.

Examples X and Y in Fig. 78 illustrate the construction of a large check pattern in which the effect is due to lines formed in a single thread of one of the colours. The order of colouring in both warp and weft is 3 dark, 1 light for as many times as required, and 2 dark, 2 light. In X the positions of the backing ends and picks are indicated by the shaded lines, and in Y the different weaves by different marks. Any size of check may be obtained by repeating the ends and picks 1 to 8; while the repetition of the ends and picks 9 to 16 will enable variety of effect to be formed by the introduction of two or more of the single lines of colour. The binding of the large section of solid colour is effected by two out of each four picks passing alternately from one side to the other in the manner illustrated by the example given at O in Figs. 71 and 72.

**Double-Plain Effects in Three and Four Colours.**—As there are only four picks in the repeat of the double-plain weave, the limit as to the number of colours which can be introduced is four, if each line on the surface is required to be solid in colour. If one colour is brought to the surface for two or more consecutive threads, in order to form a plain weave there must be at least two picks of that colour out of the four in the repeat of the wefting plan. Hence, in such a case, the limit as to the number of colours is three, of which two must form single lines of colour.

In the designs given in Figs. 79 and 83 the weave marks indicate weft, and the differently coloured threads are represented by different marks along the bottom and at the side of each plan. In the bottom portion the shaded squares show the position of the threads when on the underside. In the centre portion the marks which indicate where the weft passes over the face ends correspond with the marks which are used to represent the colours; the diagonal marks indicate the backing weave, and the dots the backing ends down on the face picks. In the top portion a different kind of mark (corresponding with that used to represent the colour) is employed for the purpose of indicating the surface colour of each section of the pattern.

Flat views and sections showing the interweaving of the threads are given of the majority of the designs; and in order that comparisons between them may be readily made, the threads in the diagrams are shaded in different ways to represent the colours. The colours are also indicated by numbers—shade 1 corresponding with the full squares on the point paper, shade 2 with the circles, shade 3 with the crosses, and shade 4 with the vertical lines.

*Four Shade Effects Coloured 1-and-1 in the Warp.*—The designs A and B in Fig. 79, and the corresponding drawings, similarly lettered, in Fig. 80, will serve to illustrate the method of producing patterns in four colours in the system of arrangement in which two face or two backing threads are brought together where the weaves interchange. The shades in the warp are arranged in the order of 1, 2, 3, and 4 throughout, and in A the wefting is in the same order. The weave in section 1 of A brings the odd ends and picks in shades 1 and 3 to the surface, while the even ends and picks in shades 2 and 4 pass to the underside. Each face end floats under its own colour of weft and over the other colours, vertical lines in shades 1 and 3 being formed on the face. The weave in section 2 of A brings the even ends and picks in shades 2 and 4 to the surface, while the odd ends and picks in shades 1 and 3 pass to the underside. Again each face end floats under its own colour of weft and over the other colours, with the result that vertical lines in shades 2 and 4 are formed on the face. The complete pattern produced on the surface by the design A is a single thread stripe with the shades arranged in the order of 1, 3, 1, 3, 2, 4, 2, 4. By combining four threads of section 1 with four threads of section 2, the single thread vertical hairline in four colours is formed.

The design B in Fig. 79 is exactly the same as the design A, except that in the weft the shades 2 and 4 are reversed in order that they will occupy different positions in relation to the corresponding shades in the warp. An examination and comparison with the drawings given at B in Fig. 80 will show that in section 3 each face pick passes under its own colour of warp and over the other colours, with the result that horizontal lines in shades 2 and 4 are formed on the surface. In the same manner, if the shades 1 and 3 are reversed, section 1 will produce horizontal lines. The complete effect produced on the surface by the design B

is a stripe arranged—one of shade 1, one of shade 3, one of shade 1, one of shade 3, and four of the horizontal hairline in shades 2 and 4.

With regard to the underside of the cloth, an examination will show that in A, section 1 produces a horizontal hairline in shades 2 and 4, and section 2 a similar effect in shades 1 and 3; while in B, section 1 produces a vertical hairline in shades 2 and 4, and section 3 a horizontal hairline in shades 1 and 3.

It is evident from the foregoing that with the warp arranged 1-and-1 throughout in four shades there is considerable scope for producing variety of pattern in stripe form by varying the spaces occupied by the

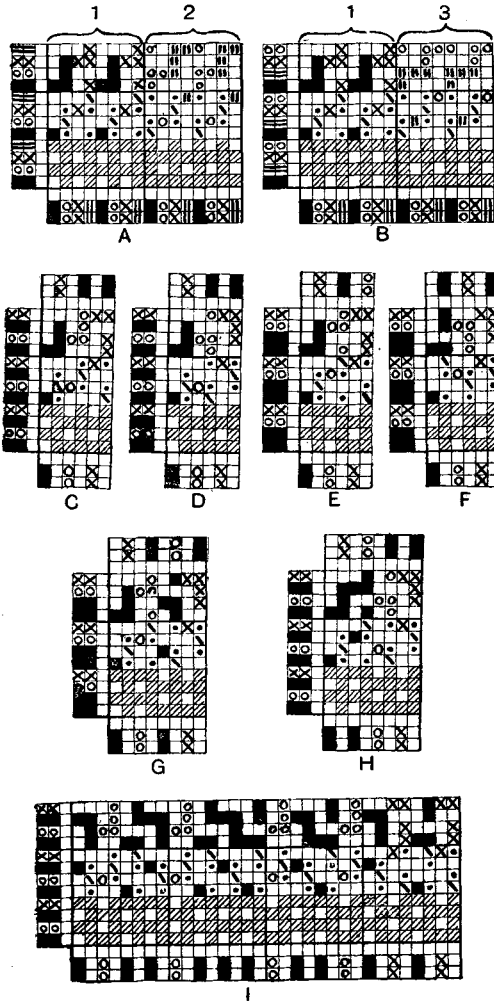


Fig. 79.

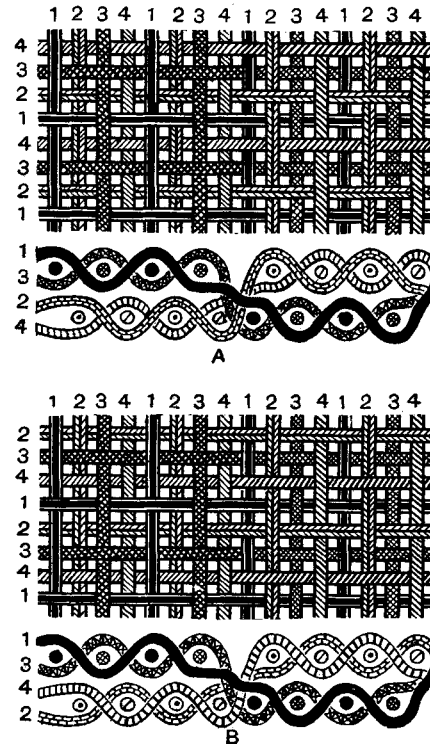


Fig. 80.

weaves and by changing the order of wefting. The weaves may also be arranged and combined to form figured styles in which the pattern is due not only to contrast in colour, but the direction of the lines of colour may be varied as desired. Three-colour effects may be obtained by employing the same shade for all the odd or for all the even threads.

Stripe patterns in three and four colours are usually produced in the system in