

will be understood from the examples in elementary weave compounds illustrated in Figs. 57, 58, and 59. The textural effects A, B, C, D, E, F, and G in the respective specimens, are the result of using specially contrived weaves or crossings to develop pattern or design elements as distinct from a simple scheme of cloth structure. The range of such "weave" factors is very extensive. The effects in these styles have been woven in fine woollen yarns, and therefore are not so clearly defined as if they had been woven in Botany worsted warp and weft; but still they are sufficiently distinct and dissimilar in character as to show that "weave" is a valuable feature in relation to design developed in the loom. It is not, however, in that sense in

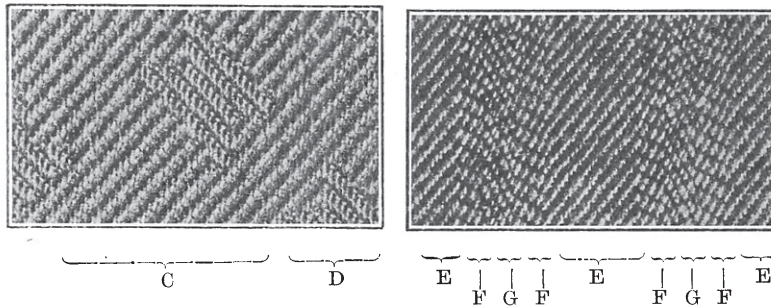


FIG. 58.

FIG. 59.

which it has now to be considered and is of chief importance. Weaves here are mainly applicable and useful in the production of standard cloths, as plans or schemes of interlacing warp and weft yarns to form soundly constructed and firmly-built fabrics. Scope for diversity of textural effects is, as a consequence, narrowed, whereas scope for cloth manufacturing is correspondingly extended.

II. Diversity and quality of texture are obtained in these cloths by (*a*) the selection and blending of raw materials; (*b*) the systems of yarn construction practised; (*c*) scheme of fabric setting; (*d*) methods of finishing; and (*e*) adaptability of the routine of manufacture to the class of cloth required.

III. Standard cloths are grouped into single, backed, and

compound structures, the same type of weave being utilized in each build of fabric. The weaves are changed in structure to give the requisite weight, substance, and character of cloth, but not to acquire pattern or design due either to the interlacing of warp and weft threads, or, with few exceptions, to technical schemes of colouring.

(74) WEAVE NOMENCLATURE AND CLASSIFICATION.

TABLE IV.

On Plates II, III, and IV the principal series of standard weaves are illustrated. They comprise the following types:—

Plate II.—*Single structures* used in the production of such varieties of cloth as are composed of one warp and one weft only.

Plate III (Series I, A to M inclusive).—*Weft-backed structures*, single in the warp and two-fold or two-ply in the weft.

Plate III (Series II, N, O, P).—*Weft-backed structures*, single in the warp and three-fold or three-ply in the weft.

Plate IV (Series I, A to G inclusive).—*Warp-backed structures*, two-fold or two-ply in the warp, and single in the weft.

Plate IV (Series II, H and I).—*Warp-backed structures*, three-fold or three-ply in the warp and single in the weft.

Plate IV (Series III, J to Q inclusive).—*Double-cloth structures*, being composed of two sets of warp and weft yarns, one set being used in the construction of an upper or face fabric, and the other set in the construction of a lower or back fabric. The respective fabrics are regularly stitched or bound to each other in the weaving process.

Plate IV (Series IV, R and S).—*Treble or three-fold structures*, being composed of three sets of warp and weft yarns, the first set being used in the construction of the face fabric; the second set, the centre fabric; and the third set, the underneath or backed fabric. As in double-weave structures, the three distinct textures are systematically stitched together in weaving.

The terminology applicable to the several types of weaves with descriptive data are tabulated below.

(75) SINGLE-WEAVE STRUCTURES.

TABLE V.—PLATE II.

Weave	A—Plain make.
„	B—2/2 warp cord or rep.
„	C—2/2 weft cord or rep. (These weaves—B and C—are made with cords of either warp or weft in different forms, e.g. 3/3, 4/4, etc., or irregularly, e.g. 2/4, 2/6, 3/1, 1/3, etc.)

Weave	D—Prunelle or 2/1 warp-face twill.
„	E—Prunelle or 1/2 weft-face twill.
„	F—2/2 mat, hopsack, or celtic. (See note relative to weaves B and C.)
„	G—2/2 or cassimere twill.
„	H—2/2 twill woven two picks in one shed.
„	I—2/2 twill, cutting 2's in the warp.
„	J—2/2 twill, cutting 2's in the weft.
„	K—2/2 twill, four-and-four "angle" or "herring-bone".
„	L—2/2 twill, four-and-four check.
„	M—3/1 or swansdown twill, warp face.
„	N—1/3 or swansdown twill, weft face.
„	O—3/1 twill, two picks in a shed.
„	P—3/1 irregular swansdown, warp face.
„	Q—1/3 irregular swansdown, weft face.
„	R—Four-shaft twill, composed of 2/2 and 3/1 twills arranged pick and pick.
„	S—Five-shaft doeskin or sateen, warp face.
„	T—Five-shaft doeskin or sateen, weft face.
„	U—Venetian twill.
„	V—Six-shaft sateen.
„	W—3/3 twill.
„	X—3/3 twill, cutting 2's in the warp.
„	Y—Seven-shaft sateen, warp face.
„	Z—Seven-shaft sateen, weft face.
„	A ¹ —Seven-shaft whip-cord twill.
„	B ¹ —Seven-shaft fine twill.
„	C ¹ —Eight-shaft doeskin, warp face.
„	D ¹ —Eight-shaft doeskin, weft face.
„	E ¹ —Buckskin twill.
„	F ¹ —Eight-shaft irregular sateen.
„	G ¹ —Reverse check.
„	H ¹ —Modification of the eight-shaft buckskin.
„	I ¹ —Eight-shaft twilled mat (also constructed on ten, eleven, and thirteen shafts).
„	J ¹ —Mayo.
„	K ¹ —Eight-shaft crape effect, weft face.
„	L ¹ —Broken twilled mat.
„	M ¹ —Four-and-four double-plain check, cutting.
„	N ¹ —Four-and-four double-plain; uncutting.
„	O ¹ —Four-and-four double-plain stripe, cutting.
„	P ¹ —Satarra.
„	Q ¹ —Open texture, or mock gauze effect.

Weave	R ¹ —Cord check.
„	S ¹ —Plain rib.
„	T ¹ —Four-and-four plain rib and weft cord stripe.
„	U ¹ and V ¹ —Whip-cord twills.
„	W ¹ —Nine-shaft fine warp twill.
„	X ¹ —Nine-shaft whip-cord.
„	Y ¹ —Nine-shaft twilled warp cord—warp face. (Also made on seven, eleven, and thirteen shafts with weft face or warp-face twill.)

(76) WEFT-BACKED STRUCTURES.

TABLE VI.—PLATE III—SERIES I.

Weave	A—Cassimere backed with the 3/1 twill, arranged 1 pick face and 1 pick backing.
„	B—Cassimere backed with the eight-shaft sateen, arranged 1 pick face and 1 pick backing.
„	C—Reversible weft swansdown, arranged 1 pick face and 1 pick backing.
„	D—Reversible weft broken swansdown, arranged 1 pick face and 1 pick backing.
„	E—Reversible weft broken swansdown, arranged 2 picks face and 2 picks backing.
„	F—Weft swansdown face and eight-end sateen back, arranged 2 picks face and 1 pick backing.
„	G—Weft swansdown face and eight-end sateen back, arranged 3 picks face and 1 pick backing.
„	H—Reversible five-shaft weft doeskin, arranged 1 pick face and 1 pick backing.
„	I—Reversible five-shaft weft doeskin, arranged 2 picks face and 2 picks backing.
„	J—Reversible weft six-shaft sateen, arranged 4 picks face and 2 picks backing.
„	K—Prunelle twill (warp face) backed with nine-shaft sateen, arranged 1 pick face and 1 pick backing.
„	L—Swansdown twill (warp face) backed with twelve-shaft sateen, arranged 1 pick face and 1 pick backing.
„	M—2/2 warp cord backed with 3/1 twill, arranged 2 picks face and 1 pick backing.

PLATE III—SERIES II.

„	N—Reversible 1/3 twill with plain centre, arranged 1 pick face, 1 pick centre, and 1 pick backing.
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- Weave O—Reversible weft doeskin with prunelle twill centre, arranged 1 pick face, 1 pick backing, and 1 pick centre.
 „ P—Reversible eight-shaft weft doeskins with 2/2 twill centre, arranged 1 pick face, 1 pick centre, and 1 pick backing.

(77) WARP-BACKED AND COMPOUND STRUCTURES.

TABLE VII.—PLATE IV—SERIES I.

- Weave A—Reversible warp prunelle twill, arranged 1 thread face and 1 thread backing.
 „ B—Reversible (irregular) warp swansdown, arranged 1 thread face and 1 thread backing.
 „ C—Cassimere twill face 1/3 twill back, arranged 1 thread face and 1 thread backing.
 „ D—Cassimere twill face, sateen back, arranged 1 thread face and 1 thread backing.
 „ E—Reversible warp prunelle twill, arranged 2 threads face and 1 thread backing.
 „ F—Cassimere twill face 1/3 twill back, arranged 2 threads face and 1 thread backing.
 „ G—Reversible warp doeskin, arranged 2 threads face and 1 thread backing.

PLATE IV—SERIES II.

- Weave H—Reversible warp swansdown with plain centre, arranged 1 thread face, 1 thread centre, and 1 thread backing.
 „ I—Reversible eight-shaft warp doeskin with 2/2 twill centre, arranged 1 thread face, 1 thread centre, and 1 thread backing.

PLATE IV—SERIES III.

- Weave J—Double plain, arranged 1 thread face and 1 thread backing in both warp and weft.
 „ K— „ prunelle, arranged 1 thread face and 1 thread backing in both warp and weft.
 „ L— „ swansdown (warp surface), arranged 1 thread face and 1 thread backing in both warp and weft.
 „ M— „ cassimere, arranged 1 thread face and 1 thread backing in both warp and weft.
 „ N— „ five-shaft doeskin (warp surface), arranged 1 thread face and 1 thread backing in both warp and weft.
 „ O— „ prunelle, arranged 2 threads face and 1 thread backing in both warp and weft.
 „ P—Cassimere face and plain back, arranged 2 threads face and 1 thread backing in both warp and weft.
 „ Q—Double doeskin, arranged 2 threads face and 1 thread backing in both warp and weft.

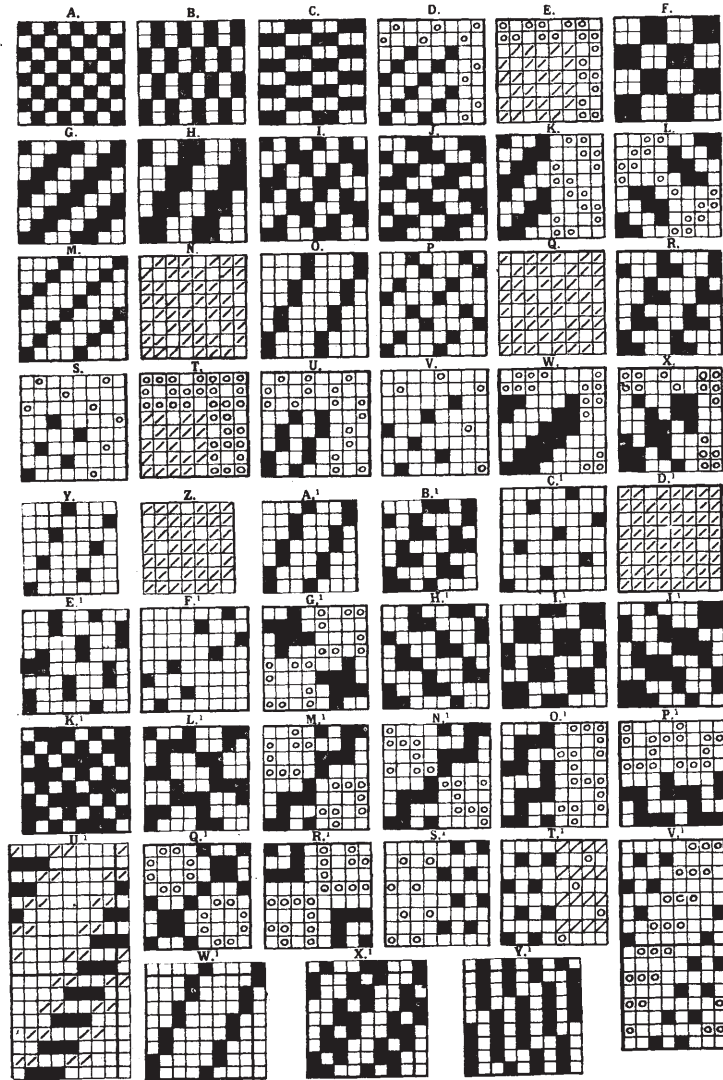


PLATE II.—Standard weaves. Single structures. (For description and names of the weaves, see Table V.)

PLATE IV.—SERIES IV.

- Weave S—Cassimere twill face and back and plain centre, arranged 1 thread face, 1 thread backing, 1 thread face, 1 thread backing, and 1 thread centre.
- „ R—Three-fold cassimere, arranged 1 thread face, 1 thread centre, and 1 thread backing.

(78) SOUNDNESS OF FABRIC STRUCTURE.

The simplest weaves, of which the plain and 2/2 twill (A and G, Plate II) are most commonly used, give the firmest, soundest, and most satisfactorily-balanced woven structures. The warp and weft yarns are equally useful in forming the face and reverse sides of cloths in which they are the schemes of intertexture. It follows that, should the same yarns as to materials, methods of construction, and counts, be employed for both warp and weft, the fabric produced would, when tested, register the same results as to tensile strength and elasticity in length and width. This rule is also common to all fabrics made from weaves identical in interlacings in both the warp and weft threads such as Plans F, G, and W and other ordinary twills and mats.

Cloth variation is obtainable in weaves of this class by the following methods :—

A. By modifications in the relative qualities of the materials used for warp and weft.

B. By modifications in the relative counts of the warp and weft yarns.

C. By modifications in the relative numbers of threads and picks in the fabric in the loom.

D. By modifications in the relative degrees of shrinkage on the width and length of the piece in milling.

E. By modifications in the relative degrees of raising on the width and length of the piece.

Considering each group of modifications briefly, under system A, the warp yarns may be of a different quality to the weft to produce a cloth of some specific character, or the weft may be reduced in quality to obtain a cloth of a definite weight at a fixed price; under B, for the latter reason, a thicker counts of weft may be used than warp; under C, the picks may be less

than the threads per inch, effecting economy in weaving. Each of these methods may be thus practised to alter the substance or diminish the cost of production; but, in the first place, without so far varying the style of cloth made as to change its standard of classification; and, in the second place, to produce different groups of standards—beavers, meltons, and costume cloths being developed in both plans A and G according to the manufacturing data utilized under these several systems of fabric modification.

In regard to practice D, it may be applied to yield substance or thickness by felting on either the warp or the weft; or to produce such thickness by equal shrinkage on both the length and width of the piece; and, in a third instance, it may be so adjusted that the ratio of threads to picks per inch will differ from those in the loom production. Assuming, for example, that weave A were used in making a texture with 32 threads and 28 picks per inch, then by felting $\frac{1}{8}$ th more in the warp than the weft, the finished cloth would test practically the same number of ends and picks on the square. This method of fabric modification is also adopted for increasing the tensile strength on the warp or weft line of the piece, and for developing a warp surface by securing a higher degree of weft than warp shrinkage, bringing the warp threads into closer or more compact relation.

Alluding, lastly, to system E, it is somewhat limited in application, but it is of utility in the manufacture of "face" cloths. Thus, when a fibrous surface with a "draw" of fibres in the direction of the warp threads has to be developed, it is the practice to raise with increased keenness on the warp and lesser keenness on the weft line; but if, as in meltons, no "draw" of fibres is required, then "cross" or weft raising may be done to a similar degree as warp or length raising. There are many degrees of raising between these two extremes which are efficient in imparting quality and character to the cloth.

(79) CHANGES IN WEAVE STRUCTURE TO IMPROVE THE TENSILE STRENGTH OF THE FABRIC (Plate II).

In standard cloths, in which it is required to develop tensile strength in either the warp or weft, without any change in the

yarns or routine of manufacture, the number of interlacings may be increased on certain threads or picks of the standard weave. For instance, Weaves I and J (Plate II) are both used in the construction of melton cloths and of the same weight and quality as obtainable in the 2/2 twill, Weave G. These results are, necessarily, only feasible when the surface of the cloths are covered with filament concealing the interlacings of the weaves. Comparing the three plans, the intersections on the *threads* in G are the same as in I but different in the picks; similarly the intersections on the *picks* in G are the same as in H, with a difference on the threads. Alternate *picks*, 2, 4, etc., in I, have double the number of interlacings as corresponding picks in G; and alternate *threads* 1, 3, etc., in H, have double the interlacings as identical threads in G. Applying the rule, the more frequent the intersections the firmer the build of the fabric—providing the setting and picks per inch of the weaves compared are alike—then the relative firmness of structure of the cloths resulting from Weaves G, I, and J would differ as follows:—

Weave G would yield a fabric of corresponding firmness of structure in both warp and weft;

Weave I would yield a fabric of similar structure to G in the *warp*, but of a firmer structure in the *weft*; and

Weave J would yield a fabric of similar structure to G in the *weft*, but of a firmer structure in the *warp*.

It should be noted that the adjustment of the relative shrinkages on the length and width of the piece, to secure increased firmness in either one or the other line of the fabric, would not give corresponding results in degrees of breaking strain to those obtainable by the technical changes determined by weave structure.

(80) WARP AND WEFT-FACE WEAVES (Plate II).

These form an important class of weaves. In the simple makes D and E, M and N, P and Q, S and T, Y and Z, and C¹ and D¹, there is only one thread depressed, or one thread lifted, on each pick of the weave; hence plans D, M, P, S, Y, and C¹ produce *warp-face* fabrics (i.e. a preponderance of *warp* on the

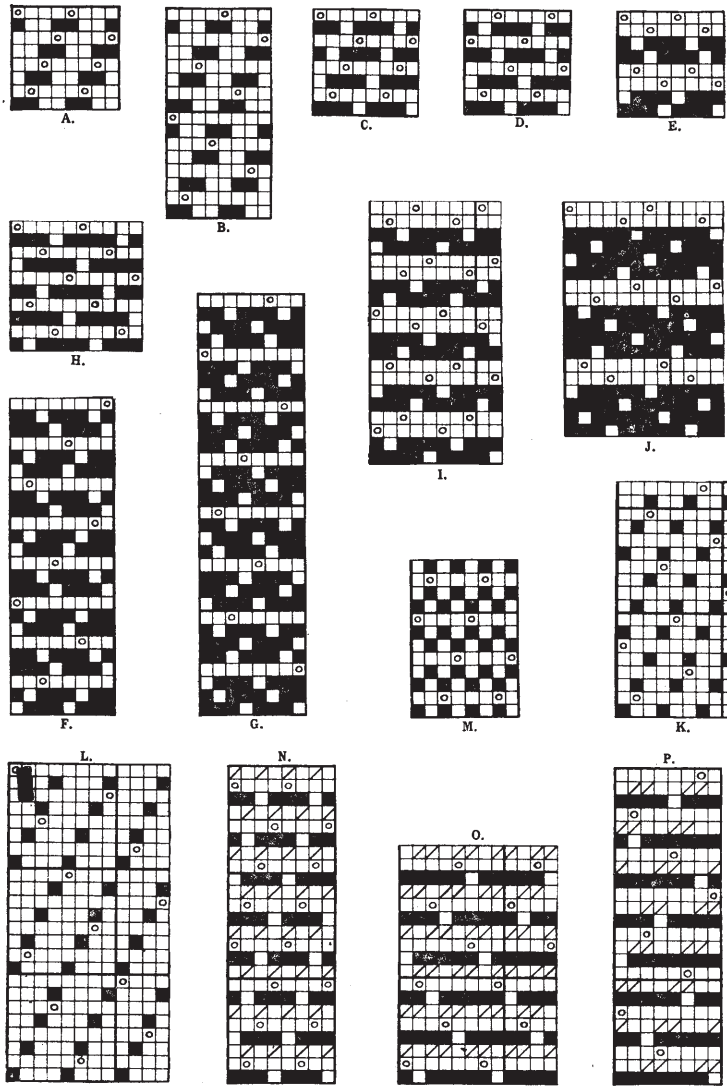


PLATE III.—Standard compound weaves. Weft-backed structures. (For descriptions, see Table VI.)

Sign equivalents:—

Solid squares = Face weave.

Circles = Backing weave and stitches or binding places on the backing picks.

Diagonal marks = Centre weave in Plans N, O, and P.

surface of the cloth) ; and plans E, N, Q, T, Z, and D¹ *weft-face* fabrics (i.e. a preponderance of *weft* on the surface of the cloth). The former are used in the manufacture of standard woollen fabrics. With the exception of Plan D—applied to light costume textures—they are used in the construction of face cloths in which the lustrous pile of filament is developed by raising on the *warp* and not on the *weft* yarns. Plans S, Y, and C¹ are the standard weaves for doeskin and beaver cloths single in structure. The irregular sateens on six and eight shafts, V and F¹, each yield a surface of cloth well adapted for this style of finish.

In applying weaves of this description, seeing the *weft* appears in a lesser degree on the face than on the reverse side of the fabric, this yarn may, without detriment to the appearance of the texture, be of a lower quality and somewhat thicker in counts than the *warp* yarn. The *weft* in such manufactures should be a soft spun thread to give fullness of handle to the cloth, and also expand the felting property of the piece.

In a second type of *warp-face* weaves the proportion of *warp* to *weft* is increased, but not to such an extent as to cause the *weft* to be a feature of the face of the cloth. Weaves used in the production of woollen and worsted whip-cords, Venetians, fine twills and buckskins (Plans O, U, A¹, E¹, and W¹) are of this class.

Weaves R, B¹, and X¹ are also applicable to whip-cord textures, but they are constructed to afford some prominence to the *weft* as well as the *warp* in the fabric.

(81) ANGLED AND CHECKED TWILLS: MATS (Plate II).

Angled-twilled stripes and checks are not utilized in the manufacture of any particular class of standard cloth, but occur in such a variety of forms in different makes of woollens, worsteds, and unions, as to be comprised in the category of standard weaves. The two examples given—(Plans K and L) are the most elementary types. By systems of drafting or extension of each section of the weaves, that is, by increasing the number of threads in each stripe of weave K, and both the threads and picks in the four sections of L, enlarged and

diversified effects are producible. The twills so treated being equal, or balanced, in warp and weft intersections, the cloths woven are correctly constructed. They are developed in Saxonies, Cheviots, Botany's, and Crossbreds in suiting and costume textures.

Twilled mats and weaves of a similar structure, such as the Mayo, have, like angled-twilled compounds, numerous applications, but, as in the preceding examples, they are not applied to any specific type of cloth which is definable as a "standard". Chiefly suitable for worsted warp and weft fabrics, they are developed in a wide range of piece-dye and mixture coatings, suitings, and costumes. In the latter by employing a fine Saxony yarn for weft and two-fold Botany worsted for warp, provision is made for some degree of felting and damp raising in finishing, but not of such a nature as to cause the weave effect to be too subdued to form a characteristic feature of the face of the texture.

(82) DOUBLE PLAINS ($M^1 - O^1$, Plate II).

Double plain makes are extensively employed in woollen cloth manufacture. They are applied to different qualities and counts of yarns and settings in (1) the production of face cloths, light, medium, and heavy in weight; (2) clear-finished cloths in similar grades; (3) rough fibrous cloths of the melton and overcoating class; and (4), in the worsted trade, in the making of Vicuna coatings and suitings in which no weave effect is traceable but a soft, short pile of filaments raised on the face of the fabric.

Features common to all cloths acquired in these weaves are firmness of structure and fineness of surface. When modified, or combined in stripe sections, e.g. Plan O^1 , the weaves are applicable to the several groups of standard hair-line cloths, which are manufactured in both woollen and worsted yarns in various grades and qualities.

Weave O^1 is used in producing in worsted yarns—top or piece-dye fabrics—small line effects resembling the stocking-ette pattern, and weave P^1 —which is O^1 inverted—is one of the standard makes for the Satarra, a fine woollen cloth.

(83) REPS OR CORDS AND CORD TWILLS (Plate II).

The former, as observed from the Bedford cord (Fig. 42), comprise a group of standard woollen cloths. Other weaves of a more elementary type than Fig. 43 are employed in the construction of this class of fabric, such as Plans S¹ and T¹, but the cord feature does not possess that clearness of definition which characterizes Fig. 42, and which is due to the interlacing threads B, B¹ in Fig. 43.

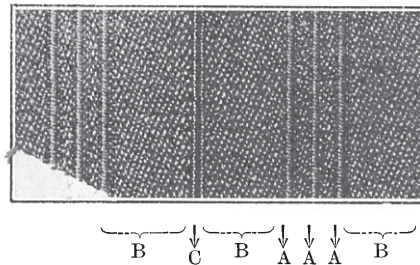


FIG. 60.—Composed of plain rib, warp twill, and weft cord.

The ordinary types of these weaves are classified into plain ribs (Plan S¹), rib and weft cord (Plan T¹), and rib and twill. These standard effects are combined in Fig. 60—design Fig. 61—parts A being plain rib, parts B, weft cord, and parts C buckskin twill.

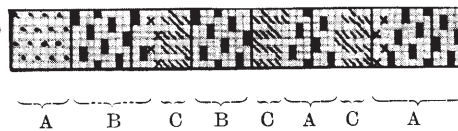


FIG. 61.—Sectional plan for fig. 60. A = plain rib; B = warp twill, repeated to give dimensions of stripe required; C = weft cord.

Ordinary rep or cord weaves are extensions of the plain make, as, for example (a) in the picks, and (b) in the threads, giving the simplest form of cords, or plans B and C. When the base or fundamental weaves are enlarged to floats of 3, 4, etc., in either warp or weft, and arranged in twill order, they constitute twilled cords. Plan Y¹ is a 9-shaft “warp” twilled cord, derived from the warp cord four picks in a shed. If in-

verted, and warp threads substituted for weft picks, it becomes a twilled "weft" cord. The weft does not show on the face of the fabric in the former, nor the warp in the latter;—a feature

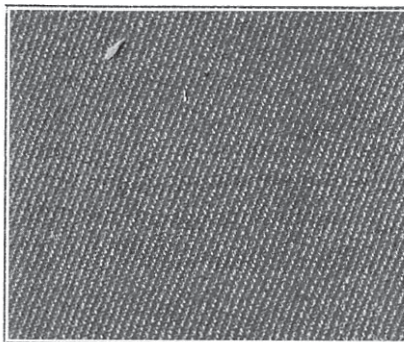


FIG. 62.—Fine twist-warp whip-cord.

in which such twills resemble the original or base weaves utilized in their construction.

Whip-cord twills, to which allusion has been made, vary in

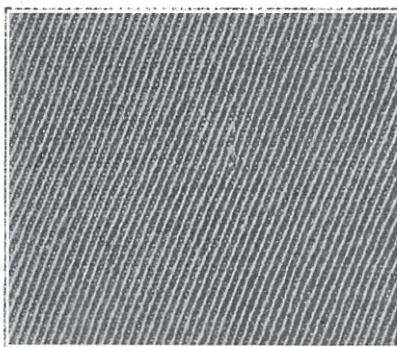


FIG. 63.—Nine-shaft whip-cord twill.

clearness and definition of effect and also in ribbed characteristics.

Three typical fabrics of this class, woven in 7 and 9 shaft weaves—are illustrated in Figs. 62, 63, and 64. They have been produced in the Plans A¹, X¹, and U¹ on Plate II. Fig. 62

is also producible in weaves of the B¹ type constructed on 7 or 9 threads and picks, and, in a simpler texture, in the 4-shaft twill, Plan R. For finer cord twill effects, in which the warp threads conceal the weft threads, such weaves as E¹ and W¹ are suitable.

Small diagonal patterns are classed in the dress trade as whip-cords. These are developed in various styles on 8, 9, 10, and 11 shafts. One typical example is given in Plan V¹. It consists of three distinct twills composed of warp, weft, and of a warp-and-weft twill in which the two yarns intermingle. If, for example, this plan should be woven in a light-

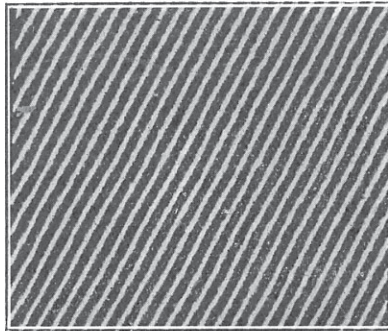


FIG. 64.—Whip-cord twill with pronounced warp and weft effects.

grey warp, and black weft, the twills marked in blank squares would be formed in light grey; the twills in circles in black; and the twills in solid squares in the two shades interlacing plain.

(84) COMPOUND STRUCTURES (Plate III).

Compound textile structures result from the use of a combination of two or more single-weave elements, each forming a specific method of interlacing warp and weft yarns, and producing a distinct texture or woven surface. Such structures consist of two or several (as a rule not exceeding three) layers of threads composing separate fabrics and bound or stitched uniformly to each other.¹

The elementary weaves are convertible into these fabric structures by three methods, viz. :—

¹ See Chap. XIII in "Woollen and Worsted," by the same Author.

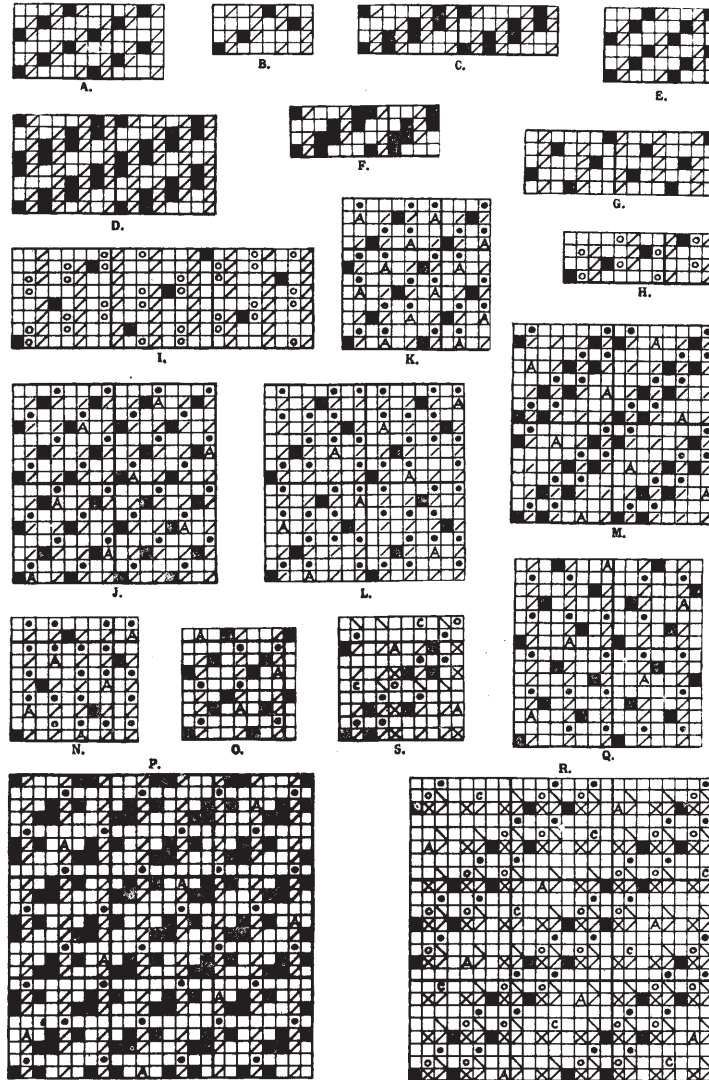


PLATE IV.—Standard weaves. Warp-backed and compound structures.
(For description of the weaves, see Table VII.)

Sign equivalents:—Solid squares = Face weave in all plans. Dots = Backing weave in Plans J to S. (1) Diagonal marks to the right = Backing warp threads depressed, forming the backing weave in Plans A to I. (2) Diagonal marks to the right = Backing warp threads depressed on the face picks in Plans J to S. Diagonal marks to the left = Backing warp threads depressed on the centre picks of Plans R and S. Circles = Centre weave in Plans H, I, R, and S. Crosses = Centre warp threads depressed on face picks in Plans R and S. (1) A = Backing warp threads raised over face picks for tying in Plans J to Q. (2) A = Centre warp threads raised over face picks for tying the centre texture to the face fabric in Plans R and S. C = Backing warp threads raised over centre picks for tying the backing texture to the centre fabric in Plans R and S.

1. They may be rendered compound in the *weft*, consisting of one series or group of warp threads interlacing with two or more groups of weft threads, and yielding face, intermediate, and back textures.

2. They may be rendered compound in the *warp*, consisting of two or more series or groups of warp threads interlacing with one group of weft threads, and forming face, intermediate, and backing textures.

These two schemes of compound structures are the reverse of each other in the arrangement of warp and weft yarns, but correspond in principle of construction.

3. They may be rendered compound in both warp and weft, consisting of two or more series or groups of *warp* and *weft* threads, each separate weft interlacing with a separate warp, and producing a distinct fabric, namely face, intermediate, and back textures, which, in weaving, are united into one and the same compound structure.

Each scheme is utilized in cloth manufacturing. First, facilities are thus afforded for acquiring novelty in weave design and pattern work of a colour description;¹ and, second, for variations in fabric build. In standard manufactures, compound weave structures are mainly applied for the latter purpose. Here they are employed (*a*) for modifying the weight per yard of a fabric or for converting a thin, light, single texture into a cloth of the same or similar surface features, but heavier in construction; (*b*) in producing reversible cloths or fabrics with the same weave element on both sides, and composed of the same or dissimilar counts and qualities of yarns; and (*c*) in reducing the cost of manufacture by applying yarns of an inferior quality, to the intermediate and back textures in the compound structure, to those employed in the production of the face fabric.

Examples in each of these applications will emphasize the technicalities defined.

(*a*) Taking a typical problem, a solid twill worsted (Fig. 105), made of 2-fold 30's warp and weft with 56 threads and 52 picks per inch, indicates 14 oz. per yard. It is required to be changed into a 21 oz. fabric without altering its structure or the

¹See "Colour in Woven Design," by the same Author.

threads and picks per inch. This could be effected in a compound plan, weft, warp, or double in arrangement. Adopting the first method and applying Fig. 105b, if set as follows the required cloth would be obtained :—

Warp : 2-fold 30's worsted.
 14's reed 4's.
Weft : 2 picks of 2/30's worsted.
 1 pick of 15 skeins woollen.
 78 to 80 picks per inch.

Here some 7 oz. per yard are added to the original worsted texture by the supplementary series of 26 picks per inch of 15 skeins backing yarn.

Should Plan F, Plate IV, be utilized the supplementary yarns would be introduced into the warp, changing the set from 56 *threads* and 78 *picks* per inch to 78 *threads* and 56 picks per inch.

(b) In converting "single-weaves" into "reversible" fabrics, three schemes of construction may be analysed, namely :—

I. Single in the warp and 2-fold in the weft, woven 1 pick face and 1 pick backing yarn.

II. 2-fold in the warp and single in the weft arranged in the warp 1 thread face, 1 thread backing, and 1 thread face yarn.

III. 2-fold in both warp and weft, arranged 1 thread face, and 1 thread backing yarn.

I. The first of these principles (Plan D, Plate III) admits of the use of a cotton warp and yet of the formation of a woollen face and backing (see also Figs. 49, 50, and 54), the wefts effectively concealing the warp yarns. A thick union overcoating may be woven in this plan to the following particulars :—

Warp : 2-fold 22's cotton.
 12's reed 2's, 80 in. in the reed.

Weft : 1 pick of 20 skeins dark-grey mixture
 1 pick of 20 skeins medium-gray mixture

} Or all white weft.
 Different qualities
 of yarns are also em-
 ployed for each side
 of the texture.

76 to 80 picks per inch.

For a lower quality of cloth of a different weight the counts of the yarns would be reduced and also the picks per inch, effecting economy in both spinning and weaving.

II. By the second method a fabric of the same features as the above may be obtained but suitable for a cloaking. Using Plan B, Plate IV, a method of manufacture for a heavy fabric is:—

Warp: 1 thread of 14 skeins white,
 1 thread of 14 skeins colour.
 12's reed 5's.
Weft: 2-fold 20's worsted.
 30 picks per inch.

Milling and raising are essential operations in finishing this structure of fabric when woven as here indicated; but this type of weave is also developed in fine cloths with worsted face and backing warps, and woollen weft centre; and manufactured on the following lines:—

Warp: 1 thread of 2/30's medium grey } Or all one shade and piece dyed.
 1 thread of 2/30's dark grey }
 20's reed 5's.
Weft: 22 skeins grey woollen intermediate in shade between the face and
 backing warp yarns.
 44 to 48 picks per inch.

A "clear" finishing routine is practised to give definition to the twill of the weave. The Venetian is used in some cloths, in preference to the sateen, making a smarter weave effect.

III. The third variety of reversibles comprises such weaves as double-plain, double-swansdown, double-cassimere, double-five-end doeskin (Plans J, L, M, and N, Plate IV) and other schemes of intertexture. Whereas, in the two preceding structures, the single weaves must necessarily be of a warp or weft face description, in double-cloth reversibles other varieties of weave are applicable, e.g. warp and weft equally interchanging on both sides of the texture; weft face; warp face; or irregular in arrangement as in Plans R, B¹, H¹, K¹ L¹ and X¹, Plate II.

(c) Compound structures for the reduction of the cost of manufacture, resulting in weaving from a combination of yarns

of different qualities, are either *two-* or *three-fold*. By means of the latter, technical practices are feasible which effect economy in production, with a minimum amount of interference with the face and back of the compound cloth. Weight and strength are in this way obtainable by the centre yarns which neither appear on one side of the fabric or the other. It follows that these yarns may be of an inferior material to the rest of the yarns in the composition of the fabric, and still not be detrimental to either the face or backing textures, as the following example, producible in Plan S, Plate IV, demonstrates:—

Warp : 4 threads of 2/44's worsted.
 1 thread of 20 skeins woollen.
 20's reed sleyed 7's and 8's, 66 in. in the reed.
Weft : 4 threads of 20's worsted.
 1 thread of 18 skeins wool.
 144 picks per inch.

This setting results in a fabric with worsted yarn on the face and back interlacing 2/2 twill, and with a woollen centre texture interlacing plain. Other typical combinations practised comprise — (a) worsted face and back with cotton warp and woollen weft centre yarns; (b) woollen yarns face and back, and cotton yarns for centre; and (c) worsted yarns for face, woollen yarns for back, and cotton yarns for centre.

(85) RATIO OF FACE AND BACKING YARNS IN TWO-FOLD STRUCTURES AND OF FACE, CENTRE, AND BACKING YARNS IN THREE-FOLD STRUCTURE.

Several schemes of grouping the threads and picks of the face and backing, or of the face, centre, and backing textures, in each of these systems of constructing compound woven fabrics, are illustrated on Plates III and IV, and are stated in detail in the following Table:—

TABLE VIII.

SCHEMES OF ARRANGING COMPOUND FABRICS.

A. *Two-fold Structures.*

Applicable to warp-backed, weft-backed, and double- cloth structures.	{	Grouping 1 = 1 thread of face yarn.
		1 ,, ,, backing yarn.
		Grouping 2 = 2 threads of face yarn.
		2 ,, ,, backing yarn.
		Grouping 3 = 2 threads of face yarn.
		1 thread of backing yarn.
		Grouping 4 = 3 threads of face yarn.
		1 thread of backing yarn.
		Grouping 5 = 4 threads of face yarn.
		2 threads of backing yarn.

B. *Three-fold Structures.*

Applicable to warp-backed, weft-backed, and two- and three-fold structures.	{	Grouping 1 = 1 thread of face yarn.
		1 ,, ,, centre yarn.
		1 ,, ,, backing yarn.
		Grouping 2 = 1 thread of face yarn.
		1 ,, ,, centre yarn.
		1 ,, ,, face yarn.
		1 ,, ,, backing yarn.
Adapted mainly to two- and three-fold structures.	{	Grouping 3 = 2 threads of face yarn.
		1 thread of centre yarn
		2 threads of face yarn.
		1 thread of backing yarn.
		Grouping 4 = 1 thread of face yarn.
		1 ,, ,, backing yarn.
		1 ,, ,, face yarn.
		1 ,, ,, backing yarn.
		1 ,, ,, centre yarn.

The applications of these standard yarn groupings to the compound weaves on Plates III and IV comprise:—

A. TWO-FOLD STRUCTURES.

Weft Reversibles.—Plate III, Grouping 1, Plans C, D, and H; Grouping 2, Plans E and I; Grouping 3, Plan F; Grouping 4, Plan G; and Grouping 5, Plan J.

Warp reversibles.—Plate IV, Grouping 1, Plans 4, A, and B; and Grouping 3, Plans E and G.

Double-cloth Structures.—Plate IV, Grouping 1, Plans J, L, M and N ; and Grouping 3, Plans O and P.

B. THREE-FOLD STRUCTURES.

Weft Principle.—Plate III, Grouping 1, Plans N, O, and P.

Warp Principle.—Plate IV, Grouping 1, Plans H and I.

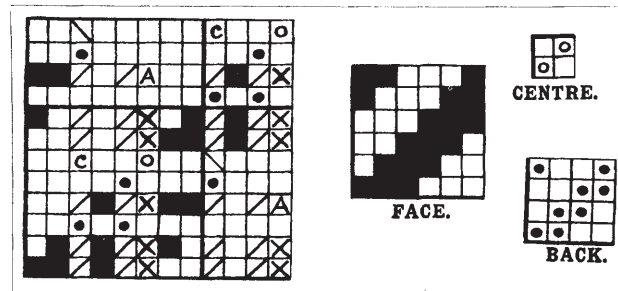


FIG. 65.—Sign equivalents: solid squares = face weave ; dots = backing weave ; circles = centre weave ; crosses = centre threads depressed on the face picks ; diagonal marks to the right and left = backing threads depressed on the face and centre picks respectively ; A = centre threads raised over face picks for stitching the centre to the face fabric ; C = backing threads raised over centre picks for stitching the backing to the centre fabric. *N.B.*—Like signs have the same equivalents in Figs. 66, 67, 68, and 69.

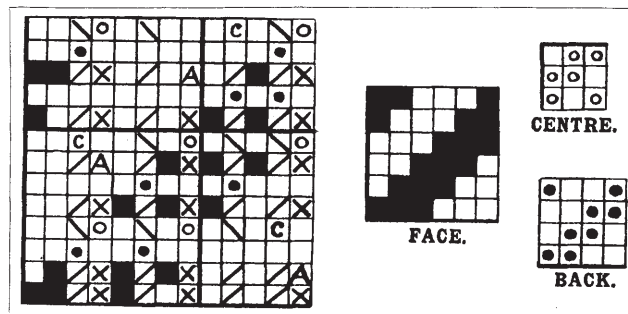


FIG. 66.

Three-fold Fabrics.—Plate IV, Grouping 1, Plan R ; and Grouping 4, Plan S.

Further analysing the yarn groupings tabulated, more particularly in relation to the weaves combined and not to the

counts of yarns usable, groupings 1 and 2 (two-fold structures) are the standardized orders of face and backing yarns, and are applied to *warp* or *weft* weaves. Groupings 3, 4, and 5 in the same series are utilized in the production of cloths woven with a finer face than under surface, and, as seen above, developed chiefly in weaves reversible in the weft (Plans F, G, and J, Plate III), and which are applicable to the inferior qualities of union overcoatings. Neither groupings 2 or 5 are adapted to warp-backed and double structures.

In cloths three-fold in the warp or weft, the centre yarns are faster woven than either the face or backing yarns (Plans

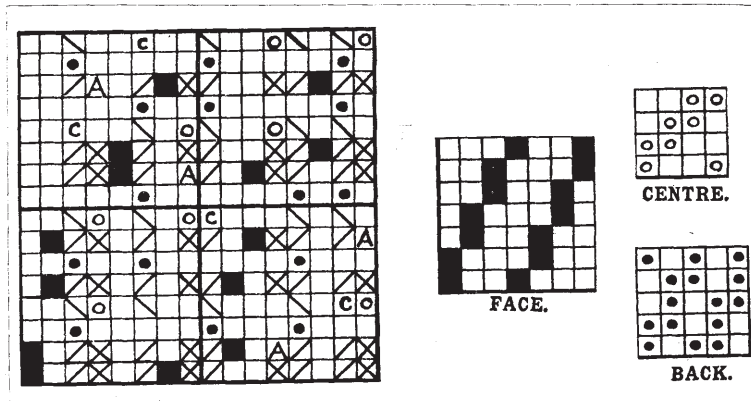


FIG. 67.

N, O, and P, Plate III, and H and I, Plate IV) but in three-fold cloths, the weaves combined must coincide in frequency of interlacings with the proportionate quantities of the three sets of warp and weft yarns, that is, the intersections in the weaves combined should agree with the ratio of the diameter of the yarns composing the face, centre, and backing textures.

Thus in Grouping No. 1 (three-fold fabrics) the weaves should be the same for each of the three cloths, e.g. three plain makes; three prunelle twills, namely 2/1 for face, and 1/2 for centre and back; or three cassimere twills; but in Grouping No. 2—the face yarns being equal in number to the centre and backing yarns combined—a more open weave structure

should be used for the face than the centre and backing textures, e.g. 2/2 twill face and plain weave for centre and back, or 3/3 twill face and 1/2 twill for centre and backing. Grouping No. 3 consists of four threads of face to one thread backing and one thread centre; and Grouping No. 4 of two threads of face and two threads of backing to one thread of centre yarn, so that weaves of the ratio of intersections stated below are accurate for these Groupings:—

- No. 3 = 4/4 twill face, and plain weave for centre and backing.
 No. 4 = 3/3 twill face and backing and prunelle twill for centre.

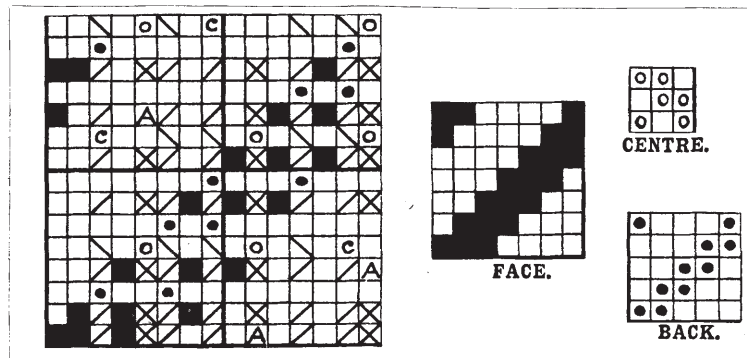


FIG. 68.

Other weaves than those enumerated may be employed in the foregoing examples. The law of intersections should be observed in their selection though, in practice, some latitude is allowed in its application.

(86) YARN GROUPINGS FOR IRREGULAR THREE-FOLD FABRICS.

The three-fold fabrics analysed have, as observed from the groupings of yarns, been of a regular construction, that is, the order of the sets of threads for face, centre, and backing has been uniform throughout the repeat of the compound plan. Certain types of three-ply textures do not admit of this. Being developed from double-make fabrics irregular in construction, they are also irregular in the arrangement of the yarns. For instance, in a double-weave on 21 threads and picks with a

12-shaft weave on the face and a 9-shaft weave on the back the grouping of face and backing yarns would be :—

Face and Backing F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B. F. B.
 Number of Threads 2 1 1 1 1 1 2 1 1 1 1 1 2 1 1 1 1 1

Applying, to this arrangement of double cloth, a 5-shaft centre-weave, the complete order of yarns for the 3-fold structure would be :—

Face, Back-
 ing, Centre F. B. F. C. B. F. B. F. C. F. B. F. B. F. C. B. F. B. C. F. B. F. B. C.
 Number of
 Threads 2 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1

Stated in another way the order is :—

For 10 threads { 4 threads of the double weave.
 1 thread ,, ,, centre ,,
 5 threads ,, ,, double ,,
 1 thread ,, ,, centre ,,
 For 10 threads { 4 threads ,, ,, double ,,
 1 thread ,, ,, centre ,,

The face yarns are grouped in two's and singles and the centre yarns are placed between face and backing threads and two face threads successively.

Figs. 65 to 69 are examples in this type of three-fold structure which is used in the manufacture of woollen and worsted overcoatings and cloakings. They are derived from two-ply weaves constructed as below :—

- a. 3/3 twill face, and 2/2 twill back, double weave complete on 10 threads and picks.
- b. 7-shaft twill face, and 5-shaft twill back, double weave complete on 12 threads and picks.
- c. 11-shaft twill face, and 9-shaft twill back, double weave complete on 20 threads and picks.

TABLE IX.

SCHEMES OF CONSTRUCTION APPLICABLE TO IRREGULAR THREE-FOLD FABRICS.

Taking each structure separately there are alternative yarn groupings and centre weaves applicable, namely:—

Structure <i>a</i> , Arrangement 1 = 5 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = Plain.	} Fig. 65.
Arrangement 2 = 3 threads of the double weave. 1 thread of the centre weave.	} Re-peat. } Fig. 66.
4 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = Prunelle twill.	} Fig. 67.
Structure <i>b</i> , Arrangement 1 = 3 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = 2/2 twill.	} Fig. 67.
Arrangement 2 = 4 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = 1/2 twill.	} Fig. 68.
Structure <i>c</i> , Arrangement 1 = 4 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = 3/2 twill.	} Fig. 69.
Arrangement 2 = 5 threads of the double weave. 1 thread of the centre weave. <i>Centre Plan</i> = 2/2 twill or 2/2 mat.	

A problem in setting to be taken into account here is the "counts" of yarns to use for the centre weave. This is determined by the ratio of face and backing to the centre threads in the compound weave, and also by the intersections in a repeat of the centre weave. The double-weave structure in such plans is of a character and arrangement that the face and backing yarns should be alike in diameter, but the yarns of the centre fabric must be changed in quality and size according to the weight and strength of cloth to be manufactured.

(87) YARN COUNTS IN COMPOUND WEAVES.

As the counts of yarns and setting of weave structures are mainly determined by the nature of the cloth to be produced, or

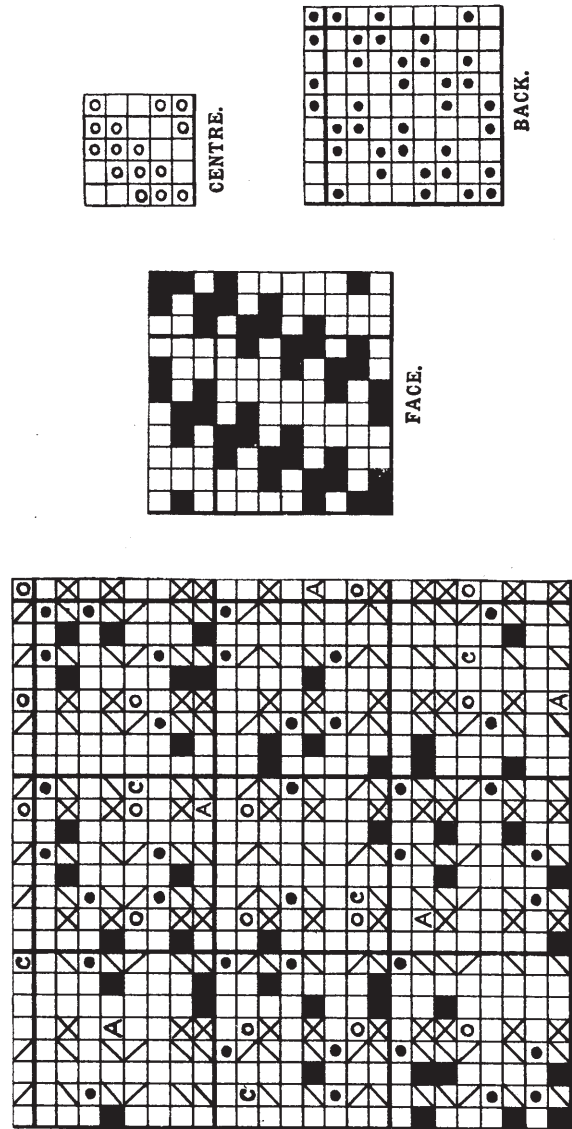


FIG. 69.

by the scheme of manufacture practised, they have only entered into the analysis of compound weaves in relation to such examples for which detailed weaving particulars have been supplied for giving a specific style of cloth. Relatively, in two- and three-fold fabrics, the diameters of the yarns vary with the ratio of the intersections in each weave, and the proportionate number of threads in each texture per inch. For this reason, in reversibles arranged one face and one backing, identical yarn counts may be used in the composition of each surface of the fabric; and for a like reason, in reversibles in which the ratio of face and backing yarns is dissimilar, the diameters of the yarns for the respective surfaces is different. Analysing two typical examples, Plan J, Plate III, and Plan G, Plate IV, the face yarns for which may be taken as 20 skeins and 30 skeins respectively, then, from an examination of the plans, it will be clear the backing yarn for each should be half the diameter of the face yarn. This is essential to correctness of fabric manufacture, if the face and backing surfaces are to be of a similar compactness of threads; for in Plan J two picks of backing yarn should cover the same fraction of an inch in the fabric, and be in equal degree of contact with each other as four picks of face yarn; similarly with the warp yarns—face and backing—in Plan G. It will be noted that the relative diameters and not relative count numbers of the yarns are calculated. Based on the latter two picks of 10 skeins yarn are the same in weight, though half the length, of four picks of 20 skeins yarn (Plan J); and one thread of 15 skeins to two threads of 30 skeins yarn (Plan G). Hence if it were a problem of providing the same proportionate weight in the fabric with the face as the backing yarns, these counts would be accurate. But based on the law of diameters these results are not satisfactory. Thus the actual working diameters (15 per cent deducted for the extraneous fibre) of 20 skeins and 30 skeins are $\frac{1}{60}$ in. and $\frac{1}{75}$ in., so that the diameters of the backing yarns should be $\frac{1}{30}$ in. and $\frac{1}{37}$ in., or equal, approximately, to 5 and 7 skeins yarns. For the weft-backed weave, Plan J—this counts of yarn is practicable, but for the warp-backed weave (Plan G)—10 or 12 skeins yarns would be

selected as affording better results in weaving. Necessarily the exigencies of manufacture, weave structure, and the method of applying the backing yarns in the *warp* or *weft*, modify in some degree the actual counts arrived at by calculation.

(88) VALUE OF INTERSECTIONS IN COMPOUND WEAVES.

A general rule applicable is, the more frequent the interlacings on the backing threads or picks the less their number in a given fabric setting per inch. Hence, though the face weave in both Plans A and B, Plate III, is 2/2 twill, yet if the same backing yarn were applied to A as B, weave A would be produced in 25 to 30 per cent less picks per inch than B; or a proportionately thicker backing yarn used for B than A. A corresponding rule is followed in the weaving of warp-backed textures, e.g. Plans C and D, Plate IV.

In the backing of some varieties of weaves the relative counts of the face and backing yarns are not fixed by intersection rules but by the build of the fabric. Plans K and L, Plate III, are warp face twills of this order arranged one pick of face yarn and one pick of backing yarn. Both plans have six intersections on each face pick and two intersections on each backing pick, allowing for the use of a thicker yarn for the under than the face surface. Such is the disparity between the diameters of the two yarns combined in this type of cloth—the face four to five diameters finer than the backing—that should ordinary warp setting be practised the face texture would be defective. The backing picks would show, in this arrangement, on the face of the fabric. By adopting a setting in which the warp threads are above the average per inch (e.g. 2/50's worsted, 16's reed 6's and woven 1 pick of 2/60's cotton and 1 pick of 6 or 8 skeins woollen yarn, with 90 picks per inch), the warp yarns would conceal the backing picks constituting the greater proportion of the weight per yard of the cloth.

In centre warp and weft cloths (Plans N, O, and P, Plate III, and H and I, Plate IV) the threads or picks marked in circles interlace more frequently than the face and backing

threads. Being utilized for forming the centre of the compound and for giving additional firmness of structure, they have no function in the production of either the face or backing surface of the fabric, and should therefore invariably be yarns small in diameter.

Various other elements—not coming within prescribed theories and data—have to be taken into account in cloth setting. These relate to the quality and structure of the yarns, the measure of felting in the width and length of the piece, and to the properties of firmness of construction, flexibility, and tensile strength to be developed in the finished fabric, and form features in woven design which will be more fully defined in treating of the manufacture of specific cloths.

CHAPTER VI.

FABRICS LIGHT IN WEIGHT AND STRUCTURE.

(89) Fabric Weight per Yard ; (90) Yarn Preparation for Fine-grade Fabrics ; (91) Uses of Fine and Loose-twisted Yarns in Flannels ; (92) Makes of Flannels ; (93) Angola Flannels ; (94) Flannel Suitings and Costume Cloths ; (95) Saxony Group of Light Fabrics ; (96) Qualities of Saxony Costume Fabrics ; (97) "Habit" or Face Costume Cloths ; (98) Worsted Warp and Woollen Weft Costume Cloths ; (99) Cheviot Group of Light Fabrics ; (100) Fourteen- to Eighteen-ounce Suiting Fabrics ; (101) Examples in Saxony Suiting Cloths of Light and Medium Structures ; (102) Examples in Cheviot Suiting Cloths of Light and Medium Structures ; (103) Worsted Group of Costume and Suiting Cloths ; (104) Methods of Setting Worsted-yarn Textures ; (105) Examples in Standard Systems of Setting ; (106) Worsted Serges ; (107) Surface Characteristics of Botany and Cross-bred Fabrics.

WOVEN fabrics light in build, substance, and weight, range from 4 to 10 or 12 oz. per yd., 56 or 58 in. wide. Flannels, and certain varieties of costume cloths, are manufactured in different widths. The former are set in the reed to finish 28 in., 30 in., and 32 in., and the latter 36 in., 44 in., and 46 in. For the purposes of comparison the standard double width in the trade of 56 in., including lists, or 54 in. within the lists, will be taken as the basis of calculation.

(89) FABRIC WEIGHT PER YARD.

Weight per yard is a controlling factor in the production of all classes of woollen, worsted, and union fabrics, and the margin allowed in merchandising either above or below the prescribed number of ounces per yard is small. This accounts for "weight" being made a primary consideration in textile manufacturing. Inaccuracy has to be guarded against for two reasons, first if the fabrics are too light the pieces are liable to be rejected ;

and, second, if too heavy, though accepted, the maker is the loser by the value of the materials and yarns used in excess of the actual requirements. Either consequence may, by skilful practice, be avoided. All fabrics vary in weight with the counts of yarns and setting applied in their construction; in other words, the weight per yard is fixed by the diameter and thickness of the yarns, and their number in a given area of the cloth. Shrinkage, or contraction of the piece in milling, also modifies the weight, and in light as in medium and heavy fabrics cannot be regarded as a negligible quantity. Flannels, "habit" cloths, and dress-face costume textures are in some degree felted, and this results in the pieces being narrower and shorter in the finished than in the scoured condition. The counts of the yarns remain in this process unaltered, but the threads and picks per inch are increased by the ratio of shrinkage. To take a costume cloth, counting 40 threads and picks per inch scoured, and made of 30 skeins yarns; then, a 25 per cent shrinkage would increase the threads and picks to 54 per inch, and the weight proportionately with the decrease in the length of the piece.

(90) YARN PREPARATION FOR FINE-GRADE FABRICS.

To produce a fine woollen texture only weighing 5 to 7 oz. per yd. (56 in. wide) necessitates the manufacture of yarns small in diameter. Considering that in the ordinary plain-woven flannel, the twilled flannel suiting, and, in a lesser degree, the coarser wool grades of flannel, the warp and weft threads are clearly distinguishable, it is essential the yarns should be uniformly spun, even in circumference, and free from neppiness. Any defect in carding, or irregularity in spinning, is immediately traceable in the finished fabric.

Wools of suitable fineness of fibre and spinning property having been selected, they are thoroughly opened and intermixed by an adequate amount of treatment in carding. Successful manufacture in the various groups of fine woollen textures is dependent upon the efficiency with which this work is done. Usually, in flannel yarn making, which may be taken as typical of the essential conditions required in preparing for fine spinning,

a set of carding machines comprises a Scribbler or Breaker with breast cylinder and two swifts, an Intermediate with one swift, and a Carder and Condenser with a breast cylinder and one swift.¹ This measure of carding surface ensures the production of a sheet of carded fibres effectively intermingled, and free from clusters of unseparated filaments, and which may be readily divided, in the operation of condensing, into slivers of uniform fibrous consistency and weights.

Textures of the flannel group differ in fineness, flexibility, softness, and fibrousness. Wool characteristics and finishing methods affect these qualities, but in manufacturing they are mainly formed in the carding and spinning operations. These determine the structure and regularity of the counts of the yarns, and therefore the fineness and evenness of the fabric, and also its property of softness of handle.

(91) USES OF FIRM AND LOOSE-TWISTED YARNS IN FLANNELS.

In spinning, apart from the actual thickness or size of the yarn, the relative degrees of twine in the warp and weft threads have to be considered. The number of turns per inch in the yarn is a technicality which modifies the quality of the texture produced. Harshness of feel, and lack of fibrous fullness, may be caused by the yarns being too firmly twisted; and, on the other hand, sponginess and excessive flexibility are liable to be produced by combining yarns too loosely twisted. Yet, a warp thread must be provided of sufficient tensile strength and elasticity to sustain the tension and friction in weaving; and, in spinning fine woollen counts, this necessitates the construction of comparatively a hard-twisted yarn. Now, if the weft yarn should be of a similar structure, the plain texture of the flannel would be clearly developed, but the deficiency of extraneous fibre on the circumference of the threads would render raising unsatisfactory. Hence the practice in flannel and cognate manufactures of combining well-twisted with loosely-twisted weft yarns. The utility and necessity of this arrange-

¹ See "Woollen and Worsted," Chapter III.

ment will be more clearly understood by taking an example. The following are the particulars of the yarn and setting of a medium quality of Welsh flannel:—

Warp : 21 skeins yarns 13·5 turns per inch, left-hand twine.
12's reed 2's.

Weft : 25 skeins yarns 10·4 turns per inch, left-hand twine.
30 picks per inch.

The warp though some 16 per cent thicker than the weft yarn contains three additional turns per inch, which implies relatively, hard and soft spun threads. The breaking strain and elasticity of the two yarns further exemplify these differences in twine. On an average of tests the results are:—

Warp : Breaking strain, 9·5 oz., elasticity, 2·5 in.

Weft : Breaking strain, 2·4 oz., Elasticity 1·5 in.

These relative yarn characteristics and values are the general rule in practice—the warp yarns impart firmness of fabric structure, and the weft yarns impart softness of texture and raising quality. Deviations from these practices are made in manufacturing with a view of minimizing the shrinkage of the flannel in the made-up garment, and of obtaining textural clearness by utilizing well-twisted *weft* in combination with hard-twisted *warp* yarns, but the result is a variety of flannel of comparative hardness though durable and clear in the weave.

The direction of the twine in the yarns also affects distinctiveness of weave intersections. When both warp and weft yarns are of a corresponding spin, the fibres of the former are arranged in the woven fabric in the reverse direction to the latter. This, providing the degrees of twine are similar in the two yarns, causes the twist of the warp yarn to oppose the twist of the weft yarn, and result in the weave interlacings being well defined.

A better raising surface is, however, the resultant of combining yarns of like twine both as to direction of twist, and number of turns per inch. In thin fabrics, and also cloths of a heavier construction, it is advantageous to give prominence in the woven structure to the yarns of the better raising quality, or, in this example, to the weft. This is usually effected by an excess of

picks over threads per inch. Thus the additional six shots per inch in this setting gives a weft "cover" which develops in scouring and milling, raising filament, so that in this operation the circumference of the warp threads is barely affected by the action of the points of the teazles.

(92) MAKES OF FLANNELS.

Welsh, Shetland, Lancashire, Yorkshire, and Scotch are the chief varieties of flannels, the better qualities being termed "Fine Mediums," "Saxonies," and "Printers" (textures on which the pattern is printed and not woven).

Formerly, Welsh wool was the staple material used in the manufacture of this class of flannel, but now English Downs and Crossbred wools are freely employed. The pure Welsh flannel—made largely in Newtown, Welshpool, and Llangollen

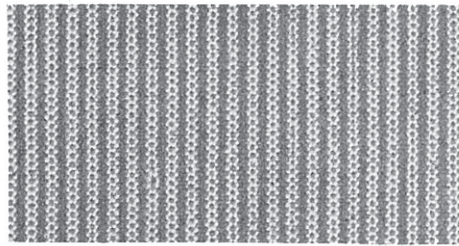


FIG. 70.—Angola flannel stripe, weave and colour effect.

—is sound in texture and of excellent wearing strength but not generally of a fine quality.

"Shetlands" form one of the coarser textures being made of wools of inferior fineness and wanting in elasticity and softness of staple or lock. The counts of yarns in this flannel rarely exceed 20 to 22 yd. per dram.

Yorkshire and Lancashire productions cover a wide range of flannel manufacturing in the plain, uncoloured, and fancy branches. Accordingly, the wools are diverse in quality, such as English and New Zealand and other colonial Crossbreds for the ordinary varieties, and Australian, Cape, and South American Merinos for the "Saxonies".

"Blending" for fabric quality is an important work in

flannel manufacturing. The selection of the correct sorts of wool—including fineness of fibre, strength of staple, and spinning and milling characteristics—and the blending of these in suitable proportions for producing a flannel of a definite structure and quality, are technical work in which proficiency is only attained by practice, observation, and experience.

(93) ANGOLA FLANNELS.

Union or Angola flannels are made of yarns acquired by blending wool and cotton in different ratios, e.g. :—

50 per cent of wool and 50 per cent of cotton.					
60	”	”	”	40	”
75	”	”	”	25	”

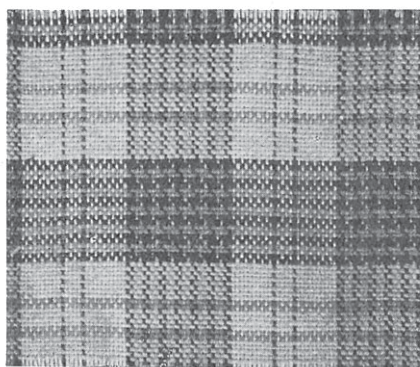


FIG. 71.—Checked flannelette.

In all “Angola” mixtures of this kind the warmth-yielding property of the flannel diminishes with the increase in the proportion of cotton to wool fibre. The texture also suffers in a like gradation in softness and flexibility. Still, such flannels are largely manufactured, and are considered for blouses and other garments to be satisfactory on account of being comparatively unshrinkable.

The following are the manufacturing data for the weave-effect Angola stripe in Fig. 70 and the clear-finished checked flannelette in Fig. 71.

FIG. 70.—ANGOLA FLANNEL.

Warp: 32 skeins Angola yarn.
 8's reed 4's.
 Weft: 40 skeins Angola (soft twine).
 42 picks per inch.

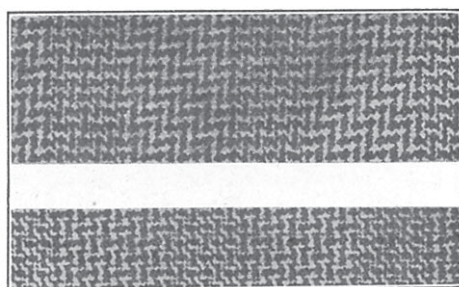
FIG. 71.—FLANNELETTE.

Warp: 20's single cotton (2 threads counted as one in looming).
 12's reed 4's = 24 double threads per inch.
 Weft: 12's single cotton (soft spun).
 38 picks per inch.

Order of Colouring.

Dark shade	4	—	—	—
Medium shade	4	—	4	4
Light shade	—	12	8	12
	} For			
	24			
	threads			

The weft yarn in both examples should be quite loosely twisted to impart fibrousness of texture.



72

72a

FIGS. 72 and 72a.—Saxony suiting or costume cloths. (Compound check patterns.)

(94) FLANNEL SUITINGS AND COSTUME CLOTHS.

Greater variety of texture and range of manufacture are obtainable in these fabrics than in the ordinary flannel. Yarns more diversified in counts and materials are employed, and, in addition, weave compounds in simple forms are applied.

The two cloths are classed together, but on the average the costume textures are lighter in structure and weight than the suitings. Differences also obtain in the settings of the fabrics,

and to a degree in the finishing methods practised. Both varieties are divisible into Saxonies and Cheviots, and have similar contrasting features to those described relative to these distinctive types of all-wool fabrics in Chapter III.

(95) SAXONY GROUP OF LIGHT FABRICS.

Both the costume and suiting fabrics are of two classes, *clear* and *soft-finish*. Dress textures also comprise two other varieties, namely, the "habit" cloth and a quality of "face" cloth made partially of worsted and partially of woollen yarn, such as worsted yarns for warp and woollen yarns for weft. Weave pattern or effect is distinguishable in the *clear* and also the *soft-finish* textures (Figs. 72 and 73), but in both the "habit" and "face" cloths it is concealed by the face filament acquired in the operation of raising.

Considering, in the first order, the Saxony types of costume fabrics, the following are methods of setting to produce structures of 11 to 13 oz. per yard.

TABLE X.

METHODS OF MANUFACTURING LIGHT AND MEDIUM WEIGHT COSTUME FABRICS.
Saxonies.

EXAMPLES A AND A', CLEAR-FINISHED CLOTHS (Figs. 72 and 72a).

Example A = Warp: 3 threads of 24 skeins black } For 54 threads.
 3 " " " white }
 2 " " " black }
 1 thread " " white } For 36 threads.
 1 " " " black }
 2 threads " " white }
Weft: 3 picks of 20 skeins black.
 3 " " " white.

Example A' (Fig. 72a) = Warp: Same as in example I.

Weft: 2 picks of 24 skeins black.
 1 pick of 24 " white.
 1 " " 24 " black.
 2 picks of 24 " white.

9's reed 4's, 66 in. wide in the reed, 32 picks per inch.

Weave: 2/2 twill.

Approximate weight per yd.: 12 oz.

EXAMPLES B AND C, SOFT-FINISH COSTUME CLOTHS.

Example B (Fig. 73) = *Warp* : 1 thread of 36 skeins light shade } For 72
 2 threads of 36 " dark shade } threads.
 1 thread of 36 " light shade }
 1 thread of 36 skeins dark shade } For 72
 1 " " " light " } threads.
Weft : 1 pick of 32 skeins light shade (loosely spun).
 2 picks of 32 skeins dark shade (loosely spun).
 1 pick of 32 skeins light shade (loosely spun).

11's reed 4's, 72 to 76 in. in the reed. (The wider in the reed the more fibrous cover developed and the heavier the texture.)

42 picks per inch.

Weave : Angled twill in proportions to fit the order of warping.

Approximate Weight per yd. : 11 to 12 oz.

Example C = *Warp* : 30 skeins, 17.5 turns per inch, left-hand twine.

Weft : 30 " 13 " " " " " " "

11's reed 4's, 75 in. wide in the reed, 44 picks per inch.

Weave : Angled 2/2 twill or stripe of 24 threads of 2/2 twill and 8 threads of 2/2 mats, and similar elementary stripe and check combination designs.

Approximate Weight per yd. : 12 to 12½ oz.

EXAMPLE D AND D¹ "BAULK" FINISH COSTUME CLOTHS.

Example D = *Warp* : 30 skeins woollen, 15.5 turns per inch, left-hand twine.

Weft : 30 skeins woollen, 12 turns per inch, left-hand twine.

12's reed 4's, 66 in. wide in the reed, 44 to 48 picks per inch.

Weave : 2/2 twill and simple weave compounds.

Approximate Weight per yd. : 12 to 12½ oz.

Example D¹ (Fig. 74) = *Warp* : 44 skeins black and 44 skeins light gray twist.

Weft : 22 skeins black, loosely twisted.

11's reed 4's, 64 in. wide in the reed, 28 to 30 picks per inch.

Weave : Fig. 74a, Plate V.

Approximate Weight per yd. : 13 oz.

EXAMPLE E, HABIT OR FACE COSTUME CLOTH.

Example E = *Warp* : 32 skeins woollen, 18 turns per inch, right-hand twine.

Weft : 28 " " 12 " " " left " "

10's reed 4's, 75 to 80 in. wide in the reed, 34 picks per inch.

Weave : 5-end sateen (woven face downwards).

Approximate Weight per yd. : 12 to 13 oz.

EXAMPLE F, FACE COSTUME CLOTH WORSTED WARP AND WOOLLEN WEFT.

Example F = Warp : Two-fold 40's worsted, 60's quality.
 Two-fold = 17.5 turns per inch left-hand twine.
 Single = 16.5 " " " right " "
Weft : 30 skeins woollen, 16 turns per inch left-hand twine.

17's reed 4's, 68 in. wide in the reed, 48 to 50 picks per inch.
Weave : T, or U.—Plate II.
Approximate Weight per yd. : 13 oz.

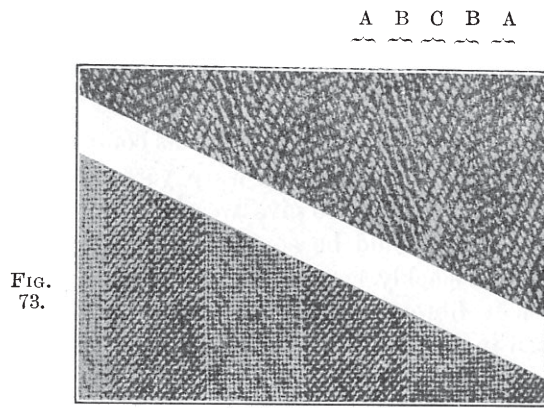


FIG. 74.

FIG. 73.

B A B A
 FIGS. 73 and 74.

(96) QUALITIES OF SAXONY COSTUME FABRICS.

These examples are illustrative of the standard makes and qualities of Saxony costume fabrics. The counts of yarns, setting, shrinkage, and weaving data are typical of this class of woven manufactures, but are necessarily variable with the quality, fineness, and substance of the texture required.

It is of course understood that the orders of warping and wefting in examples A, A¹, and B are only given as suggestive of the styles developed in such cloths and not as standard patterns. Style and schemes of colouring are not standardized, and are largely diversified in this variety of fabrics. In each specimen, however, the standard weave or make employed, is indicated, and is rarely changed or modified.

The technicalities in finishing are different in the treatment of each type of cloth and afford features for analysis and comparison. Each system of manufacture may be separately examined.

To produce the clear-face variety, both the warp and weft yarns should be firmly spun, so that the shrinkage on the width is not more than 15 per cent and on the warp 10 per cent, and the cloth, following slight raising, cut quite clear. The result of this setting and combination of yarns is seen in the precise pattern details in Figs. 72 and 72a.

Usually "soft" or fibrous face costume Saxonies are made of finer counts of yarns than type A, and are necessarily set wider in the reed, not less than 72 in. to 76 in. as compared with 66 in. in the reed in the former. The warp yarns should be fine in counts and closely twisted to give weaving property; on the other hand, the weft should be somewhat thicker in diameter than the warp and slackly spun. It is the weft thread which develops the soft fibrous face, giving a mellow tone to the pattern as seen in Fig. 73, and the warp yarn which imparts firmness of fabric structure. The scheme of manufacture practised is given in the particulars for example B. Provision is made in the setting for a shrinkage of 25 per cent in the width. A satisfactory practice is to regulate the "length" shrinkage by the loss in weight in the cloths in scouring and other finishing operations. If the latter should be 10 per cent, then the contraction in felting would be between 8 per cent and 12 per cent to acquire a cloth of the correct weight per yard.

The counts of the warp and weft yarns, and also of the number of threads and picks per inch, in this make of cloth, are dissimilar, but this is not an invariable rule. Thus example C is woven on the square and manufactured of the same counts of yarns—30 yd. per dram—in both warp and weft. A difference is made, however, in the turns per inch, the weft thread containing $4\frac{1}{2}$ less turns than the warp. This method of cloth construction produces, when the ratios of width and length contraction are similar in felting, a fabric more correctly balanced

in regard to breaking strain and elasticity than the scheme of manufacture illustrated by example B.

Example D is not strictly the setting for a "face" cloth, but it forms a useful variety of fabric. The surface is fibrous, but the pile of filaments produced in the milling operation remains undressed, laid, or combed by the action of the teazles of the gig or card wire of the Moser machine. Hence the terms "natural," "milled," or "bault," finish, defining the condition of the face of the cloth after treatment in the process of felting. The method of manufacture given is for the finer quality of fabric. If thicker yarns are employed, e.g. 24 skeins warp and 22 skeins weft, and the ends and picks per inch reduced proportionately, the cost of production is lowered. A defect in this style of texture is the tendency to develop roughness in the wear due to the surface fibres being unraised, for the raising operation both lays and spreads the fibres and also combs off the texture some amount of loose, extraneous, filament. The thicker and lower the quality of the yarns the more does this unsatisfactory feature become apparent. It should, however, be noted that the "felt-like" fibrous characteristic distinction of this cloth is not so well acquired by any other practice than that described.

Setting example D¹ (Fig. 74) results in a distinct type of "natural-finish" texture. The clearness of twill definition combined with a degree of fibrousness is the characteristic quality. It is due to the employment of hard twisted two-fold warp yarns which give effect to the weave structure (74a, Plate V) without the operations of finishing causing the surface of the yarns to be affected.

The routines of finishing for examples C, D, and D¹ are as follows:—

Example C: Knot and mend before scouring; scour; mill to 58 in.; wash off; tenter; raise four times from each end of the piece alternately and with the cloth in a wet condition; steam and dry beat on the gig; cut; warm press; blow with steam; brush and steam; warm press and steam.

Examples D and D¹: Same routine as C up to the operation

of tentering, then cut level but not close; blow with steam; brush and steam; warm press twice to fix the fibre and set the cloth.

Clearly, it is the omission of the raising process from the latter routine which makes the chief feature of distinction between these fabrics.

(97) "HABIT" OR FACE COSTUME CLOTHS.

The "habit" costume cloth is the "face" fabric, light in structure, which in quality of finish—lustre and density of pile—most closely resembles a fine woollen doeskin. The pieces are set 75 to 84 in. in the reed to develop a sufficient quantity of

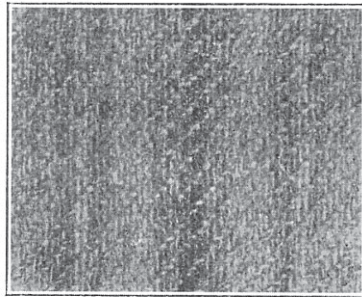


FIG. 75.—Cheviot tweed costume.

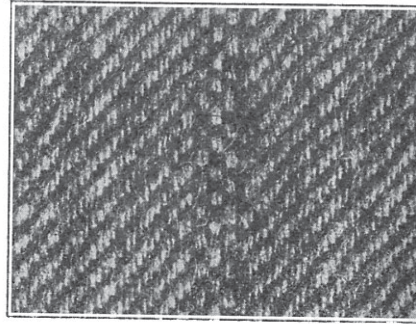


FIG. 76.—Weave stripe Cheviot costume.

"balk" fibre in milling for effective raising. Milling is sometimes done at two periods, after scouring, and after first raising. In the preliminary work—preferably done in the stocks—the shrinkage is some 10 per cent to 15 per cent on both warp and weft of the piece. Raising after washing off follows, then final milling to the requisite length and width in the milling machine. The effect of this compound felting is to develop a full, fibrous foundation in the cloth, affording good raising property, the fibres not being disposed to leave the surface of the yarns in the operation.

In highly-finished "habit" cloths the process of boiling is practised, and, in any case, the pieces are blown with steam, developing lustre and rendering smoothness of surface more per-

manent. Subsequent to this treatment the cloths are dyed, washed off, raised damp, dried, cut, pressed, and steamed. As pointed out the quality of softness of texture is affected by the warp and weft yarn structures, that is, the turns per inch relative to the counts, and the respective functions of the yarns in the construction of the fabric. Raising work is done mainly on the firmly twisted warp yarns which give, in the standard weave, or five-shaft sateen, $\frac{4}{5}$ of these threads on the face of the cloth. The loosely-spun weft is useful in imparting milling property and in producing fibrousness of texture.

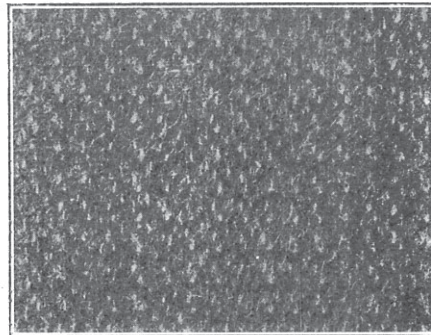


FIG. 77.—Cheviot tweed costume (weave effect).

(98) WORSTED WARP AND WOOLLEN WEFT COSTUME CLOTHS.

This class of costume fabric is of a fine quality and “face” finished. Weaves of the whip-cord type (Plans U, A¹, and E¹, Plate II) are applied in order to develop, underneath the fibrous cover, a fine twill effect on the surface of the cloth.

Combining the properties of both fine woollen and worsted yarns, the fabrics are of sound wearing strength—the two-fold worsted yarn adds to the breaking strain, and the fibrous character of the single woollen weft induces felting. If weaves of the 2/2 or 3/3 twill type were used the lustre and smoothness of the face of the cloth would suffer. Such weaves as cause five-sevenths, three-fourths, or seven-ninths of the warp yarns to be on the upper surface, and of a like proportion of weft yarns on

the lower surface, are employed ; or, in other words, weaves are selected which cause the face of the texture to be composed of worsted and the back of the texture of woollen yarns. A stratum of closely woven *picks* of woollen yarn is thus secured to a stratum of closely woven *threads* of worsted yarn. Practically the characteristics of a compound structure, e.g. Plans K and L, Plate III, are acquired. Clearness and brightness of surface are, on this system of manufacture, combined with softness and elasticity of texture. The cloth is also firmly constructed, and possesses a high degree of warmth-yielding property considering its lightness of structure.

To retain the qualities due to each kind of yarn, in the process of felting, "weft" contraction is mechanically induced, but "warp" contraction as far as feasible prevented.

(99) CHEVIOT GROUPS OF LIGHT FABRICS.

Cheviot costume textures are less varied in character than Saxonomies. Range of technicalities in fabric structure is prescribed by the thicknesses of yarns available and also by the possible methods of setting to acquire cloths of the requisite lightness of construction. Ordinarily Cheviot yarns do not exceed in counts 24 yd. per dram, whereas Saxony yarns are spun up to 36 or 40 yd. per dram, and in all the intermediate counts producible in wools of a Crossbred or Cheviot variety. Yarn counts and weave as indicated, necessarily limit the setting or the number of threads and picks per inch in the fabric, which, as understood, are also determinable by the weight per yard of the cloth to be produced. These factors when combined with the limitations in finishing applicable to all classes of Cheviot costumes and suitings materially restrict the scope of manufacture.

Three typical examples in these cloths are illustrated in Figs. 75, 76, 77. They are constructed as follows :—

TABLE XI.

METHODS OF MANUFACTURING LIGHT- AND MEDIUM-WEIGHT COSTUMES (*Cheviots*).

EXAMPLES G, H, AND I, CHEVIOT COSTUME CLOTHS (FIGS. 75, 76, AND 77).

Example G (Fig. 75) =*Warp* : 8 threads of 18 skeins Cheviot dark shade (mixture yarn).

4 threads of 18 skeins Cheviot medium shade (mixture yarn).

8 threads of 18 skeins Cheviot light shade (mixture yarn).

4 threads of 18 skeins Cheviot medium shade (mixture yarn).

4 threads of 18 skeins Cheviot light shade (mixture yarn).

4 threads of 18 skeins Cheviot medium shade (mixture yarn).

8 threads of 18 skeins Cheviot light shade (mixture yarn).

4 threads of 18 skeins Cheviot medium shade (mixture yarn).

Weft : 16 skeins Cheviot light shade (mixture).

8's reed 3's, 64 in. wide in the reed, 24 picks per inch.

Weave = 2/2 twill and similar crossings.*Approximate weight per yard* : 11 to 12 oz.*Example H* (Fig. 76) =*Warp* : 8 threads of 15 skeins Cheviot light shade (mixture yarn).

4 threads of 15 skeins Cheviot medium shade (mixture yarn).

4 threads of 15 skeins Cheviot light shade (mixture yarn).

4 threads of 15 skeins Cheviot medium shade (mixture yarn).

Weft : 12 skeins dark shade (mixture yarn).

8's reed 3's, 64 in. wide in the reed, 20 picks per inch.

Weave : 2/2 twill and 2/2 mat stripe, and similar weave compounds.*Approximate weight per yard* : 12 to 12½ oz.*Example I* (Fig. 77) = *Warp* : 18 skeins Cheviot mixture.*Weft* : 16 skeins Cheviot mixture, darker in shade than the warp yarns.

7's reed 4's, 64 to 66 in. wide in the reed, 24 picks per inch.

Weave: Plan I, Plate II.

Approximate weight per yard: 12 to 12½ oz.

Plain, twill, and mat weaves are ordinarily used in the weaving of these cloths. Example I is an exception. Here every



FIG. 78.—Fine Saxony suiting (milled).

other pick interlacing plain results in a firmer fabric being produced than in the common twill. For more open or porous

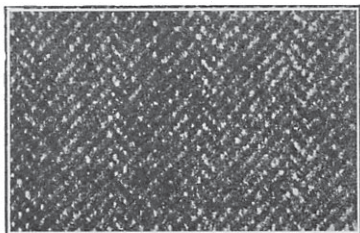


FIG. 78a.—Saxony flannel suiting.

effects and "oatmeal" textures weaves of the formation of Plans L, G', and Q', Plate II, are employed. The methods of setting given in this example are also adapted for these makes, but the ends and picks per inch should be slightly increased.

The yarns are firmly twisted in both warp and weft, hence only a minimum degree of contraction is allowed from the loom width to the finished width.

(100) FOURTEEN TO EIGHTEEN-OUNCE SUITING FABRICS.

Saxony and Cheviot suiting cloths, of 14, 16, and 18 oz. per yard, differ, from the costume fabrics considered, in warp and weft setting, and degree of milling. The yarns in some of the textures are the same, but in other specimens they are thicker in counts than is feasible in the manufacture of 11 to 12 oz. woollen fabrics. Saxony suitings may be either clear or soft finish—but rarely dress face. Cheviots are invariably rough or natural finish.

Typical settings are schemes of manufacture for 13 to 14 oz., 16 oz., and 18 oz. Saxonies; and 14 to 18 oz. Cheviot cloths are tabulated in Paragraphs 101 and 102:—

(101) EXAMPLES IN SAXONY SUITING CLOTHS LIGHT IN STRUCTURE.

TABLE XII.

Example J (Fig. 78) = *Warp* : 32 skeins medium grey.
Weft : 30 skeins dark grey.
 12's reed 4's, 75 in. wide in the reed, 44 picks per inch.
Weave : Angled 2/2 twill.
Approximate weight per yard : 13 to 13½ oz.

Example K (Fig. 79) = *Warp* : 2 threads of 22 skeins white or light shade.
 1 thread of 22 skeins medium shade.
 1 ,, ,, ,, white or light shade.
 2 threads of 22 skeins medium shade.
 1 thread ,, ,, white or light shade.
 1 thread of 22 skeins medium shade.
Weft : same as warp.
 10's reed 4's, 64 in. wide in the reed, 40 picks per inch.
Weave : Angled 2/2 twill.
Approximate weight per yard : 15½ to 16 oz.

Example L (Fig. 80) = *Warp* : 20 skeins dark shade yarn twisted with 40 skeins light shade yarn.
Weft : 10 skeins very dark shade yarn.
 7's reed 4's, 66 in. wide in the reed, 24 to 26 picks per in.
Weave : Fig. 80a, Plate V.
Approximate weight per yard : 18 to 18½ oz.

Three standard weights of Saxony cloths, light in structure, are typified in these examples. The counts of the yarns and the methods of setting are different in each case, namely, 32 yards per dram and 48 threads per inch in J; 22 yards per dram and 40 threads per inch in K; and 13½ yards (average) per dram and 28 threads per inch in L. The weight per yard of the fabrics increases with the decrease in the number of threads, being controlled by the thickness of the yarns. The relative shrinkages from the loom to the finished width should

be noted—some 25 per cent in J, 15 per cent in K, and 12 per cent in L. Textural characteristics vary accordingly; the fabric in Fig. 78 is fine in the twill and of fibrous softness, in Fig. 79 the threads and pattern are clearly defined, and in Fig. 80 the comparative thickness of the yarns produces a roughness of surface and openness of twill in marked contrast with Fig. 78. The gradation in the fineness of the twills in the two cloths is particularly noticeable, due to the smallness of the yarns in Fig. 78 as compared with those used in Fig. 80, and the relative numbers of threads per inch and degrees of shrinkage, developing some sixteen repeats of the twilled weave per inch in the

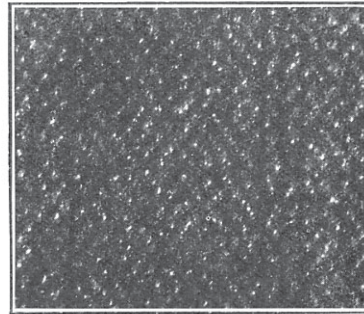
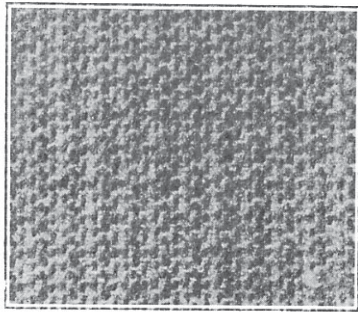


FIG. 79.—Saxony suiting (colour effect). FIG. 80.—Saxony suiting (weave effect).

fine-set texture, and only eight repeats per inch of the same twill in the coarser-set texture.

Yarn compactness, caused by felting, is different, in quality and effect in the cloth, to a corresponding compactness caused by close setting in the loom. This distinction is apparent in the surface conditions and character of the fabrics in Fig. 78 and Fig. 78a, yet both cloths are made of the same class of wool and counts of yarns, and test, finished, a similar number of threads and picks per inch. An excess contraction of 10 per cent to 12 per cent in the felting of the pieces in the former over the latter fabric is the cause of the two distinct qualities of these cloths. To produce soft textural effects, as in Fig. 78, loose setting in the reed should be practised, followed by some 25 per cent of milling contraction, but to produce fabrics with

the weave and threads clear and distinct, as in Fig. 78a, closer loom setting is the rule with a lesser degree of shrinkage.

As in the costume patterns illustrated, the styles in the suitings are types only, the counts of yarns, settings, reed widths, and picks per inch, forming reliable bases on which to manufacture cloths of the materials and weights indicated.

(102) EXAMPLES IN CHEVIOT SUITINGS, LIGHT IN STRUCTURE.

TABLE XIII.

Example M (Fig. 81) = Warp :

2 threads of 20 skeins Cheviot white
 2 ,, ,, twist yarn composed of 2/30's medium shade } For 88 threads.
 and 2/40's light shade Crossbred worsted.
 1 thread of 20 skeins Cheviot white } For 18 threads.
 1 ,, ,, twist yarn

Weft : Same as warp.

18's reed 2's, 64 in. wide in the reed, 36 picks per inch.

Weave : 2/2 twill or mat.

Approximate weight per yard : 14 to 15 oz.

Example N (Fig. 82) = Warp yarns :—

	<i>Order of Warping.</i>							
24 sks. grey and 24 sks. white Cheviot twist	1	1	1	1	—	1	—	1
2/24 skeins Cheviot white								
24 sks. black and 24 sks. grey Cheviot twist	—	—	—	—	3	—	—	—
24 sks. black and 24 sks. white Cheviot twist	—	—	—	—	—	—	—	1 1
2 threads (counted as one) of 24 sks. Cheviot white	—	—	—	—	—	—	—	1 — 1
								24 threads

Weft : 1 pick of 12 sks. Cheviot black

1 ,, ,, 24 sks. black and 24 sks. grey Cheviot twist.

7's reed 4's, 64 in. wide in the reed, 24 to 26 picks per inch.

Weave : 2/2 twill.

Approximate weight per yard : 17 oz.

Example O (Fig. 83) = Warp : 8 threads of 16 sks. dark shade (Cheviot).

8 ,, ,, 24 sks. Cheviot (dark shade)
 twisted with 44's Crossbred worsted (light shade).

Weft : same as warp as to yarns but woven 12 and 8.

10's reed sleyed 4's, 64 in. wide in the reed, 36 picks per inch.

Weave : 2/2 twill.

Approximate weight per yard : 18½ to 19 oz.

It is only necessary to compare briefly Figs. 81, 82, and 83 (Cheviots), with Figs. 78, 79, and 80 (Saxonies) to distinguish the essential technical features and differences between these cloths when manufactured in medium structures. With Cheviot yarns it is not practicable to weave a fabric of the fineness and quality of Fig. 78; and, in a like relation, it is not feasible with Saxony yarns to manufacture a fabric of the precise fibrous features of Fig. 82. Fig. 83 is illustrative of the nearest to the Saxony style of texture obtainable in Cheviot suitings—the wools usable, and the yarn structure and methods of setting combined, render the somewhat broader effects and rougher fibrous characteristics, seen in Figs. 76 and 82, paramount features in fabrics made of the coarse as of the finer counts of yarns spun from Crossbred wools.

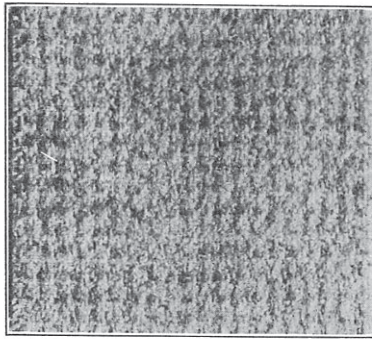


FIG. 81.—Light Cheviot costume.

From the distinctive qualities of these specimens (Examples M, N, and O) it is obvious there is, in their manufacture, scope for grades in textural construction or make, Fig. 81 being comparatively loose in structure, Fig. 83 fine in the twill, and Fig. 82 fastly woven but more pronounced in surface details. The cloths weigh approximately 15, 17, and 18 oz. per yard, the smaller yarn being used in Fig. 81 and the thicker yarn in Fig. 83. Two-fold 24 skeins (= 12 yards per dram) yarns compose the warp and part of the weft of Example N. This is a practice in Cheviot manufacturing when the single yarns are small in dia-

meter in relation to the spinning qualities of the wools from which they are produced. Doubling or twisting results in a strong compound yarn, and one which is useful in imparting freshness of effect. For "folding" purposes Crossbred worsted yarns are combined with Cheviot yarns, or the twist, as in example N, may be a composition of one thread of Cheviot and one thread of Crossbred worsted. In either combination the twist yarn lends brightness of tone to the texture.

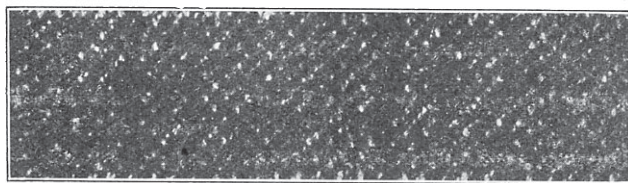


FIG. 82.—Cheviot suiting, medium weight, from fine counts of yarns.

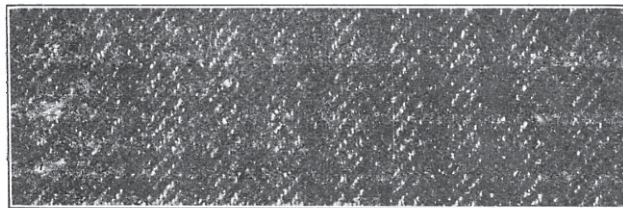


FIG. 83.—Fine Cheviot suiting.

Again it should be understood as in foregoing illustrations, these specimens are to be considered as suggestive of standard weights of cloth and methods of manufacture rather than of pattern composition and style.

(103) WORSTED GROUP OF COSTUME AND SUITING CLOTHS.

This group of textures is divisible into three distinctive grades:—

I. Fine or Botany grade of fabrics made of Botany worsted yarns ranging from 2-fold 20's to 2-fold 60's counts.

II. Medium or Crossbred grade of fabrics made of Crossbred worsted yarns ranging from 2-fold 18's to 2-fold 44's counts.

III. Serge fabrics made of the lower counts of Crossbred worsted yarns in 2-fold 12's, 2-fold 16's, 2-fold 18's and 2-fold 22's and similar counts.

Neither the first nor the second grade of fabrics undergo, from the loom width to the finished width, on an average a shrinkage contraction exceeding 8 to 12 per cent, but textures of the third grade vary, in costumes, from 10 to 15 per cent, and, in suitings, from 15 to 20 per cent.

The worsted scheme of manufacture—particularly in Botany yarns—admits of diversity of weave compatible with the construction of a sound fabric. This obtains in light textures, but not to the same extent as in cloths of 18, 20, 22, and 24 oz. per yard. Two examples adapted primarily to costumes, but which, if set firmer—84 threads and 80 picks, and 64 threads and 60 picks per inch respectively—are equally applicable to suiting cloths, have been manufactured to the data given under Examples P and Q, the patterns being sketched in Figs. 84 and 85. The former is woven in a ten-shaft weave angled (Fig. 84a) and the latter in the simple weave compound in Fig. 85a, the sections 1, 2, and 3 being grouped to coincide with the pattern.

Order of Warping.

Example P (Fig. 84) = Warp:—

2-fold 50's black	1 3 1	1 1 1	3 1 1 1
2-fold 50's white	1 1 1	— —	1 — — — —
60's/2 silk (doubled) white	— — —	— —	1 1 1 1
2/50's black and 60's/2 silk twist	— — —	1 1	— — — — —

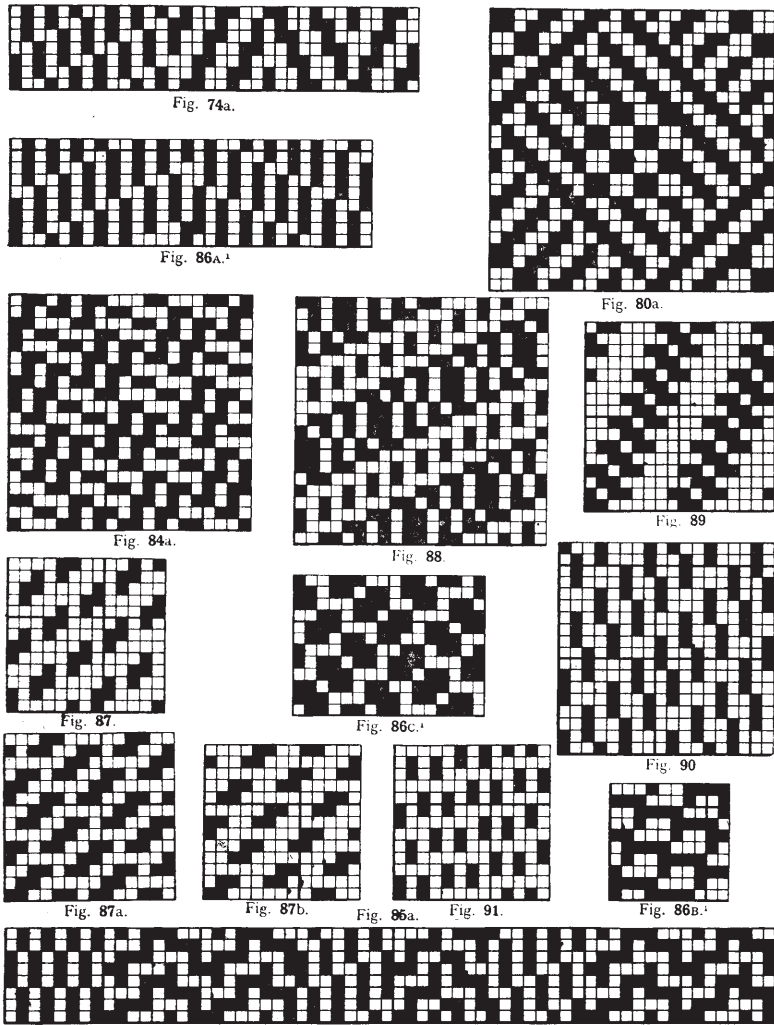
$\underbrace{\quad\quad\quad}$ $\underbrace{\quad\quad\quad}$
 8 30 28

Weft: 2-fold 50's black 1 1
 2-fold 50's white 2 —

19's reed 4's, 64 in. wide in the reed, 72 to 74 picks per inch.

Weave: Fig. 84a, Plate V. Angled to coincide with the order of warping and the pattern, Fig. 84.

Approximate weight per yard: 11½ to 12 oz.



A
B
C
D
C
B
For 8 threads. For 48 threads. 8 threads. 20 threads. 8 threads. 48 threads.

PLATE V.—Weave types applicable to light- and medium-weight fabrics.

Example Q (Fig. 85) = *Warp* :—

2-fold 60's dark shade	1	} For requisite number of threads to conform with sections B and D in plan.
2-fold 60's light shade	1	
2-fold 40's dark shade	1	} For requisite number of threads to conform with sections A and C in plan.
30's/2 white silk	1	

Weft : 1 pick of 24's dark shade.

1 " " light "

20's reed 4's, 62 to 64 in. wide in the reed, 76 to 80 picks per inch.

Weave : Fig. 85a, Plate V.

Approximate weight per yard : 10½ to 11 oz.

Though in example P three varieties of yarns are combined in the warp and two varieties in example Q, yet for practical calculations and piece making, the former may be averaged as 2/50's and the latter as 2/64's. The settings are, therefore, typical of fabrics made in 2-fold 50's yarns (warp and weft), and in 2-fold 64's warp crossed with 24's weft.

(104) METHODS OF SETTING—WORSTED-YARN TEXTURES.

Two objects have to be attained in the loom setting of standard worsted suiting and coating cloths in both Botany and Crossbred yarns, namely, the construction of a fabric of corresponding breaking strain on the warp and weft line combined with firmness of structure, and also clearness of weave effect with a suitable degree of flexibility of handle. Close, full setting develops twill or weave distinctiveness, but produces hardness of fabric; and open or loose setting develops the quality of softness, but yields a texture defective in wearing and tensile properties. Medium setting, in single-make fabrics, based on the diameter and intersection theory, gives the most satisfactory cloths. Allowances are made, on the calculated results, for the adaptation of the settings to the nature of the yarns (a higher percentage is deducted from the theoretical diameters of Crossbred than Botany yarns) and to the measure of contraction in the pieces in the finishing processes.

Three standard systems of setting are practised:—

I. Setting on the square or with the same number of threads and picks per inch.

II. Setting closer or more compact in the warp than in the weft of the fabric.

III. Setting with a smaller number of warp threads than picks of weft per inch, or closer wefting than reeding.

The superior class of wearing fabric is obtained in System I, which is generally applied to standard makes of piece-dye and mixture-yarn suitings and coatings.

Two-fold yarns are essential, in both warp and weft, if the fabrics manufactured are to indicate a similar breaking strain in width and length. Single-weft yarns, though of the same circumference as the 2-fold yarns in the warp, do not produce cloths of a corresponding degree of elasticity and firmness and durability as 2-fold weft yarns. Should, for example, the warp of the fabric be 2-fold 30's and the weft 15's or 14's, and the ends and picks be equal, the result would be a cloth inferior in quality, fineness of texture, clearness of twill, and wearing strength to one woven with 2-fold warp and weft.

System II is utilized in the construction of fabrics made (a) of the same counts of warp and weft yarns; and (b) of thicker weft than warp yarns. The latter combination is applied to balance the deficiency in strength on the warp, as compared with the strength on the weft of the fabric, due to the higher ratio of threads to picks in the setting.

System III has only a limited application, but typical examples will be illustrated.

(105) EXAMPLES IN STANDARD SYSTEMS OF SETTING.

The analysis of fabrics manufactured in accordance with these systems of setting will be rendered feasible by taking a series of types in cloths consisting of different counts of yarns, ends and picks per inch, and ounces per yard.

Manufacturing data of these typical cloths are indicated in the following table:—

TABLE XIV.

I. SYSTEM OF SETTING-FABRICS WOVEN ON THE SQUARE.

Example R = Warp and weft : 2-fold 24's worsted.

10½'s reed 4's, 64 in. wide in the reed, 40 picks per inch.

Weave : 2/2 twill.

Approximate weight per yard : 13 oz.

Example S = Warp and weft : 2-fold 30's worsted.

14's reed 4's, 63 in. wide in the reed, 54 picks per inch.

Weave : 2/2 twill.

Approximate weight per yard : 14 oz.

Example T = Warp and weft : 2-fold 36's worsted.

16's reed 4's, 66 in. wide in the reed, 64 picks per inch.

Weave : 2/2 twill.

Approximate weight per yard : 13½ to 14 oz.

Example U = Warp and weft : 2-fold 40's worsted.

18's reed 4's, 64 in. wide in the reed, 70 picks per inch.

Weave : 3/3 twill.

Approximate weight per yard : 14 oz.

Example V = Warp and weft : 2-fold 50's.

15's reed 6's, 63 in. wide in the reed, 90 picks per inch.

Weave : 3/3 twill.

Approximate weight per yard : 13½ to 14 oz.

II. SYSTEM OF SETTING CLOSER IN THE WARP THAN IN THE WEFT.

Example W = Warp and weft : 2-fold 42's worsted.

17's reed 4's, 64 in. wide in the reed, 60 picks per inch.

Weave 2/2 twill.

Approximate weight per yard : 12 oz.

Example X (Fig. 86, Pattern A) = Warp : 2-fold 48's worsted.

Weft : 24's worsted.

20's reed 4's, 64 in. wide in the reed, 72 picks per inch.

Weave : 86a, Plate V.

Approximate weight per yard : 11½ oz.

Example Y = Warp : 2/40's worsted.

Weft : 18's worsted.

20's reed 4's, 68 in. wide in the reed, 54 picks per inch.

Weave : Fig. 87, Plate V.

Approximate weight per yard : 13½ oz.

Example Y¹ = Warp : 2-fold 50's worsted.

Weft : 22's worsted.

20's reed 4's, 64 in. wide in the reed, 80 picks per inch.

Weave : Fig. 87a, Plate V.

Approximate weight per yard : 12 to 12½ oz.

*Example Y*² = *Warp* : 2-fold 50's worsted.

Weft : 24's worsted.

20's reed 4's, 64 ins. wide in the reed, 96 picks per inch.

Weave : Fig. 87b, Plate V.

Approximate weight per yard : 13 to 13½ oz.

Example Z = *Warp* : 2/44's worsted.

Weft : 20's worsted.

14's reed 6's, 64 in. wide in the reed, 70 picks per inch.

Weave : Fig. 88, Plate V.

Approximate weight per yard : 13½ oz.

*Example A*¹ = *Warp* : 2/56's worsted.

Weft : 48's worsted.

18½'s reed 6's, 66 in. wide in the reed, 90 picks per inch.

Weave : Fig. 89, Plate V.

Approximate weight per yard : 11½ to 12 oz.

*Example B*¹ = *Warp* : 2-fold 56's worsted.

Weft : 2-fold 48's worsted.

17½'s reed 6's, 64 in. wide in the reed, 68 picks per inch.

Weave : Fig. 90, Plate V.

Approximate weight per yard : 12 oz.

III. SYSTEM OF SETTING—FABRICS—CLOSER WEFITING THAN SLEYING.

*Example C*¹ = *Warp* : 2/40's worsted.

Weft : 20's worsted.

17's reed 4's, 66 in. wide in the reed, 84 picks per inch.

Weave : Plans T¹ and V¹, Plate II.

Approximate weight per yard : 14-14½ oz.

*Example D*¹ = *Warp* : 2/56's worsted.

Weft : 60's worsted.

19's reed 6's, 64 in. wide in the reed, 140 picks per inch.

Weave : Fig. 91, Plate V.

Approximate weight per yard : 12 oz.

From these examples in fabric manufacture it is evident that similar weights of texture are producible in different counts of yarns and settings, which denotes that cloths may be of the same substance and have similar wearing characteristics, though distinct from each other in fineness of structure. Analysing the first series, Example R is typical of the coarser type of fabric and is made of 2-fold 24's yarns. As a texture it contrasts in smallness of twill, compactness of threads, and quality with Example T consisting of 2-fold 36's yarns, the diameter of which is $\frac{1}{90}$ in. as compared with $\frac{1}{75}$ in., the diameter of the 2-fold

24's. The breaking strain of the thicker-yarn specimen is the higher of the two cloths, and it is obviously the cheaper fabric to construct as to yarns and looming, over one-third extra labour being required in the weaving of pieces with 64 picks per inch (Setting T) than of pieces with 40 picks per inch (Setting R). The commercial features in the favour of specimen T are fineness, quality, and neatness, combined with better wearing characteristics.

Examples U and V are adapted for more open weave structures than Examples R, S, and T. They are too compactly set for the $2/2$ twill, but yield standard cloths in the $3/3$ twill and such schemes of intersections. Finer counts of yarns are

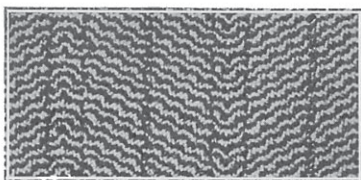
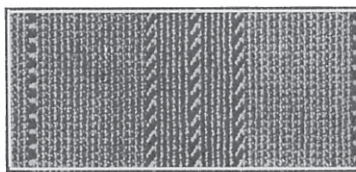


FIG. 84.—Worsted costume texture.
Weave 84a, Plate V.



A ——— C | C | C ——— A
B D D B
FIG. 85.—Worsted costume. Stripe
pattern composed of double plain,
corkscrew twill, and warp cord.
Weave 85a, Plate V.

used—2-fold 40's and $2/50$'s, which, to give better-class fabrics, should be spun from 60's top. Both form firm structures, smart and clear in the twill, and of sound wearing property.

The second system of setting does not produce fabrics so well balanced in tensile strength as setting on the square. It may, however, be utilized in the construction of cloths finer in the warp than in the weft. If the counts of both these yarns are the same the angle of the twill is changed, being made more upright in character. Thus as the ratios of the threads to picks in Examples W and X are as 68 : 60 and 80 : 72, the angle of the twill would vary from 45° to 50° .

In addition to applying weaves of equal warp and weft interlacings, important groups of plans in which the warp predominates on the face of the cloth (Figs. 90 and 91, Plate V)

are also woven in these settings. Imitation warp-backed fabrics (Example Y, Fig. 87) are, moreover, manufactured on this principle. The extent to which, in practice, the number of threads to picks per inch may vary is stated in Examples Y and B¹, namely as 80 : 54 and as 105 : 68; but the average proportions are as 6 : 5; 5 : 4; and 4 : 3.

For single-weave structures the third system of setting is adapted to special builds of fabric such as weft cords (Example C¹, Plans T¹ a stripe, and V¹ a cord twill, Plate II), imitation weft-backed fabrics, and fine warp twill effects (Example D¹); or textures closely set in the warp, and yet in which there are more picks than threads per inch. In this latter type of cloth, the weft is finer spun than the warp yarn.

Examples Y¹ and Y² form settings for imitation weft-backed fabrics, produced in plans 87a and 87b, Plate V, or 1/2 and 2/2 twill face effects—but the weaves constructed on 3 picks linked together and 1 pick omitted; or 2 picks linked together and 1 pick omitted in the arrangement of the plans. The latter is the same plan as Fig. 87, but turned round, and the marks, instead of the blanks, lifted. The ratio of picks to threads in example Y is as 3 : 2; but in Y¹ the two sets of yarns are equally combined with the weft though thicker in counts than the warp. Both are useful types of coating structures.

(106) WORSTED SERGES.

Crossbred yarns are employed in the production of this group of fabrics. The costume cloths are as a rule more loosely set and lighter in construction than the suitings as illustrated in the following tables :—

TABLE XV.
COSTUME-FABRIC SETTINGS.

Counts of Warp and Weft Yarns.	Counts of Reed.	Picks per inch.	Width in Reed.	Weave.	Approximate Weight per yd. in oz. ¹
2-fold 20's	8's reed 4 s	30	64 in.	Plain	12
2-fold 24's	10's reed 4's	40	64 in.	2/2 twill	12
2-fold 32's	13 s reed 4's	50	64 in.	2/2 twill	12

SUITING-FABRIC SETTINGS.

Counts of Warp and Weft Yarns.	Counts of Reed.	Picks per inch.	Width in Reed.	Weave.	Approximate Weight per yd. in oz. ¹
2-fold 20's	9's reed 4's	36	64 to 68 in.	2/2 twill	14
2-fold 24's	11's reed 4's	44	64 to 68 in.	2/2 twill	14
2-fold 32's	14's reed 4's	56	64 to 68 in.	2/2 twill	14

¹ The weight per yard is variable with the measure of length shrinkage.

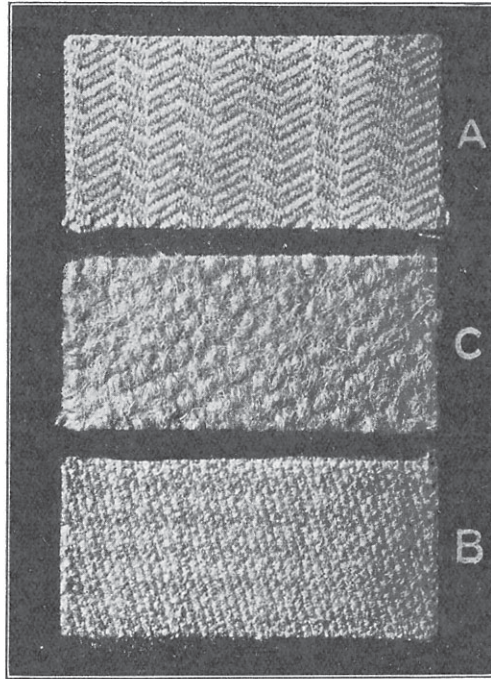


FIG. 86.—A = Botany worsted ; B = Fine Crossbred ; C = Milled serge.

Felted serges are also manufactured. Coarser spun yarns are used such as 2-fold 12's and 2-fold 16's with a small number of threads per inch. Shrinkage or felting is effected with the pieces in the open width to prevent the development of faults due to the cloths "cockling". As seen from Figs. 86 B and

86 C ordinary Crossbred and milled serges differ from each other in structural character.

(107) SURFACE CHARACTERISTICS OF BOTANY AND CROSSBRED FABRICS.

Figs. 86 A, B, and C (Plans 86 A¹, B¹, and C¹, Plate V) are typical of the three standard fabrics of a light structure producible in Botany and Crossbred yarns. Pattern 86 A possesses a smooth, clear surface with well delineated textural effects, being composed of fine counts of Botany yarns (Example X). Pattern 86 B consists of coarser yarns and is woven on the square and in the particulars stated in Example R. The effects due to the weave are distinctly developed, lacking, however, the smoothness of fabric surface characteristic of Fig. 86 A. The milled serge (Pattern 86 C) is made of Crossbred yarns,—2/20's, counts with 36 threads and picks per inch—and resembles, in fibrousness, a Cheviot fabric in which two-fold warp yarns are used. The settings and weave structures accentuate the differences in the yarns. Those in Fig. 86 A and B have a smooth regular circumference free from extraneous filament. Such surface fibre in the milled serge develops felting property and, as a result, strength and compactness of fabric, but it also produces the rough fibrous features observed in the illustration.

In unmilled serges there is an absence of this fibre. The twill or weave elements are clearly distinguishable and pronounced. A finishing routine is followed to acquire these results. The differences between such textures and those of the Botany class exist in fineness, smoothness, and suppleness which obtain to a superlative degree in the latter. "Crossbreds" like Cheviots possess crispness of handle as distinct from the fullness and softness peculiar to both Botany and Saxony cloths of a fine quality.

CHAPTER VII.

MEDIUM-WEIGHT WOOLLENS.

(108) Technical Differentiations in Cloth Manufacture ; (109) Thread Distinctiveness ; (110) Grades of Medium and Heavy Cloths. GROUP I, SINGLE CLOTH STRUCTURES ; (111) Examples in Medium and Heavy Suitings—Saxonies and Cheviots ; (112) Saxony Types ; (113) Setting in Relation to Cheviot Types. GROUP II, WARP-BACKED and DOUBLE-WEAVE STRUCTURES ; (114) Applications of Elementary Compound Weaves ; (115) Methods of Manufacture Applied to Clear-finished, Compound-weave Saxonies ; (116) Standard Double-plain Cloths. GROUP III, TWO-FOLD or FIRMLY-SPUN WARP YARN FABRICS ; (117) Cord Cloths ; (118) Example Settings for Bedford and Whip-cord Cloths ; (119) Bedford Cord Structures ; (120) Woollen Whip-cord Structures. GROUP IV, CLOTHS OF A FIBROUS FINISH AND MEDIUM WEIGHT ; (121) The Plain “Super” Cloth ; (122) Loom Setting and Milling Contraction in the Manufacture of Plain-woven Saxony Face Cloths ; (123) Billiard Cloth Manufacture ; (124) Billiard Cloth : Data of Construction ; (125) The “Satarra” ; (126) Medium-weight Meltons.

(108) TECHNICAL DIFFERENTIATIONS IN CLOTH MANUFACTURE.

THE general principles and routine of manufacture are applicable to each grade of woollen cloth production, but there are several technicalities involved in which light, medium, and heavy structures differentiate. Setting, or proximity of warp and weft yarns, and the finishing treatment the fabrics undergo after weaving, are two important characteristics in which a light woven texture is dissimilar from one of a heavier composition. Density or compactness of cloth is not to be estimated purely by the quantity of material employed in the construction of the yarns combined. Fabric weight per yard is one significant of warmth-yielding property, but there are others, particularly the constructive gauge of the fabric in the loom, felting contraction, and raising property. A cloth loosely built, though consisting

of thick yarns denoting weight or substance, may be inferior in warmth in the wear to a thinner and lighter structure more densely woven. The minuteness of the interstices, caused by the yarn interlacings, are diminished in the ratio of the fineness of the yarn counts, and the compactness of setting. This textile characteristic is emphasized in the technical features of flannel, and light suiting fabrics, in which the degree of shrinkage due to milling is small, yet textural soundness, density, and closeness are obtained.

Fine-spun yarns are also utilized in the construction of medium and heavy cloths with other characteristic results. Thin textures made of yarns of 30 to 36 yd. per dram are supple and flexible. Heavy textures composed of similar yarns are firm, less elastic, and of higher tensile strength and wearing property. When thick-yarn textures—light and heavy in make—are compared the differences are equally accentuated, and attributable to like technical causes—relative settings and milling shrinkages. Cheviot costume cloths, made of yarns $\frac{1}{30}$ in. diameter, loosely set in the reed, and woven with a minimum number of picks per inch, are open, porous, and loose in construction. Cloths of a heavier character (Saxonies) are producible in yarns ranging in counts from 5 to 44 yd. per dram.— $\frac{1}{30}$ in. to $\frac{1}{50}$ in. in diameter—yet possess firmness and density of structure. These features denote differentiations in manufacture as produced in loom setting, and in milling machine contraction.

(109) THREAD DISTINCTIVENESS.

Evenness of yarn construction, and absolute regularity in the motions of the loom, are essentials in the manufacture of thin fabrics in which the warp and weft threads are clearly distinguishable. In the weaving operation, the warp yarns require to be equally tensioned throughout the production of the piece; also to be uniformly and automatically delivered, and correctly sleyed to give a level texture. Sleying in 2's should, as a rule, be the practice when the set does not exceed 28 to 32 ends per inch. A texture of an evener surface is thus obtained, if the yarns are well spun or of suitable weaving strength and quality, than by

sleying in 3's or 4's. Wefting, or the number of picks per inch, is needed to be of corresponding regularity as warp tensioning and delivery. It implies accurate and uniform take up of the fabric, proportionate to the length of warp let off, minus the contraction in warp length due to the frequency of the interlacings of the threads and picks, and the thickness of the weft yarns. Variations in yarn construction, and in the technicalities in weaving, result in shady or streaky pieces. Inequalities in either one or the other develop defects which are rendered increasingly discernible by the distinctiveness of the yarns in the fabric. It might be considered that defects due to these causes would not be so noticeable in thick cloths, milled and raised;

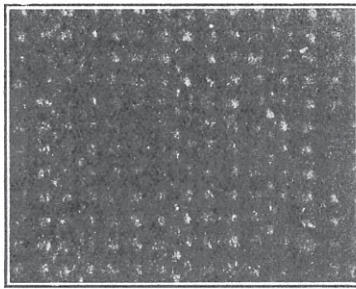


FIG. 92.—Milled Saxony, mat weave.

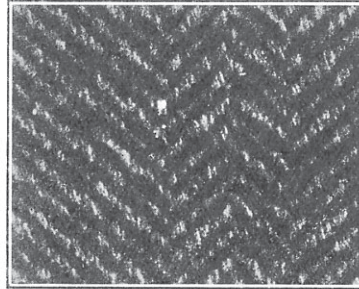


FIG. 93.—Heavily-milled Saxony.

and that is partially correct. They are less visible in the thread form, but none the less detract from the true standard of manufacture, being developed in the operations of milling and raising, which are supposed to suppress, or assist in concealing, their presence in the cloth. Possibly, in low and medium class fancies, minor irregularities in manufacture are less apparent. Slight unevenness in yarn preparation may be concealed by the nature of the materials employed, but not unevenness in weaving. Heavy cloths require to be as accurately manufactured as to carding, spinning, and weaving, as fabrics light in structure. In some grades of fabrics, e.g. clear-finished Saxonies (Figs. 52, 100, and 101), the yarns are seen on the face of the cloth distinctly, each thread retaining its separatedness of character. They are not milled into a condition of fibrous unity, and can be removed, by

dissection, from the textures without disturbing their surface features and formation. Such yarns have identical textural functions as the yarns in fine, thin-woven fabrics, and require to be of like accuracy of construction. If milled and raised cloths are considered, e.g. plain superfines or billiard cloths, or cloths in which yarn distinctiveness is changed into a fibrous-covered surface, defects in spinning and weaving are evident in the nature of the pile produced, namely in the qualities of density, smoothness, and evenness.



FIG. 94.—Slightly milled Saxony.

(110) GRADES OF MEDIUM AND HEAVY CLOTHS.

Medium and heavy cloths are divisible into the following groups:—

I. Fabrics composed of Saxony or Cheviot yarns, single in structure, and elementary in weave construction.

II. Warp-backed or double-weave fabrics firmly woven or made in the loom, closely milled, and cut clear in finishing.

III. Two-fold warp-yarn, or firmly-spun warp-yarn, cloths such as whip-cords and Bedford cords.

IV. Fibrous-finished and “face” cloths.

GROUP I.—SINGLE CLOTH STRUCTURES.

TABLE XVI.

(111) EXAMPLES IN MEDIUM AND HEAVY SUITINGS—SAXONIES, AND CHEVIOTS.

The following are examples in methods of producing these fabrics:—

Example I (Saxony (18 oz.) Fig. 92).

	32	32	
<i>Warp</i> : 2-fold 30 skeins black	2 2	— 1 1	} = 96 threads.
2-fold 36 skeins and	2 2 2 1 1 2 2 2 1 1 2 2 2 1 1 2 2 2 1 1		
20 skeins twist	2 2	2 1 1 2 2 2 1 1 2 2 — 1 1 2 2 2 1 1	
2-fold 30 sks. colour	2	----- 2 -----	

Weft: 15's skeins black.

Example II (Saxony (19 oz.) Fig. 93).

Warp: 2-fold 30 skeins medium shade or twist yarn.

Weft: 24 skeins dark shade.

Example III (Saxony (19½ to 20 oz.) Fig. 94).

Warp: 2 threads of 28 skeins black and 28 skeins white twist.

2 „ „ 14 „ medium shade.

Weft as Warp.

Example IV (Cheviot (20 to 21 oz.) Fig. 95).

Warp: 6½ skeins white natural colour.

Weft: 6½ „ medium shade.

Example V (Cheviot (23 to 24 oz.) Fig. 96).

Warp: 10 skeins medium shade twisted with 14 skeins light shade.

Weft: 10 skeins dark shade twisted with 14 skeins medium shade.

Example VI (Donegal Tweed (24 oz.) Fig. 97).

Warp: Fancy spot yarn medium grey, 62·5 yd. per oz.

Weft: Fancy spot yarn dark shade, 62·5 yd. per oz.

Example VII (Donegal Tweed (28 oz.) Fig. 98).

Warp: Spot yarn natural colour, 62·5 yd. per oz.

Weft: „ „ dark shade, 62·5 yd. per oz.

Example VIII (Milled Cheviot Tweed (22 oz.) Fig. 99).

<i>Warp</i> : 14½ skeins natural colour	11 1 1 34 21	} 72 threads.
14½ „ white and 2/2/30's worsted		
colour twist yarn	1 — 1 — —	
Fancy 3-fold twist	— 1 — 1 —	

Weft: 14½ skeins dark shade.

Example IX (Yorkshire Cheviot (21 oz.) per yard).

Warp: 13 skeins woollen.

Weft: Same as warp.

The following are the data (Table XVII) of manufacture, to the counts of yarns and methods of warping and wefting given for the several examples, showing the weight of the yarns used, length of piece out of the loom and finished, approximate loss in finishing, and weight per yard.

TABLE XVII.—DATA OF CONSTRUCTION.
SAXONIES.

	Width in Loom.	Counts of Reed.	Picks per inch.	Length of Warp Woven.	Length of Piece from Loom.	Weight of Warp Yarns.	Weight of Weft Yarns.	Length of Piece Finished.	Weight of Piece Finished.	Loss in Finishing.	Approximate Weight per yard Finished.	Weave.
Example 1 Saxony (Fig. 92).	68 in.	12½'s/2's	28	58 yd.	54½ yd.	32 lb.	27 lb.	48 yd.	53 lb. 13 oz.	9 per cent.	18 oz.	2/2 mat
Example 2 Saxony (Fig. 93).	72 in.	10½'s/4's	48	60 yd.	55 yd.	39 lb. 6 oz.	30 lb. 15 oz.	50 yd.	59 lb. 12 oz.	15 per cent.	19 oz.	2/2 twill angled
Example 3 Saxony (Fig. 94).	68 in.	12's/3's	32	60 yd.	56 yd.	40 lb. 15 oz.	34 lb.	48 yd.	60 lb.	20 per cent.	19½ to 20 oz.	2/2 twill

CHEVIOTS.

Example 4 Cheviot (Fig. 95).	67 in.	7½'s/2's	17	—	—	—	—	—	—	—	20 to 21 oz.	Plain
Example 5 Cheviot (Fig. 96).	68 in.	7½'s/2's	18	—	—	—	—	—	—	—	23 to 24 oz.	Plain
Example 6 Donegal (Fig. 97).	68 in.	6's/2's	11	—	—	—	—	—	—	—	24 oz.	Plain
Example 7 Donegal (Fig. 98).	72 in.	6½'s/2's	13	—	—	—	—	—	—	—	28 oz.	Angled 2/2 twill
Example 8 Milled Cheviot (Fig. 99).	75 in.	10's/3's	30	—	—	—	—	—	—	—	22 oz.	2/2 twill and mat
Example 9 Yorkshire Cheviot.	66 in.	17½'s/2's	33	60 yd.	54½	41 lb. 10 oz.	39 lb. 10 oz.	50 yd.	67 lb.	12 per cent.	21 to 21½ oz.	2/2 twill

(112) SAXONY TYPES.

Analysing these settings and data of manufacture, it will be observed that the Saxony examples differ in principle of con-

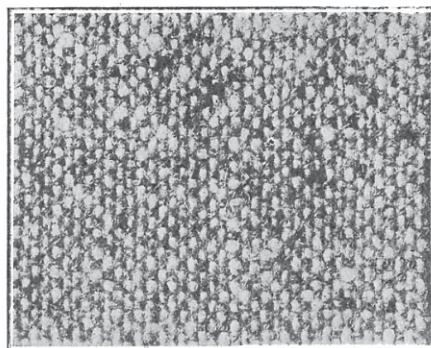


FIG. 95.—Plain woven Cheviot (unmilled).

struction. The counts of the warp yarns are practically the same in both fabrics, but in No. 1 the weft yarn is 15 skeins and in No. 2,

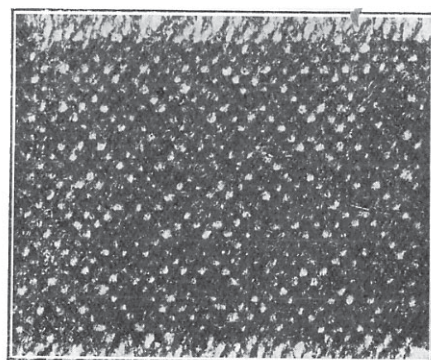


FIG. 96.—Plain woven Cheviot (slightly milled).

24 skeins. Moreover, in the first setting, there are 26 threads and 28 picks per inch, and in the second setting 42 threads and 48 picks, that is the cloths differ in compactness of structure. Each of the textures is wefted a degree closer than warped. Ordinary setting is practised in No. 1, but in No. 2 the setting is adjusted

to the counts of yarns combined, and also to the production of a special grade of fabric—one closer in density and softer in quality than obtainable in the first scheme of manufacture.

The warp and weft yarns are equally effective in Type 1, but in Type 2 a degree more prominence is afforded to the 2-fold

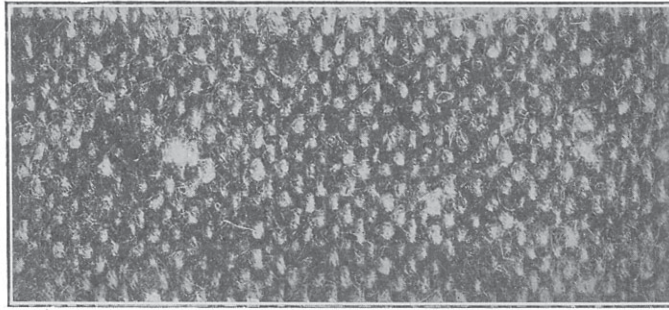


FIG. 97.—Plain-woven Donegal (loose structure).

warp than the single weft threads. Another point of distinction is the loom or reed widths, allowing for 5 per cent more contraction in milling on Cloth No. 2 than on Cloth No. 1. This, combined with the finer weft yarns and increased number of picks per inch, develops suppleness of texture favourable to the

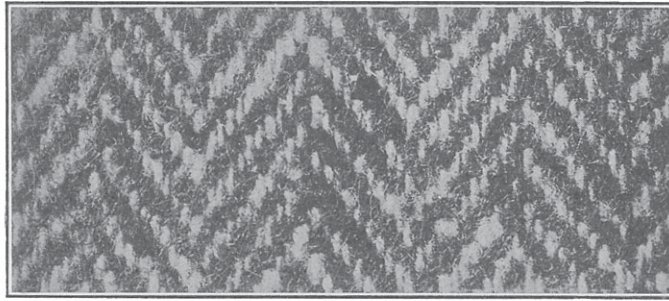


FIG. 98.—Open-make Donegal.

second example, which also results in the fabric of the higher breaking strain and warmth-yielding property.

The third example is for a medium quality of cloth in which single and folded or two-ply yarns are combined, averaging 14 skeins. It is a description of tweed manufactured, in this and

lower grades, in the West Riding of Yorkshire. Botany noils, medium sorts of Merino clothing, wools, mungo, and pulled waste form the staple materials of manufacture. They are blended in proportionate lots to produce yarns at a definite price determined by the cost per yard of the fabric. The methods of construction in the loom are fairly standardized in cloths ranging from 18 to 22 oz. per yard. It will be understood that the percentage of loss in weight in scouring and finishing fluctuates with the nature and condition of the raw materials; 15 per cent to 20 per cent may on the average be estimated. Reed setting is calculated to allow from 16 per cent to 22 per cent in contraction from the loom to the finished width. The shrinkage

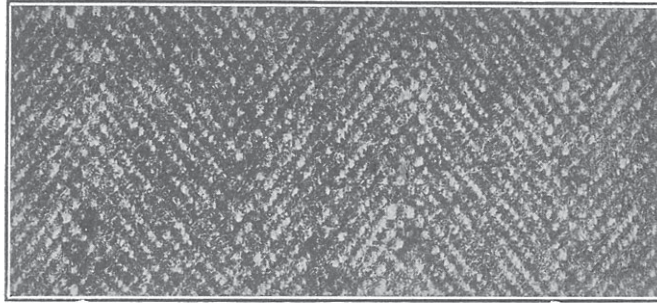


FIG. 99.—Fine Cheviot tweed.

in length is lower—10 per cent to 15 per cent—but some margin should be allowed for milling in the length of the piece for the acquirement of a cloth of a fixed weight per yard. Taking a piece of 55 yd. length to weigh 60 lb. requiring to scale 20 oz. per yard finished, then $60 \times 16 \div 20 = 48$ yd. or a shrinkage of 12 to 13 per cent; or a piece of 56 yd. of 54 lb., and requiring to weigh 18 oz. per yard, then $56 \times 16 \div 18 = 49\frac{7}{9}$ yd. or a shrinkage of 11 to 12 per cent. This ratio of length shrinkage is, however, a factor taken into account in the setting calculations. The standard is determined in such calculations to produce a cloth of a prescribed quality and character, but in milling practice some measure of length adjustment in the felted piece is permissible.

(113) SETTING IN RELATION TO CHEVIOT TYPES.

In the Cheviot examples five grades of setting are given, contrasting in yarn counts, degree of yarn compactness, and in fabric weight per yard. Three of the examples (Fig. 95, 96, and 97) are plain woven, but in manufacture and methods of construction they are dissimilar. The weights are 20-21, 23-24, and 24 oz. Pattern 97 (Example 6) is the heavier cloth, but pattern 96 (Example 5) is the evenner texture and the more compactly woven. The lightest texture of the three, and Example 5, are similar in make, though the counts of yarn are finer in the former than the latter, the threads per \square " being 33 in Fig. 96, and 32 in Fig. 95. Both Figs. 95 and 97 are set below the number of diameters, but Fig. 96 is practically set on this base. Contraction in finishing is the same in each fabric and results in Figs. 95 and 96 having 37 and 40 threads per \square ", and Fig. 97 exactly the same as obtained by calculation based on the intersection formula. The firmest of these specimens (Fig. 96) is made of 2-fold or twist yarns in both warp and weft, and is set to exceed, plus finishing contraction, by 7 threads per \square " the law of diameters and interlacings; whereas the loosest structure (Fig. 97), with contraction added, is 3 threads per \square " less than the number of diameters

In making a typical Donegal, a technical feature to observe is the number of ends and picks per inch feasible to be in actual, but not in compressed contact, with each other. When strength and openness of fabric are desiderata, the principle of setting illustrated in Figs. 97 and 98 should be practised, and when firmness of cloth is required that illustrated in Fig. 96. Pattern 95 is a fabric intermediate between these two types.

Fig. 98 is typical of the heavy tweeds producible in thick counts of yarn loosely set and woven. It should be contrasted with Fig. 46, a similar style and build of cloth, but 21 to 22 oz. instead of 28 oz. per yard as in Example 7.

Examples 8 and 9 are illustrative of the medium weight tweed suiting. No. 8 (Fig. 99) is a typical fabric made of Cross-

bred wools; and No. 9 is the scheme of manufacture for a typical fabric made of shoddy and pulled waste, representing the pure wool and the Yorkshire grades of Cheviots. In producing cloths similar to No. 8, wools of the Cheviot class are largely used, and also in the better grades—in which smaller yarns may be employed—medium Crossbred, Colonial, and South American wools. The qualities of the materials utilized in the production of these two groups of fabrics, necessarily modify the principles of loom setting, and in some measure, the system of finishing adopted. The examples are made of similar counts of yarn, and yield fabrics of approximately the same weight per yard. They differ, however, in loom setting, the Yorkshire Cheviot having the larger number of threads per inch, namely, 35 threads and 33 picks as compared with 30 threads and 30 picks in the all-wool Cheviot, or in the proportion of 68 to 60 threads per \square ". This establishes an important difference in the schemes of manufacture; the two cloths have a similar number of threads per inch finished, arising from a 25 per cent shrinkage on the pure Cheviot with only 15 per cent on the Yorkshire fabric. It follows that one piece is set 75 in. and the other piece 66 in. in the reed. This results in distinctive qualities in the finished textures. Compactness of yarns, acquired in shrinkage or felting, develops a different fabric quality from compactness of yarns acquired in weaving. It produces a softer, warmer structure, possessing a higher degree of fibrous fullness than is characteristic of cloths in which closeness of yarn contact has been obtained, to a greater extent, in the loom.

The wearing strength of the two textures is also different, being in favour of the better felted production. The quality of the materials is, moreover, evident in the brightness of texture and the purity of colour tone in the Cheviot made of new wool. To raise the percentage of shrinkage in Cheviots, made of shoddy and similar materials, would improve the density and strength of the manufactured fabric, but tend to detract further from clearness and freshness of colour quality.

GROUP II.—WARP-BACKED AND DOUBLE WEAVE FABRICS.

(114) APPLICATION OF ELEMENTARY COMPOUND WEAVES.

Weave structures applied to these cloths, as in Group I of medium-weight fabrics, are elementary in type, but the cloths are either 2-fold in the warp or 2-fold in both warp and weft. Warp-backed prunelle, 3/1 twill, and swansdown, and the double plain are the types of weaves employed; and, in closely set cloths made of high counts of yarns, warp-backed 5-end venetian and sateen. The twilled weaves may be angled in stripe combinations, but the invariable rule is to utilize a weave element producing a fine, firm, texture, and not showing too distinctly on the surface. The plans indicated are suggestive of the style of effect necessary. Each is adapted for giving clearness and definition to the warp yarns, and also for developing simple line patterns due to warp colourings (Figs. 100 and 101).

(115) METHODS OF MANUFACTURE FOR CLEAR-FINISHED SAXONIES OF COMPOUND WEAVE CONSTRUCTION.

Ordinarily, the structures are arranged in weaving two threads of face to one thread of backing yarn, resulting in the face of the texture being more compactly woven than the back, and in the practicability of using a thicker backing than face yarn. Weight is thus obtained, on the underside of the cloth, by a method not detrimental to the fineness of the face effect. The following are examples in these manufactures:—

COUNTS OF YARNS AND WARPINGS AND WEFTINGS.

Example I (Hairline or Eton Trousering, Fig. 100).

<i>Warp</i> :	22 skeins black left-hand twine	3	3	1
	44 „ „ and 44 skeins grey twist	3	1	1
<i>Weft</i> :	1 pick of 44 skeins/44 skeins twist yarn.			
	1 pick of 22 skeins black.			
	Plan : Weave E, Plate IV.			

TABLE XVIII.—DATA OF CONSTRUCTION: HAIRLINE STRIPES.

Width in Loom.	Counts of Reed.	Picks per inch.	Length of Warp.	Length of Piece out of Loom.	Weight of Warp Yarns.	Weight of Weft Yarns.	Length of Piece Finished.	Weight of Piece Finished.	Loss of Weight in Finishing.	Weight per yard Finished. 56 in. x 36 in.	Pattern
66 in. to 68 in.	19's/3's	48	60 yd.	56 yd.	40 lb. 1 oz.	31 lb. 8 oz.	52 yd.	60 lb. 10 oz.	15%	19 oz.	Fig. 100
66 in.	21's/3's	70	60 yd.	56 yd.	Face yarns = 16 lb. 8 oz. Backing yarns = 18 lb.	38 lb. 14 oz.	52 yd.	64 lb. 9 oz.	12%	19 oz.	Similar to Fig. 100
72 in.	15's/4's	64	60 yd.	56 yd.	39 lb.	33 lb. 12 oz.	50 yd.	58 lb.	20%	18½ oz.	Fig. 101

Example I Example II Example III

Example II (Worsted face Warp and Woollen backing Warp and Weft).

Warp: Face yarns = 2-fold 33's worsted.
Backings yarns = 18 skeins woollen.

Weft: 26 skeins woollen.

Plan: Fig. 100a to give a similar type of cloth to Fig. 100.

Example III (Double-plain Hairline, Fig. 101).

Warp: 2 threads of 24 skeins black.
2 ,, ,, 28 ,, light shade.

Weft: 1 pick of 28 skeins black.
2 picks of 32 skeins light shade.
1 pick of 28 skeins black.

Plan: Weave B, Plate IV. ; or Double-plain, angled and wefted 2-and-2.

The typical settings supplied (Table XVIII) are illustrative of the schemes of manufacture applicable to the production of

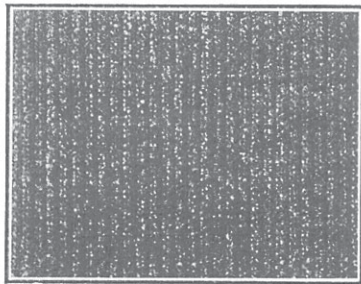


FIG. 100.—Saxony hairline.

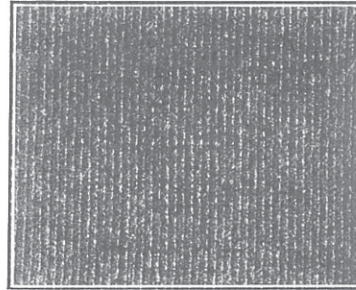


FIG. 101.—Fine Saxony hairline.

the standard Eton line trousering, the double-plain hairline, and to cloths in which worsted warp yarns are used for the face (Example II), with woollen warp yarns for the back, and fine-spun yarns for the weft.

These fabrics constitute a special class of woollen manufacture, the object of which is to produce firmness and strength of cloth, combined with clearness of textural surface, by using yarns small in diameter, compactly set in the reed, and fibrously compressed and united together in felting. The cloths are soundly constructed in the loom, but milling or shrinkage, which develops the apparent excessive degree of fibrous closeness, renders the removal of all loose fibres feasible from the face of the fabric. To effect this the pieces are raised in a dry con-

dition, first disturbing the extraneous fibre on the circumference of the yarns, and second getting up all loose or detachable filament from the foundation of the cloth. When in this condition the fabric may undergo severe treatment in the cutting operation and yet threadiness of texture is not developed. Milling contraction is not high, however, as compared with that practised in some classes of woollen cloths. It does not on an average exceed more than 20 per cent to 25 per cent. But the efficiency and value of this amount of shrinkage are evident, when considered in conjunction with the compactness of the loom settings. These may be analysed in relation to the Eton line pattern. The diameter of the warp and weft yarns is

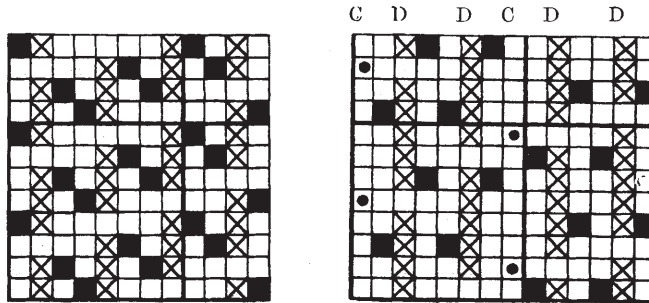


FIG. 100a.

FIG. 103a.

$\frac{1}{64}$ in., allowing of 64 threads being placed in parallel contact in a lineal inch. Calculated on the base of the weave structure this would give 45 threads $\left(\frac{64 \text{ dia.} \times 9 \text{ ends in weave}}{9 \text{ ends} + 4 \text{ intersections}} = 44.4\right)$ and 42 picks $\left(\frac{64 \text{ dia.} \times 4 \text{ pks.}}{4 \text{ pks.} + 2 \text{ intersections}} = 42.4\right)$ per inch. But the weave is 2-ply in the warp, so that 60 threads may be taken as the maximum in the warp, making 102 threads (60 threads + 42 picks) per \square'' of fabric. The cloth is set in a 19's reed and sleyed 3's and woven with 48 picks per inch so that it contains in the loom 105 threads per \square'' . Shrinkage results in a finished fabric of 64 threads and 52 picks per inch or 116 threads per \square'' . This is only 17 threads less than the actual number possible in yarns of this diameter minus interlacings.

(116) STANDARD DOUBLE-PLAIN CLOTHS.

These data determine the principles of manufacture involved, that of setting to produce as firm a fabric in the loom as possible, and of adding to the tensile strength, weaving, and other properties by milling. Standard makes of double-plain hairlines (Example III, Figs. 18 and 101) are constructed on the same system, which renders them so impervious to the weather and of a character which resists friction and strain in the wear, retaining in the process a high degree of finished "condition". It should be observed that the weave structure is a factor which contributes to the strength of the cloth, more so than the weave structure in warp-backed fabrics. The interlacings in the warp and weft being balanced, it implies, in weaves of alternate intersections as in the double-plain, the construction of a fabric of corresponding elasticity and tensile quality in whatever direction the strain is applied. Cloths twofold in the warp but single in the weft, develop a high resistance test *warp way* with a lower resistance test *weft way*. This is corrected in some methods of manufacture by using a two-fold weft yarn and inserting into the fabric the maximum number of picks per inch. Still the cloths are not in all points, as to wearing quality, comparable with cloths of the double-plain type in which the warp and weft interlacings are balanced. In the warp-backed prunelle and 3/1 twill, one set of warp threads is $\frac{2}{3}$ and $\frac{3}{4}$ on the face, and the second set $\frac{2}{3}$ and $\frac{3}{4}$ on the back of the texture, with the same series of weft yarns interlacing with both groups of warp yarns, and only appearing $\frac{1}{3}$ and $\frac{1}{4}$ of a degree on each side of the fabric. The warp yarns thus sustain the principal measure of the friction and strain applied to the cloth. This is not the condition obtaining in double-plain structures, which, if woven on the square, afford equal functions and prominence to both sets of warps and wefts. To this technicality, the superior firmness of fabric, evenness of surface, and wearing quality of the standard West of England hairline cloths are chiefly attributable—they are regular and accurate in weave construction. Supplementing this by felting some 25

per cent to 30 per cent, results in a type of cloth unsurpassed in the properties named.

Check, spotted, and small styles of varied composition, are also obtained in these weaves, when the order of warping and wefting should be thread-and-thread in contrasting shades. Fig. 102 is a small example woven in Plan 36a. It has been manufactured in 32 skeins yarns, with 60 threads and picks per inch, and set 75 in. in the reed, but the fabrics are also made in different grades and weights, from a medium costume cloth to a heavy suiting, with either a clear or fibrous finish.

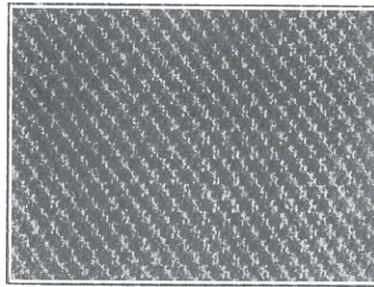


Fig. 102.—Double-plain pattern (Saxony).

GROUP III.—TWO-FOLD WARP-YARN, OR FIRMLY-SPUN WARP-YARN FABRICS.

(117) CORD CLOTHS.

In the manufacture of woollen cloths in which considerable felting is practised and yet a clear surface effect developed, firmly-spun single or two-fold warp yarns, hard in twine and well twisted together, are employed. The object of this procedure is to construct a twill, rib, or other effect, in such yarns on the face of the fabric, and not give more than a minimum degree of character to the weft yarns.

The standard woollen whip-cord and ribbed Bedford cord are two of the oldest types of two-fold or twist-warp fabrics. The Bedford cord resembles in construction the corduroy, for the making and setting of which inventions were patented at an

early date. It appears to have been originally a modification of the pile-woven cord with a view of producing a strongly developed ribbed or repped pattern, minus the employment of a pile warp or weft—the twist-warp threads being applied to this purpose. Both the rib and twilled cord (woollen cloths) are well milled with the weave characteristics distinctly developed (Figs. 103 and 104). This arises from two causes, first, to the weave effect being formed in the warp yarns; and, second, to removing by severe raising and cutting the loose filament from the surface of the texture.

Yarn structure is an important feature in these manufactures. To use ordinary spun woollen warp and weft in the plans ap-

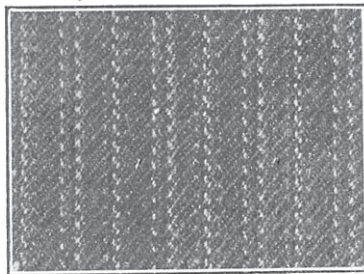


FIG. 103.—Woollen cord.

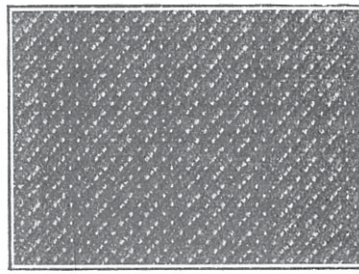


FIG. 104.—Woollen whip-cord.

plied to these fabrics, would result in fabrics possessing indefinite cord or rib characteristics. The warp yarns, as stated, are two-ply and the weft yarns single and loosely spun. In other words, the warp threads are even and level in formation and yield firmness and compactness of fabric, combined with clearness of weave development, whereas the function of the weft threads is to impart softness and suppleness on cloth of satisfactory milling facility. This compound of yarn structures is utilized in the production of Venetian and similar fabrics; and also milled worsted warp whip-cords or fine twills made of two-fold worsted yarns woven with single worsted weft or soft spun woollen yarn. These methods of manufacture are derived from those applicable to the standard structures of woollen cords illustrated below.

(118) EXAMPLE SETTINGS FOR BEDFORD AND WHIP-CORD CLOTHS.

TABLE XVIII A.

WOOLLEN OR BEDFORD CORD (Fig. 42).

Warp : 1 thread of 3-fold 36's cotton.
 6 threads of 22 skeins woollen, firmly spun, left-hand twine.
 1 thread of 3-fold 36's cotton.
 Width in reed 33 in. for 27½ in. finished.
 10's reed sleyed 2's and 6's or threads A, A' and B, B' in the
 Plan, Fig. 43, sleyed in separate dents.
Weft : 18 skeins woollen, soft spun, right-hand twine.
 60 picks per inch.
 Weight per yard (narrow width) 15 to 15½ oz.
 Plan : Fig. 43.

BEDFORD CORD—WARP BACKED (Fig. 103).

Warp : 21 skeins black 1 —
 2/44 skeins black and white twist 1 2 1
 2/24 skeins „ „ „ „ 1 1 —
 Width in reed 38 in. for 28 in. finished.
 7's reed 7's.
Weft : 2/34 skeins black and white twist 1 1
 19 skeins black 1 —
 48 picks per inch.
 Weight per yard (narrow width) 12 to 12½ oz.
 Plan : Fig. 103a.

WOOLLEN WHIP-CORD (Fig. 104).

Warp : 2-fold 30 skeins, single yarn = left-hand twine, 17 turns per inch.
 2-fold yarn = right-hand twine, 11½ „ „ „
 Width in reed 38 in. for 28 in. finished.
 14's reed 4's.
Weft : 30 skeins = left-hand twine, 12 turns per inch.
 60 picks per inch.
 Weight per yard : 13 oz. to 13½ oz.
 Plan : Fig. U, Plate II.

(119) BEDFORD CORD STRUCTURES.

These settings and plans (Figs. 42, 43, 103, and 103a) illustrate the structure of Bedford and woollen ribbed fabrics. Strictly, the standard type of Bedford cord is plain rib woven on the face, though a make of cloth is also produced with a prunelle or 3/1 twill surface, but in each class of fabric threads A, A' when separated from threads B, B' (Fig. 43) form a weft

cord texture, and give, without the addition of the plain threads, a ribbed or cord stripe. The effect of threads A is accentuated in the development of the cord in Fig. 42 by being made of three-fold cotton. They become embedded between the ribs or ridges woven in the woollen yarns, and thus impart clearness and definition to the furrows or "races" in the cloth. Such yarns require to be wound on to a separate beam from the woollen warp, making it feasible to tension the two warps differently, which are also healded on to individual sets of shafts in looming.

Fig. 103 (plan, Fig. 103a) is not the standard make of Bedford cord, but it is generally classed as such, being a well-constructed fabric of a lesser pronounced corded character than Fig. 42. The face warp yarns, as in the latter, are interlaced plain rib, but each stripe is composed of four instead of six threads. Moreover, in place of using cotton warp yarns for the furrows, special woollen threads—lettered C in the plan—are applied. The backing warp, threads D, forms a similar type of woven effect to the face warp, though looser in construction. Every third pick in the plan is single yarn and interweaves one and three with the backing threads. The dimensions of the cords in both Figs. 42 and 103 are variable in manufacturing practice.

(120) WOOLLEN WHIP-CORD STRUCTURES.

Whip-cord twills have been defined in Paragraph 83, but mainly in relation to worsted warp fabrics light in construction. The woollen whip-cord is a cloth of medium or heavy weight, and producible in fine or bold twills, and set in the loom to provide for 30 to 35 per cent shrinkage in the width of the piece. Fine Australian wools, such as Sydney, of useful milling quality, are utilized in these manufactures. The warp yarns are fine spun and two-fold, but the weft yarns single, soft, or medium spun, and, relative to the warp, small in diameter. By using, as in the example (Fig. 104), a higher counts of weft than warp, a compactly-woven texture is produced in which the warp twills are distinct and clearly defined. This is the textural characteristic to develop. Should the weft yarn be of the same or a thicker counts than the warp, and close weaving be practised, it detracts

from the whip-cord feature, subduing the warp twills. The picks of weft, like the cotton interlacing threads in the Bedford cord, should give precision to the cord effects. This is assisted by making the cloths with a larger number of picks than threads per inch, reducing the shrinkage requirements on the length of the piece. Fibrous cover on the under surface should be rendered possible chiefly by width shrinkage, as warp shrinkage tends to deteriorate the twilled characteristics.

Correct methods of manufacture consists in (*a*) using evenly-spun two-fold warp yarns; (*b*) setting wide in the reed to provide for a full degree of width contraction in milling; (*c*) the use of a smaller diameter of weft than warp yarn and wefting closely; and (*d*) a minimum degree of shrinkage on the length of piece. Other twills and settings to those indicated are also employed in these productions.

GROUP IV.—CLOTHS OF A FIBROUS FINISH AND MEDIUM WEIGHT.

The term "fibrous" is used in this connection to define (1) cloths possessing a dress or face finish; and (2) cloths of the melton character in which the pile of fibres is not spread or laid, lustred, and dressed. The lighter group of these fabrics will now be examined, those of a heavier substance and construction being treated of under "overcoatings". Four standard cloths are selected for analysis, the plain super, the Satarra, the billiard cloth, and the 20 to 22 oz. melton. With the exception of the Satarra they are plain woven, affording manufacturing details in which they may be contrasted with each other. The Satarra is acquired by using, as will be shown, a type of double plain weave. In each instance the fundamental purpose is to produce a fabric of sound, level structure, allowing in looming for a moderate percentage of felting, and, as a consequence, of the manufacture of a cloth possessing considerable surface or "balk" fibre. This is essential to the nature of the finish to be applied.

(121) THE PLAIN "SUPER".

Plain supers may be classed with the oldest types of face-finished woollens. Originally the principal wools utilized were

the merinos of Saxony and Silesia which still form, along with fine New Zealand, Tasmanian, and Australian "clothing" wools, the staple materials employed in these manufactures. Small or fine-spun yarns having to be employed, of good felting property and fibrous consistency, such close-grown, short-stapled wools are necessary.

"Supers" are wool or piece-dye cloths with a smooth lustrous surface and suppleness of texture. They should be firmly constructed in the loom to prevent the process of fulling yielding a fabric of unsatisfactory handle. As the counts of the warp yarns range from 20 to 36 yd. per dram, a sufficient degree of twine must be inserted, in spinning, to make them bear the strain in weaving without breakage, but the weft yarns may be more loosely twisted. The following are typical of the manufacturing data for a 16 to an 16½ oz. cloth:—

Warp : 28 skeins cross-band twine, firm spun.

Weft : 26 skeins open-band twine, loose spun.

90 in. wide in the reed, 8's reed 4's, 48 picks per inch, to finish
56 in. with 50 or 52 threads and 54 or 56 picks per inch.

(122) LOOM SETTING AND MILLING CONTRACTION.

Examining the particulars it will be observed that the warp and weft yarns are practically of the same thickness, but differing in direction and degree of twine. It is a correct practice to have more threads than picks per inch in the loom, the weft yarn, being the looser spun, should develop in the felting operation fibrous cover for raising. A smaller ratio of picks does not afford the same raising facility. It results in the warp yarns, or the threads of the reduced raising property, on account of being firmly spun—being acted upon to a fuller extent than the weft yarns—the threads of good raising property, by the pliable points of the teazles of the raising machine. Such a condition is unsatisfactory.

Felting is adjusted, however, to give a finished piece of a similar number of each group of yarns per inch. Thus, in the example, the ratio in the loom is as 32 : 48 but in the finished cloth as 52 : 56. It might be assumed that this would diminish

the raising contact of the weft and augment the raising contact of the warp yarns with the active points of the teazles, but such is not the result. On the contrary, this felting develops the pile-raising filament of the weft yarn; and has also the effect of equalizing the breaking strain on the length and width of the fabric, and of compressing the two groups of threads into fibrous affinity with each other.

This principle of setting and shrinkage is applicable when the counts of the warp and the weft yarns are identical. If a distinction is made, using for example a 30 skeins warp and a 20 skeins weft, then the picks per inch should be reduced to correspond with the ratio of diameters of the two yarns, and the relative proportion of picks to threads based upon the yarns being of similar diameters. Though this system of manufacture is practised with a view of effecting economies in spinning and weaving, yet it is not calculated to yield the same quality of fabric in respect to fineness of structure, suppleness, and fibrous density of pile surface, as the system described.

A second scheme of construction on the base of the above example may be indicated:—

Warp : 24 skeins cross-band twine.

Weft : 26 skeins open-band twine.

92 in. wide in the reed, 11's reed 3's, 43 picks per inch, yielding a cloth 17 to 18 oz. per yard, 54 in. within the selvages, and with 52 threads and picks per inch.

The balance of structure in the loom and in the finished fabrics is similar in both settings. The reduction in this instance of the counts of the warp yarn by 4 yd. per dram is compensated for by a reduction of 5 picks per inch and by sleying 11's reed 3's instead of 8's reed 4's. This second scheme of manufacture is the more economical in practice, providing for the use of a lower counts of warp yarn but of satisfactory weaving quality. The small diminution in the picks in ratio to the threads, as compared with the first setting, does not affect the relative value of the warp and weft yarns in the fabric structure, the weft so far preponderating as to secure the raising characteristics defined above.

(123) BILLIARD CLOTH MANUFACTURE.

The production of billiard cloths is a skilful branch of wool-len manufacture. "Picklock," "super," and the first sorts from the fleeces of the truest-grown Merino wools, possessing soundness of staple, fineness of fibre, and superior milling and raising qualities, form the staple materials employed. Purity of colour is indispensable. After scouring, the fibres should be snow-white as in Western Cape, Port Philip, and Van clothing wools. Fleeces discoloured in growth, though satisfactory in other characteristics, should be discarded as unsuitable. If the tips of the staple be yellow tinged or stained, and the locks of the wool run with filaments partially impervious to dye substances, the production of level and clear shades is rendered difficult if not impracticable. Fineness of growth affects milling and raising, but milling may be satisfactory, and yet the pile due to raising be defective. Density or fullness of pile, and also lustre and smoothness of surface, are dependent upon the fineness of the wool, and this determines the multiplicity of filaments in the diameter of the yarns of a prescribed counts. These technical qualities and physical features of the raw wool are, in this class of cloth, at the base of successful work or practice.

The fabrics differ in manufacturing minutiae from the plain "supers," though in counts of yarn, and looming, the two cloths have features in common. The warp settings and the wefting correspond, namely, the maximum in the warp, based upon the yarn diameters, and $\frac{1}{4}$ higher than the maximum in the weft. Both makes of cloth are "heavy" wefted; but in the plain super, felting, as demonstrated, is utilized to bring the two sets of threads—warp and weft—into approximate ratio, the shrinkage on the length being 20 per cent higher than on the width of the piece, so that the proportion of 33 warp threads to 43 weft threads (see the second example in beaver cloths) in the loom is altered to approximately the one quantity of 52 threads and picks per inch. This rule does not apply in the felting of billiard cloths. Here the excess of contraction is on the width, being

$\frac{1}{5}$ higher than on the warp, or changing the loom ratio of 32 threads to 42 picks to a finished cloth ratio of 45 threads to 52 picks per inch. To understand how this technicality affects the quality of the cloth the actual scheme of construction, given below, requires to be analysed and explained.

BILLIARD CLOTH: DATA OF CONSTRUCTION.

Warp: 24 skeins woollen, cross-band twine, 16 to 18 turns per inch.

Weft: 24 skeins woollen, open-band twine, 10 to 12 turns per inch, 108 in. wide in the reed, 16's reed 2's, 42 picks per inch, for yielding a finished cloth 72 in. wide with 44 or 45 threads and 54 to 56 picks per inch, 19 oz. per yard.

Eighteen turns per inch produces a firmly-spun yarn in 24 skeins, a "counts" of comparative high-breaking strain and weaving property. The felting of yarns of this structure, with more loosely-twisted yarns, imparts soundness of construction to the fabric. A billiard cloth is required to be equally firm and durable in length and width, the stretch on the texture being uniform in both directions. Tensile strain on the length of the piece has chiefly to be sustained by the warp. Yet the warp threads are the less numerous, though of the same diameter as the weft yarns. Hence the breaking strain and firmness in the length of the fabric have to be derived from the compact consistency and formation of the warp yarns. Tensile strength in the width of such a fabric, woven with soft-spun yarns, is obtainable in two ways: (1) by using a thick counts of weft thread; and (2) by inserting an excess of picks to threads per inch. Balance of fabric structure as regards tensile property is thus producible. Thick weft yarns necessarily diminish the fineness of the cloth woven, and should not therefore be utilized in this instance. On the other hand, by employing small weft yarn and increasing the ratio of picks to threads, fineness of texture is retained, and, at the same time, the felting and raising qualities of the piece are improved. This is, therefore, the correct principle of construction to apply to the manufacture of cloths of this nature, and as detailed in the loom setting given.

The example is typical of the system of manufacture applicable to cloths with a dense, lustrous pile surface in which (*a*) the same counts of warp and weft yarns are combined but of

different degrees of twine, the harder spun yarn giving tenacity and soundness of construction to the length of the piece, and the softer spun yarn developing felting and raising quality; (b) balance of structure is obtained by having an excess of threads per inch of the more loosely spun yarn; (c) a fuller degree of raised filament is acquired from the weft than the warp yarn, raising principally across this yarn but in a line with the length of the warp yarn; and (d) fineness of texture, in combination with equality of length and width tensile property, are produced by the ratio of warp and weft setting, and the ratio of warp and weft contraction in milling.

(125) THE SATARRA.

For the purpose of explaining this standard and old type of woollen manufacture, a cloth of 27 to 28 oz. per yard will be analysed. Fabrics of like quality and construction are, of course, made in lighter and heavier weights, but the setting practised in this production suitably illustrates the more salient points of manufacture. As already stated the weave (Plan P¹, Plate II) is a derivative of the double-plain, the stitching or binding of the upper and lower textures to each other being effected by reversing the positions of the yarns in each group of four picks. If, for instance, this plan were warped and woven one thread of dark grey and one thread of light grey, the first section would form a transverse line of the dark shade, and the second section a transverse line of the light shade in the cloth, proving that the weave construction changes the two textures, of which the compound fabric consists, from face to back, and from back to face, each successive four picks.

The "Satarra" is, however, a piece-dyed cloth having a fibrous or semi-dress-face finish, but the fibrous pile is neither so dense, smooth, nor lustrous as in either the plain "super" or the doeskin. The distinctive feature of the cloth is the clean-cut lines traversing the piece from selvedge to selvedge, and due to the technicality defined in the weave. To operate upon the piece to the same degree, in raising, as in finishing a doeskin, would tend to subdue and partially erase the cutting lines;

and these are required to be, in the finished texture, clear and distinct.

The method of loom setting differs from either the "super" or the billiard cloth.

SATARRA—WEAVING DATA.

Warp : 21 skeins, cross-band twine.

Weft : 18 skeins, open-band twine.

76 to 80 in. wide in the reed, 14's reed 4's, 56 picks per inch, finishing 56 in. wide and 28 oz. per yard. Loss in finishing 18 per cent.

Like the plain "super" the cloth has approximately the same number of threads as picks per inch finished, but it differs as indicated in loom setting, being woven on the square. Structurally, the cloth is determined in the loom and not by felting the piece differently in length and width, for the shrinkage should result in the same ratio of threads to picks in the finished as in the unfinished fabric. From the principles of manufacture defined, it will be understood that this is an accurate scheme of setting to practise in the production of cloths in which the warp and weft yarns are of similar counts, and required to develop corresponding qualities in the finished fabric.

(126) MEDIUM-WEIGHT MELTONS.

Melton cloths are fully considered in Chapter IX., but it is useful to contrast briefly, at this stage, the construction and technical features of this firmly-made and heavily-milled woven structure, with the dress-face finished fabrics described. Meltons are produced from medium and fine but strong-grown wools, and in the lower varieties from wool substitutes such as pulled waste, mungo, and similar materials, used separately or blended with wools of a sound staple to improve the strength and fullness of handle of the cloth. The fabrics are plain or broken 2/2 twill woven (I, Plate II.). Compound weaves are seldom used excepting in "union" manufactures. Substance and weight of texture are obtained by variations in yarn counts, setting, and milling, and not by variations in weave construction.

A standard setting for a 22 oz. cloth is as follows :—

Warp : 13 skeins, cross-band twine.

Weft : 12 skeins, open-band twine.

90 in. wide in the reed, $12\frac{1}{2}$'s reed 2's, 25 picks per inch, yielding a 24 oz. cloth 54 in. wide within the selvedges. Estimated loss in finishing, 15 per cent to 20 per cent according to the quality of the material used, and percentage of oil applied for blending and carding.

As a result of the contraction in length and width in milling, a quantity of "balk" fibre or entangled filaments cover the surface of the cloth. This is not spread and developed into a smooth, bright fibrous condition as in "face" cloths, but levelled to form a short, dense pile or nap.

CHAPTER VIII.

MEDIUM-WEIGHT WORSTEDS.

(127) Acquirement of Weight per Yard in Worsted; (128) Threads per square inch and Weave Structure; (129) Weight Variations without Altering Textural Fineness; (130) Reduction of Picks in Relation to Backing-Yarn Diameters; (131) Factors affecting Weaving Economy; (132) Two-ply Warp and Two-ply Weft Methods of Construction Compared; (133) Principles applicable to Double-weave Structures; (134) Weight Modification of Double Fabrics; (135) Group Classes of Union Worsted; (136) Setting Examples in Compound Worsted; (137) Looming and Finished data of Examples in Compound Worsted Cloths; (138) Analytical Contrasts in Setting and Fabric Composition; (139) Union Worsted Partially Composed of Cotton Yarns; (140) Manufacture of Warp-backed Textures; (141) Examples in Double-make Manufactures; (142) Setting Comparisons; (143) Practical Requirements and Cloth Compounds; (144) Structural Contrasts.

(127) ACQUIREMENT OF WEIGHT PER YARD IN WORSTEDS.

DISTINCTIONS in principles of fabric structure and methods of woven manufacture are involved in the acquirement of weight per yard in woollen and worsted cloths. In both types of fabrics, the counts of the yarns, and the number of warp and weft threads per square inch in the texture in weaving, constitute the base on which calculations are formulated. Woollen-cloth manufacture provides a degree of latitude in loom setting, and also in contraction, not available in the manufacture of worsted cloths. Analytical standards have been stated and defined, indicating how varied is the relation in woollen fabrics of the *woven* or *loom* length and width to the *finished* length and width. Pieces 66 in., 70 in., or over 90 in. of 52 yd. or 56 yd. from 60 yd. of warp may measure finished 56 in. of 40 yd. or 48 yd., This contraction is a controlling factor in the acquirement of weight per yard in woollen cloths, resulting in the

compression of the threads of warp and weft into a reduced fabric area. As the yarns retain their original diameters and length, remaining unaffected in counts, the ratio of weight added is proportionate to the compression applied, that is to say, providing 40 threads and picks per inch yield a 16 oz. cloth from the loom, and that shrinkage results in the same cloth possessing 60 threads and picks per inch, the finished result is, theoretically, a heavier fabric—losses in scouring and milling not being estimated.

Many varieties of worsted fabrics—e.g. costumes, coatings, and suitings in piece dyes and fancies—have identically the same textural characteristics in the finished and loom conditions, denoting (1) a corresponding number of threads per inch in the fabric *woven* and the fabric *finished*; (2) no appreciable alteration in the *loom* and *finished* weight per yard; and (3) that the qualities designed and developed in weaving form the qualities and technical features of the fabric finished. It is understood that in certain classes of tweeds and Saxony costume fabrics, the modifications produced in finishing, and affecting the weight and quality of the cloth, are not pronounced in degree, but, in other classes of woollens, milling and raising develop new qualities and may duplicate the weight per yard.

Worsteds—with the exception of a limited variety of milled fabrics—are not manufactured on these lines. The pieces are loom set approximately corresponding to the finished set, therefore the chief factors on which weight is obtained are the counts of the yarns, and the multiplicity of the threads per inch in weaving. On an average, worsted pieces do not lose more than $7\frac{1}{2}$ to 10 per cent in the finishing routine, further approximating the weight per yard of the finished fabric to the weight per yard of the fabric calculated on the looming data.

Summarizing these points in *woollens*, the weight per yard is calculated on the loom setting—yarn counts and threads per []'—plus the changes produced in the cloth by felting which renders the fabric more compact and closer in structure, of improved wearing strength and increased weight; whereas in the

ordinary classes of *worsted*s, weight per yard is determined almost solely by the yarn counts and the ends and picks per \square in weaving. Scouring produces some contraction in the piece, and develops suppleness of fabric, clearness of textural characteristics, and also improved wearing quality, but it is not a process which appreciably modifies the weight. Milled worsteds, such as khaki serges, khaki tartans, Vicunas, and several varieties of Crossbred overcoatings and suitings are differently constructed, and come under another category of worsted manufactures. Ordinary worsteds are designed and produced without fulling or milling, hence the method of loom setting fixes the weight per yard of the cloth.

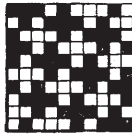


FIG. 105.—Ten-shaft weave.

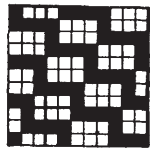


FIG. 106.—Twilled mat, or eleven-shaft Barathea.

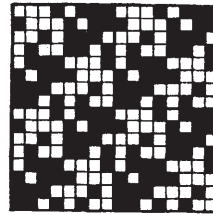


FIG. 107.—Checked weave.

(128) THREADS PER SQUARE INCH AND WEAVE STRUCTURE.

The weight of the fabric in worsted manufacture is changeable in two ways: (1) by altering the number of threads per \square , and (2) by altering the counts of the yarns utilized. Either method varies the character of the texture. If the threads per inch are increased to give a heavier cloth without any change in the weave, the fabric, if correctly set as originally woven, will be hard in the handle and unsatisfactory in structure. Should thicker yarns be used, and the same weave and number of threads per inch be employed, a heavier fabric is obtained, but one defective in fineness. Assuming the weave to be $2/2$ twill and the yarns 2-fold 40's in the sample cloth, set in a 16's reed 4's with 64 picks per inch, then by adopting the first method and weaving with 72 threads and picks per inch, the weight per yard would be increased in the ratio of 128 : 144 or as 8 : 9. By the

second method, reducing the counts to say 2-fold 30's, and retaining the same number of threads and picks per inch in the loom, the weight per yard may be increased in the inverse proportion of the lengths of 20×560 and 15×560 , denoting the use of an additional weight of the thicker yarn, to produce the

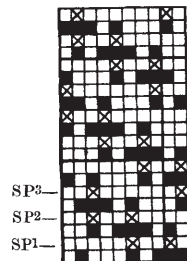


FIG. 105a = FIG. 105.—Backed with weft, pick and pick.

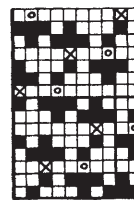


FIG. 105b = FIG. 105.—Backed with weft, 2 picks face and 1 pick backing.

same width and length of piece, than required in employing the finer yarn, and in exact ratio of the two counts. Two distinct cloths are thus acquired, both overcrowded in the setting, though made of yarns of dissimilar diameters. Neither cloth would be satisfactory. It would be necessary to change the weave to $3/3$

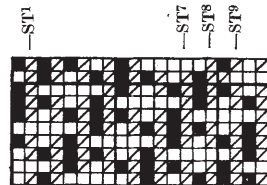


FIG. 105c = FIG. 105.—Backed with warp, thread and thread.

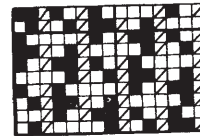


FIG. 105d = FIG. 105.—Backed with warp, 2 threads face and 1 thread backing.

twill, and this would result in a fabric improved in quality of handle, but more open in the make, and of a different twilled appearance to the original pattern. Certain variations of the standard setting are feasible in these two examples which would closely resemble the "type" fabric selected, and give an increase of 1 to 2 oz. per yard, such as using the same counts of warp and 18's weft, woven with 68 threads and 64 picks per inch, or $2/36$'s warp and 18's weft and practising the same set-

ting. Moreover, other fabrics of satisfactory structure having some of the characteristics of the original cloth, and of 2 and 3 oz. per yard heavier, could be obtained thus:—

Fabric.	Warp.	Weft.	Set.	Picks per Inch.	Weave.	Twills per inch.	
						Warp.	Weft.
A	2-fold 36's	18's	20's reed 4's	72	4/4 twill	10	9
B	2-fold 44's	20's	20's reed 4's	72	3/3 "	13½	12
C	2-fold 48's	21's	15's reed 6's	84	4/4 "	11¼	10½

Fabric A = a 16 to a 17 oz. cloth with 10 warp and 9 weft twills per inch.

B = a 14½ oz. " " 13½ " " 12 " " " "

C = a 15½ oz. " " 11¼ " " 10½ " " " "

The original pattern (12½ to 13 oz.), 2/40's warp and weft with 64 ends and picks per inch, has 16 warp and 16 weft twills per inch, so that example B would approximate it in twilled appearance. In A the warp twills are $\frac{1}{10}$ in., in B $\frac{1}{13.5}$ in., and in C $\frac{1}{11.5}$ in. as compared with $\frac{1}{18}$ in. in the standard. The weft twills are a degree opener in structure in these three settings than the warp twills, causing the angle of the twills not to correspond with that of the type cloth namely 45° in both warp and weft.

(129) WEIGHT VARIATIONS WITHOUT ALTERING TEXTURAL FINENESS.

These settings, and the principles of intertexture defined, clearly indicate that to change the weight of a worsted cloth substantially, and yet retain the original textural characteristics, other schemes of manufacture to those considered must be practised. No appreciable variation in the counts of the yarns nor in the relation of the warp and the weft threads is feasible, which necessitates the application to the texture they form of a supplementary series of yarns. Three systems of construction are possible, namely, utilizing (a) a supplementary stratum of *weft*; (b) of *warp*; and (c) of *warp* and *weft* yarns. Such threads have distinct functions from those employed in making the fabric proper. They bear no relation to the face effect, and may

either correspond in scheme of interlacings and yarns, or be dissimilar, in both technicalities, to those applied in the construction of the face fabric. Fineness of cloth structure, and the twilled or weave characteristics of the original sample, remain unaltered. On the underside of this structure a "back" or "cover" of yarns is woven. The principles of fabric setting and manufacture will be better understood by examining types in each class of production.

Figs. 105, 106, and 107 are three weave bases which, when made in the settings given below, produce 14, 13, and 16 oz. cloths respectively:—

Fig. 105 = *Warp*: 2-fold 40's. *Weft*: same as warp. *Ends and picks* per in. 70.
 Fig. 106 = ,, 2-fold 48's. ,, ,, ,, ,, ,, ,, 80.
 Fig. 107 = ,, 2-fold 30's. ,, ,, ,, ,, ,, ,, 60.

It is required to increase the weight per yard in Fig. 105, first, by a supplementary set of weft yarns, and, second, by a supplementary set of warp yarns; in Fig. 106 by a supplementary set of warp and weft yarns of the same counts and setting as in the face cloth; and in Fig. 107 also by additional warp and weft yarns but of different counts, setting, and materials, from those employed in making the standard texture. Then the types of fabric structures illustrated in Figs. 105a, 105b, 105c, and 105d, and in Figs. 106a and 107a, would provide for the application of the supplementary yarns on these principles.

The weft system of construction is shown in two forms in Figs. 105a and 105b, the former being arranged 1 pick face and one pick backing yarn, and the latter 2 picks face and 1 pick backing yarn. The face fabric is identical in fineness and structure in both plans, but the thickness of the supplementary yarn is varied, that for Fig. 105a being 20 skeins or $\frac{1}{8}$ inch in diameter, and that for Fig. 105b 10 skeins or $\frac{1}{4}$ inch in diameter. This produces a difference in weaving, and also in the backing material of the two fabrics. Should, however, the finishing routine result in the fibre of the yarns being raised on the under surface, it would minimize the distinctiveness of quality due to the backing yarns being of dissimilar counts.

Analysing these examples in which the warp and face weft yarns, and the set—14's reed 5's—are the same as in Fig. 105, two typical methods of wefting may be considered:—

FIG. 105a.

Warp: 2/40's worsted.
 14's reed 5's.
Weft: 1 pick of 2/40's worsted for face.
 1 ,, ,, 20 to 22 skeins woollen for back.
 120 to 130 picks per inch.

FIG. 105b.

Warp: 2/40's worsteds.
 14's reed 5's.
Weft: 1 pick of 2/40's worsted for face.
 1 ,, ,, 10 to 12 skeins woollen for back.
 1 ,, ,, 2/40's worsted for face.
 93 to 105 picks per inch.

(130) REDUCTION OF PICKS AND BACKING YARN DIAMETERS.

To reduce the number of picks per inch, though the counts of the face weft may not be changed, modifies the weave effect, making the fabric more open in structure. Within certain limits, variations in the backing-yarn counts, and in the picks per inch, are practicable; and, for a similar reason, 110 picks in Fig. 105a or 90 picks in Fig. 105b would, in the warp setting stated, yield satisfactory cloths. When the picks are diminished to this degree, or in a like proportion, then the counts of the backing weft should be similarly reduced if a heavy cloth is required, say to 15 skeins in the first instance, and to 8 skeins in the second instance. It is, moreover, essential that the backing yarn should "cover" or give a compact texture, and that the fineness and closeness of the weave formation of the single-make fabric should be obtained. The employment of a yarn for the under surface too small in diameter, in proportion to the picks of weft inserted, is detrimental to firmness of fabric structure, and if the yarn is too thick in counts it shows through on to the face and develops a faulty cloth. From a like cause, if the picks are not sufficiently compacted in weaving, the face fabric is too thin, and the compound cloth proves unsatisfactory

in the wear. Experiments are necessary, but the elements on which correct structures are formulated are the diameters of the yarns, the frequency of the interlacings in the weave, and the relative density or proportion of the face to the backing weft picks. Taking these illustrations, the face warp and weft yarn is $\frac{1}{95}$, and the backing weft yarns $\frac{1}{80}$, and $\frac{1}{42}$ of an inch in diameter, with 60 or 65 face and backing picks per inch in Fig. 105a; and 62 or 70 face picks, and 31 and 35 backing picks per inch in Fig. 105b. For the number of the face picks in each example, plus the number of the warp threads, the fabrics are correctly constructed; and, obviously, the number of backing picks applied of these diameters, combined with the warp interlacings,

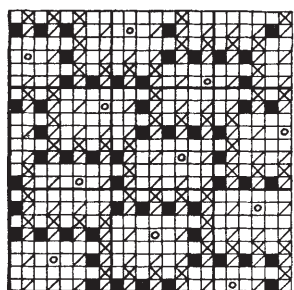


FIG. 106a = FIG. 106.—Double structure Barathea.

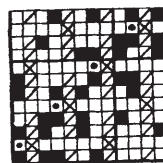


FIG. 107a = FIG. 107.—Double structure with plain back.

would cause the backing weft threads to be in contact with each other, thus complying with the accurate scheme of manufacture.

Fabric weight per yard is also a fundamental factor for consideration. Here the resultant cloths are 23 to 24 oz. and 25 to 26 oz. per yard, illustrating the utility of the backing yarn in imparting weight in these types of fabric—this yarn yielding in both Figs. 105a and 105b some 50 per cent of the weight of the cloth. By decreasing, within the practical wefting limits, the picks per inch, or by using a smaller backing weft yarn, the weight per yard may be diminished, but the correct and economic principle of construction in this class of worsted manufacture, is to acquire, with the backing yarn, as large a proportion of the weight of the fabric as possible to be in agreement with the formation of the fineness and quality of the face texture.

(131) FACTORS AFFECTING WEAVING ECONOMY.

In regard to weaving economy, the second system of applying the supplementary or weight-producing yarns to a single-weave fabric, is more appropriate and useful than the first system, for the application of additional yarns in the warp does not increase the amount of weaving. Fig. 105a having 130 picks per inch would be nearly double the cost per piece for weaving of Fig. 105 having 70 picks per inch;¹ or contrasting the time taken in the production of pieces in Figs. 105b and 105c, in which the picks per inch are 105 and 60 respectively, and weaving in looms running at 100 picks per minute, and allowing 20 per cent for stoppages to produce a 60 yd. piece, in the former would occupy $47\frac{1}{4}$ hours, but only 27 hours in the latter; thus—

$$\text{I. } \frac{105 \text{ pks. per in.} \times 36 \text{ in.} \times 60 \text{ yd.} \times 100 \text{ per cent}}{100 \text{ pks. per min.} \times 60 \times 80} = 47\frac{1}{4} \text{ hrs.}$$

$$\text{II. } \frac{60 \text{ pks. per in.} \times 36 \text{ in.} \times 60 \text{ yd.} \times 100 \text{ per cent}}{100 \text{ pks. per min.} \times 60 \times 80} = 27 \text{ hrs.}$$

Therefore, obtaining weight per yard by increasing the threads and not the picks per inch is, as regards weaving, distinctly the more economic principle of manufacture. Counterbalancing this there are in favour of the weft system, (1), the feasibility of using a thicker and less costly yarn for backing weft than warp; and, (2), its adaptability to the production of cloths of a heavy structure. The warp system on these grounds is employed in the construction of the better qualities of fabrics, and in which, on an average, the weight of the single cloth is increased in weight by the backing warp from 15 per cent to 30 per cent; but the weft principle is utilized in the weaving of the lower and heavier makes of cloth, and in which the weight may be increased by the addition of the backing weft yarns 50 to 60 per cent.

(132) TWO-PLY WARP AND TWO-PLY WEFT METHODS OF CONSTRUCTION COMPARED.

Examining the weaves—Figs. 105c and 105d—and comparing them with Figs. 105a and 105b, it will be observed that the two

¹This is exclusive of the extra price paid for box-loom weaving as compared with plain shuttling.

types are related in plan of construction, though differing in the use of the kind of yarn *warp* or *weft* for backing purposes. The face weaves are identical in formation, and the face and backing surfaces also correspond in scheme of interlacing, but are developed in threads of weft and warp respectively. Taking, for example, the supplementary picks 1, 2, 3, etc., in Fig. 105a, they correspond in order of intersections with the supplementary threads 9, 8, 7, etc., in Fig. 105c as follows:—

SP¹ (Fig. 105a) = on the back five weft, one warp, two weft and one warp: and ST⁹ (Fig. 105c) = on the back five warp, one weft, two warp and one weft.

SP² (Fig. 105a) = on the back two weft, one warp, two weft and four warp: and ST⁸ (Fig. 105c) = on the back two warp, one weft, two warp, one weft and four warp.

SP³ (Fig. 105a) = on the back two weft, one warp, six weft, and one warp: and ST⁷ (Fig. 105c) = on the back two warp, one weft, six warp and one weft.

That is to say, the under surface in both textures is precisely the same in weave character. This is not an invariable rule, but it is generally the case in the standard makes of these cloths. Developing the weaves in the same counts of yarns and setting, but with the supplementary threads applied as indicated in the illustrations, would give compound fabrics of a like structure, weight, and quality with, however, the extra oz. per yard and tensile strength developed by the picks, SP, in Fig. 105a, and by the threads, ST, in Fig. 105c. From these comparisons it will be understood that the data determining the selection of the counts of the yarns adapted to weft-backed structures, as also to the relative diameters and compactness of the face and supplementary threads, control the setting of warp-backed cloths.

Two schemes of manufacture applicable to Figs. 105c and 105d, retaining the same face warp and weft yarns as in Fig. 105, are as follows:—

FIG. 105c.

Warp : 1 thread of 2/40's worsted for face.
 1 „ „ 2/40's „ „ back.
 26's reed 5's.
Weft : 2/40's worsted, 65 picks per inch

FIG. 105d.

Warp : 1 thread of 2/40's worsted for face.
 1 ,, ,, 15 skeins woollen for back.
 1 ,, ,, 2/40's worsted for face.
 21's reed 5's.
Weft : 2/40's worsted, 70 picks per inch.

The first of these backing arrangements adds 5 oz. per yard to the single cloth and the second 9 oz., as compared with the system practised in Fig. 105a adding 9 to 10 oz., and in Fig. 105b, 10 to 11 oz. per yard. No marked alteration occurs in the face effect or fabric, which possesses the same textural characteristics in Figs. 105a, b, c, and d. This feature, in conjunction with the comparative weights per yard of the four cloths, suggests the advantage of the weft over the warp system of backing in producing weight in the fabric. As already explained, warp backing is ordinarily of a finer quality of yarn than weft backing, and is frequently composed of worsted yarn like those forming the face of the fabric; but, on the other hand, the several grades of standard worsted cloths made on this principle are manufactured with a woollen weft for backing.

(133) PRINCIPLES APPLICABLE TO DOUBLE-WEAVE STRUCTURES.

According to the third system of construction (Fig. 106a) a similar weave (usually that applied to the face texture) is developed on the back of the fabric to that employed in making the single cloth. Here the yarns on the underside may be either of the same, or different counts, to those used for the face side. If the structures are arranged on the base of Fig. 106a, which gives the same number of face and backing threads per \square " in the fabric, the weave on both surfaces of the cloth should be of a similar construction; but in instances where the proportion of the face to the backing threads is dissimilar as in Fig. 107a, distinct weaves counts and qualities of yarns are applicable to each side of the compound cloth.

The first principle produces a "reversible" fabric, and is commercially designated "double-make," such as double-make cassimere, double-make Mayo, and double-make mat. The term

is descriptive of a compound texture 2-fold in weave and in warp and weft yarns. Many of the best qualities of winter-weight worsteds are made on this principle, which is a type of textural construction that gives a cloth of high tensile strength and wearing property. If the pieces consist of fancy styles it is the correct practice to develop the same colour effect or pattern on both the face and under surfaces. The cloths are cheapened in manufacture by using 2-fold warp yarns and single weft yarns, or by having the backing yarns a few degrees coarser in counts than the face yarns. Irregular types of double weaves

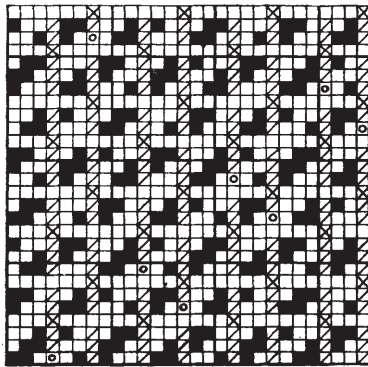


FIG. 107b.—Double structure 2-and-2 twill face and plain back, equal to 5 threads of face to 2 threads of backing.

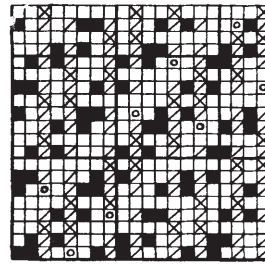


FIG. 107c.—Double structure 2-and-2 twill face and back, equal to 6 threads of face to 3 threads of backing yarn.

are useful for this practice. Eliminating the centre twill of Fig. 67, the two-fold structure might be woven in 2-fold 48's face and 2/34's backing yarns with 132 threads and picks per inch, producing a texture of a similar character and handle as a double-make seven-shaft worsted whip-cord. Strictly, it is this weave on the face, and the 5-shaft venetian on the back, but the ratio of the threads per \square'' —77 : 55—of the two sets of yarns, and the corresponding ratio of interlacings between the weaves of the face and backing textures, produce a compound cloth closely resembling, in technical features, a reversible two-ply fabric.

Each texture, however—face and backing—should correspond in this type of double-make in weight per yard as well

as in weave effect and other technical features. Producing Fig. 106a in 2/48's yarns and in 80 ends and picks per inch yields a $12\frac{1}{2}$ to 13 oz. cloth. Therefore if Fig. 106a (the double make) were woven in the same warp and weft with 160 ends and picks a 25 oz. cloth would result. To alter either the weave or the counts of the yarns for the back fabric, would change the structure and also the ratio of weights of the two textures. By the use of irregularly arranged double weaves these factors are, to some degree, adjustable. If the correct weave is used, it admits of the employment of such yarn counts, and setting, as will ensure the weaving of a compound cloth in which the face texture will correspond in weave characteristics, strength, and weight per yard, with the back texture. Figs. 107b and 107c are examples in twilled weaves of the correct construction for this class of double-make worsted. Knowing, either from experiment, or calculation, the yarns to use for the face cloth, it is a question of proportion as to the counts of the yarns to apply to the backing, when the ends and picks per inch and the number of intersections in the weave are fixed factors.

Taking Fig. 67 reduced to a double weave as an illustration, suitable face yarns would be 2-fold 48's with 77 ends per inch, then first ascertain the weight of the warp yarns per yard of the fabric 65 in. in the reed. Thus set, it would be $77 \times 65 \div 24's \times 35$ (yd. per oz. in hank of worsted) = 6 oz. Now the ends per inch in the face cloth being 77, and the double weave containing 12 threads in a repeat with a 7-shaft twill face and 5-shaft twill back, there must be 55 ends per inch on the back, for $77 \text{ ends} \div 7 \text{ threads}$, in the face weave, gives 11 repeats of the double weave per inch. It therefore follows that $55 \text{ ends} \times 65 \text{ in. (reed width)} \div 6 \text{ oz.} \times 35$ (yd. per oz. in worsted hank) will equal the counts of the backing yarn required, namely, 17's or 2-fold 34's.

The type of double cloth structure, illustrated in Fig. 107a, is adapted to the production of heavy fabrics of a winter suiting and overcoating character. Setting the single weave (Fig. 107) in 2-fold 30's yarns in a 15's reed 4's, and with 56 picks per inch, yields a $14\frac{1}{2}$ oz. cloth, but if warped and woven, as follows:—

1 thread of 2-fold 30's worsted for face,
 1 " " 20 skeins woollen for back,
 1 " " 2-fold 30's worsted for face,

and set in a 15's reed 6's, with 90 picks per in., a 26 oz. overcoat-
 ing cloth is produced. This heavier cloth would have precisely
 the same weave structure on the face as Fig. 107, but be twilled
 woven, and composed of woollen yarn, on the back.

Fabrics of this description are constructed in a variety of
 ways. As an example, Fig. 107a, which is a standard type of
 weave structure, may be taken. The plan may be woven in the
 following settings in addition to that considered:—

A.

Warp : 1 thread of 2-fold 40's worsted for face.
 1 " " 2-fold 28's " " back.
 1 " " 2-fold 40's " " face.
 18's reed 6's.

Weft : 1 pick of 2/48's worsted for face.
 1 " " 30 skeins woollen for back
 1 " " 2/48's worsted for face.
 104 to 108 picks per inch.

B.

Warp : 1 thread of 2-fold 48's worsted for face.
 1 " " 2-fold 28's " " back.
 1 " " 2-fold 48's " " face.
 21's reed 6's.

Weft : same as warp, 124 picks per inch.

The object, in setting A, of using a woollen backing weft, is
 to obtain additional weight, and improve the flexibility and
 fullness of the handle of the cloth. This weft yarn should be
 loosely spun and of good fibrous quality, so that in a piece-dye
 production the under surface of the fabric may be treated to a
 slight degree in the raising operation. When woollen yarns are
 combined for backing in both warp and weft, the pieces are
 set 68 in., 70 in., and 72 in. in the reed, providing for 12 per
 cent to 15 per cent shrinkage in width, but the milling process
 is not practised with a view of felting the face yarns, as this
 would be detrimental to the brightness and weave character of
 the face texture. The use of worsted yarns for backing, as in
 setting B, is preferable to applying woollen yarns in the manu-

facture of fancy suiting fabrics, where the pattern on the back of the cloth should resemble in style, or colouring, the pattern developed on the face. Woollen yarns, if used in this class of fabric, impart a duller tone to the pattern details on the under-side of the texture than the worsted yarns utilized in the weaving of the face effects.

(134) WEIGHT MODIFICATION OF DOUBLE FABRICS.

It should be observed that a general rule, in converting a single into a double-weave fabric, is to reduce the original setting of the single texture, from 5 per cent to 10 per cent. Fig. 106a has been referred to as set with double the number of threads per square inch in the compound as in the single structure (Fig. 106). Considering the latter is not set over the normal, this would give a double-make cloth firm in construction; but, if in the heavier build of fabric, increased softness and suppleness are essentials, then instead of setting Fig. 106a with twice the number of the ends and picks as Fig. 106, it would be a sounder practice to deduct 5 per cent or 10 per cent from the setting of the single cloth and duplicate this result for the manufacture of the double cloth: that is 100 : 95 : 80 (ends per inch in the single-make setting) = 76 ends; or, in the double make, 152 ends per inch = 19's reed 8's with 144 to 148 picks per inch; or 100 : 90 : 80 = 72 giving 144 ends in the double structure = 18's reed 8's with 136 to 140 picks per inch.

The percentage of reduction, in thus changing from the single-weave to the double-weave standard, is determined, first, by the compactness of the setting in the former; second, by the frequency of the "ties" or "stitchings"; and, third, by the quality and counts of the backing yarns. The last factor does not enter into calculation in the treatment of double structures of the type of Fig. 106a, but is important in cloths constructed on the base of Fig. 107a. Closeness of weave structure, and the thickness of the backing yarns as compared with the face weave structure and face yarns, affect the adjustment of the setting of the double cloth. The rules defined, in reference to warp and weft-backed fabrics, should be applied. It is the exception to

approved practice to set higher than the threads per square inch calculated on the yarn diameters. Providing these do not conform with the weight of cloth required, and the setting of the face fabric is accurate, irregular types of double-weave structures should be utilized, which render it feasible to vary the ratio of the face to the backing yarns without changing the number of the former, or modifying the counts of the yarns used in either the face or backing texture.

The problem is—given the setting of a worsted-face double cloth, also the counts of the yarns for the backing fabric with the ends and picks per inch—to increase or decrease the weight of the compound cloth by increasing or decreasing the number of backing yarns per \square ", the number of the face threads and picks, and face and backing yarn counts, being fixed factors. To take an example: It is required, first, to reduce by $\frac{1}{3}$, and, second, to increase by $\frac{1}{3}$ the weight per yard of Fig. 107a. On this system the ratio of the face and backing yarns must be adjusted to agree with the weights required. The original setting of this fabric is stated as 90 threads and picks per inch or 60 face and 30 backing. Therefore, to reduce the backing weight $\frac{1}{3}$ would give 60 face and 24 back, or, in the double weave structure, 5 face to 2 backing threads, grouped 3 face 1 back, 2 face, and 1 back, as in Fig. 107b. Adopting the same rule to increase the backing weight by $\frac{1}{3}$ would give 60 face and 40 backing threads per inch, or 3 face to 2 backing threads, grouped, in the double weave (Fig. 107c), 2 face, 1 back, 1 face, and 1 back. Forty threads per inch of 20 skeins yarn is too close setting, but by changing the backing weave to 2/2 twill (Fig. 107c), the difficulty would be solved. Changes in the yarn proportions may require the backing weave to be varied when the alteration in the weight of the backing cloth is a considerable percentage of the whole; or which involve, as in this latter example, the addition of 20 threads per \square " of the fabric in the loom of yarns $\frac{1}{60}$ of an inch in diameter.

A second method of altering the weight of a double-make fabric, and of retaining the original face structure, consists in varying the counts of the backing yarns. The weave construction

in this instance remains unaltered. It is a simple calculation, being based upon the number of threads in the width and length of the fabric divided by the weight in drams such yarns are to impart to the compound cloth; the result is the counts of the yarn necessary in skeins. Both methods are practised. By the yarn method, the proportionate weights obtained may be better and more readily graduated than by the "weave" method; but the latter is suitable for giving qualities and structures of cloth for which changes in the yarn counts are not adapted.

Weight per yard, as in single fabrics, is also variable to some degree by the width of the pieces set in the reed, and the measure of shrinkage in length in the scouring and finishing processes; but this principle is utilized in the manufacture of double and other compound worsted cloths more as a modifying than as a controlling factor in weight production.

(135) GROUP CLASSES OF UNION WORSTEDS.

The preceding examples demonstrate that in worsted manufacturing, in order to obtain a medium or heavy fabric in the standard weaves, compound schemes of intertexture are essential. These afford technical facilities for the combination of yarns varying in counts, materials, and structure, such as worsted, woollen, and cotton; the modification of the relative compactness of yarns forming the face and backing textures; the development of corresponding or dissimilar schemes of colouring and pattern style on the respective sides of the cloth, and the production of a face texture of fine, close structure with a similar or thicker texture, made of a stronger fibrous material, on the back, possessing either a clear or a raised-pile surface.

"Union" worsteds comprise the following principal varieties:—

TABLE XVIII B.

UNION WORSTED FABRICS.

A. *Two-fold Weft Fabrics.*

- (1) *Warp*: Worsted. *Weft*: Worsted face and woollen back.
 Arranged in the weft, 1 pick face, 1 pick backing; 2 picks face and 1 pick backing; or 3 picks face and 1 pick backing.
- (2) *Warp*: Worsted. *Weft*: Cotton and woollen.

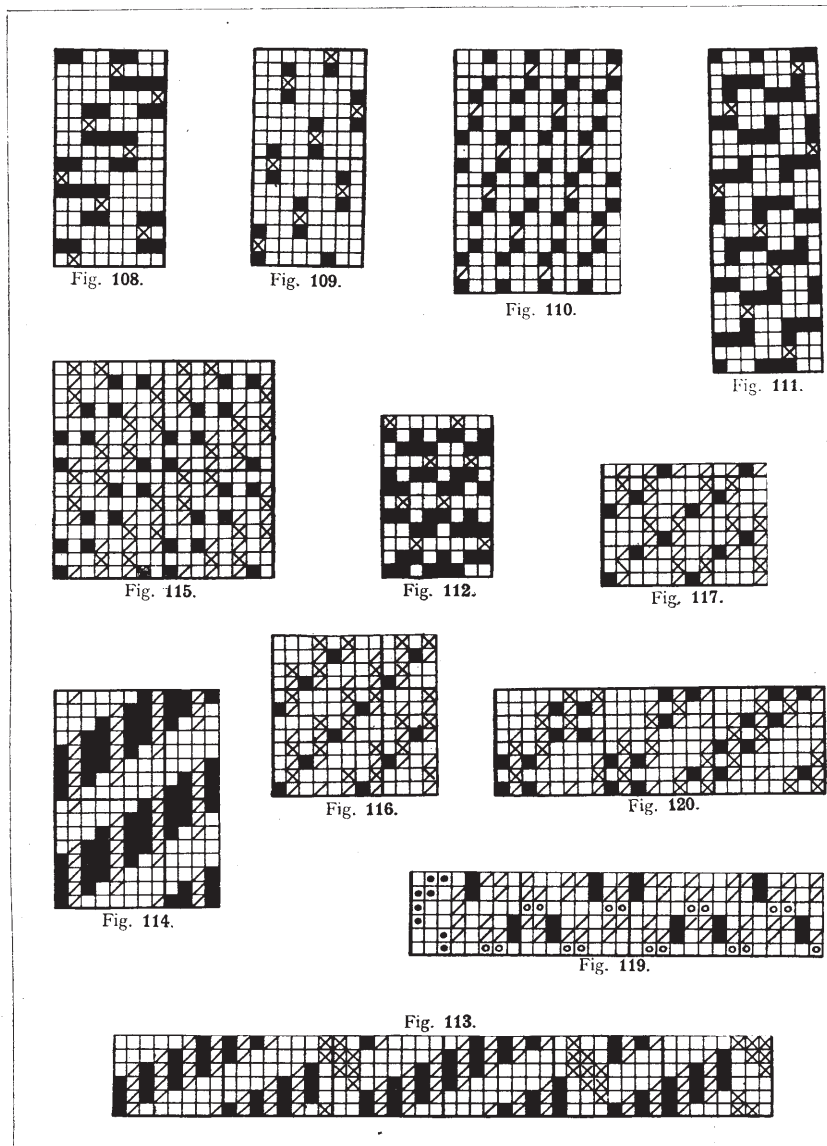


PLATE VI.—Examples in compound union worsted weaves. For weaving data see Tables XIX and XX.

- FIGS. 108 to 112.—Methods of weft backing.
 FIG. 113.—Warp-back design, 3/3 twill face angled.
 FIG. 114.—Warp-backed 4/4 twill, arranged 2 threads face to 1 thread backing.
 FIG. 115.—Double Cassimere with backing warp twill showing over face weft.
 FIG. 116.—Double Prunelle twill.
 FIG. 117.—Double Prunelle twill, arranged 1 thread face, 1 thread backing in the warp, and 1 pick face, 1 pick back and 1 pick face in the weft.
 FIG. 119.—Irregular type of compound weave.
 FIG. 120.—Reversible double make design, being a sectional plan for Figs. 120a and 120b.

Arranged 1 pick face (cotton) and 1 pick backing (woollen).
 (3) *Warp*: Cotton. *Weft*: Worsted face and woollen back.
 Arranged 2 picks worsted and 1 pick woollen.

B. TWO-FOLD WARP FABRICS.

Face Warp: Worsted or woollen. *Weft*: Usually worsted.
Backing Warp: Worsted or woollen.
 Arranged in the warp 1 thread face, 1 thread backing; 2 threads face,
 1 thread backing; and 3 threads face and 1 thread backing.

C. TWO-FOLD OR DOUBLE-MAKE FABRICS.

(1) *Warp*: Worsted and woollen. *Weft*: Worsted and woollen or
 cotton.
 Arranged 1 face and 1 backing, or 2 face, 1 backing in both warp and
 weft.
 (2) *Face Warp*: Worsted. *Face Weft*: Worsted.
Backing Warp: Worsted or woollen. *Backing Weft*: Worsted or woollen.
 Arranged 2 face and 1 backing, or 3 face and 1 backing in both warp and
 weft.

D. COMPOUND FABRICS, IRREGULAR STRUCTURES.

Composed of several groups and counts of yarns and variously arranged
 in the face and backing textures: e.g. ordinary double cloth types into which
 centre or wadding threads or picks are introduced: double weaves with the
 face and backing yarns differently arranged in the warps and wefts, such as
 face and 1 backing in the warp, and 1 face, 1 backing in the weft, etc.

(136) SETTING EXAMPLES IN COMPOUND WORSTEDS.

Examples illustrative of the principles of manufacture of the
 several types of these manufactures are given in the following
 weaving data:—

TABLE XIX.

EXAMPLES IN THE SETTING AND MANUFACTURE OF COMPOUND WORSTED FABRICS.

A. *Weft-backed Fabrics.*

No. 1. Plan, Fig. 108, Plate VI.

Warp: 2/40's worsted.
 16's reed 4's, 68 in. in the reed.
Weft: 1 pick of 2/48's worsted for face.
 1 ,, ,, 14 skeins woollen for back.
 99 picks per inch in the loom.

No. 2. Plan, Fig. 109, Plate VI.

Warp : 2/48's worsted.
 20's reed 4's, 64 to 66 in. in the reed.
Weft : 1 pick of 2/48's worsted for face.
 1 ,, ,, 20 skeins woollen for back.
 144 picks per inch in the loom.

No. 3. Plan, Fig. 110, Plate VI.

Warp : 2/40's worsted.
 15's reed 4's, 68 in. in the reed.
Weft : 1 pick of 2/40's worsted for face.
 1 ,, ,, 12 skeins woollen for back.
 1 ,, ,, 2/40's worsted for face.
 96 picks per inch in the loom.

No. 4. Plan, Fig. 111, Plate VI.

Warp : 2/40's worsted.
 16's reed 4's, 68 in. in the reed.
Weft : 1 pick of 20's worsted for face.
 1 ,, ,, 12 skeins woollen for back.
 1 ,, ,, 20's worsted for face.
 91 picks per inch in the loom.

No. 5. Plan, Fig. I, Plate III.

Warp : 2-fold 48's worsted.
 16's reed 6's, 64 in. in the reed.
Weft : 1 pick of 2/40's cotton (face yarn).
 1 ,, ,, 10 skeins woollen (back yarn)
 96 picks per inch in the loom.

No. 6. Plan, Fig. 112, Plate VI.

Warp : 2-fold 40's cotton.
 24's reed 2's, 72 in. in the reed.
Weft : 2 picks of 2-fold 24's worsted for face.
 1 pick of 10 skeins woollen for back.
 72 picks per inch in the loom.

B. *Warp-backed Fabrics.*

No. 7. Plan, Fig. D, Plate IV.

Warp : 2-fold 32's worsted.
 16's reed 8's, 61 in. in the reed.
Weft : 2-fold 40's worsted.
 59 picks per inch in the loom.

No. 8. Plan, Fig. C, Plate IV.

Warp : 2-fold 32's worsted.
 24's reed 4's, 64 in. in the reed.
Weft : 2-fold 32's worsted.
 52 picks per inch in the loom.

No. 9. Plan, Fig. 113, Plate VI. Fabric, Fig. 113a.

Warp : 2-fold 36's face and backing.
 2-fold 48's light striping shade on face and back.
 60/2 silk for the threads marked in the plan.
 2/2/48's worsted for light shade on the back.
Order of Warping to follow the Construction of the Design.
 15's reed 8's, 65 in. in the reed.
Weft : 2-fold 24's worsted.
 61 picks per inch in the loom.

No. 10. Plan, Fig. 114, Plate VI.

Face warp : 2-fold 36's worsted.
Backing warp : 2-fold 28's worsted.
 17's reed 6's, 64 in. in the reed.
Weft : 2-fold 36's or 2-fold 28's worsted.
 68 picks per inch.

C. *Two-fold or Double-make Fabrics.*

No. 11. Plan, Double Cassimere, Fig. M, Plate IV.

Face and backing warps : 2-fold 50's worsted.
 18's reed 8's, 64 in. in the reed.
Face and backing wefts : Single 30's worsted.
 148 picks per inch.

No. 12. Plan, Double Cassimere, Fig. M, Plate IV.

Face and backing warps and wefts : 2-fold 40's worsted.
 15's reed 8's, 65 in. in the reed, 96 picks per inch.

No. 13. Plan, Double Cassimere, Fig. M, Plate IV.

Face and backing warps and wefts : 2-fold 40's worsted.
 14's reed 8's, 66 in. in the reed, 112-118 picks per inch.

No. 14. Plan, Fig. 115, Plate VI. Pattern, Fig. 115a.

Face warp : 2-fold 48's worsted (dark shade).

Backing warp :—

2-fold 32's twist yarn	1	1	1	—	1	1	—	1	1	—	1	1	}	22 threads.
,, ,, dark shade	—	1	—	1	1	—	1	1	—	1	1	—		
,, ,, light ,,	—	—	1	1	—	1	1	—	1	1	—	—		
60/2 white silk	1	1	—	—	—	—	—	—	—	—	—	—		

18's reed 4's, 66 in.-68 in. in the reed.

Face weft : 2-fold 26's cotton (dark shade).

Backing weft : 13 skeins woollen.

72 picks per inch.

No. 15. Plan, Fig. 116, Plate VI.

Face and backing warps and wefts : 2-fold 36's worsted.
 16's reed 8's, 63 in. in the reed, 68 picks per inch.

No. 16. Plan, Fig. 117, Plate VI.

Face and backing warp : 2-fold 48's worsted.

15½'s reed 8's, 68 in. in the reed.

Face weft : 2-fold 48's worsted.

Backing weft : 19 skeins woollen.

75 picks per inch.

No. 17. Plan, Fig. P, Plate IV. Pattern, Fig. 118.

<i>Face warp</i> : 2-fold 50's black	1 1 — 1 1 3	}	60 threads.									
" " twist	1 1 — 1 1 3											
2/60's/60's/2 white silk	— — 2 — — —											
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{	{	{										
For	For	For										
14.	14.	30.										

Backing warp : 2-fold 40's black worsted } Arranged
 " 50's " and white worsted twist } 1 and 1.

16's reed 6's, 65 in. in the reed.

Face weft : 2-fold 50's worsted } Arranged 1 face, 1 back, 1 face.
Backing weft : 2-fold 40's worsted }

96 picks per inch.

No. 18. Plan, Fig. 119, Plate VI. Pattern, 119a.

Warp :—

2-fold 60's white mer-	1 1	-----	}	96	
cerised cotton	1 1	-----			
2-fold 32's black	1 — 1 1 1 — 1 1 1 1 1 — 1 1 — 1 1 — 1 1	-----			} threads
worsted	1 — 1 1 1 — 1 1 1 1 1 — 1 1 — 1 1 — 1 1	-----			
2-fold 32's worsted	— 1 2 2 — 1 1 2 2 1 — 1 2 2 — 1 1 — 2 2 1	-----			} in the
twist	— 1 2 2 — 1 1 2 2 1 — 1 2 2 — 1 1 — 2 2 1	-----			
2-fold 30's white	----- 1 — 1 — 1 1 — 1 — 1 — 1 — 1	-----	} pattern.		
worsted	----- 1 — 1 — 1 1 — 1 — 1 — 1 — 1	-----			
2-fold 48's worsted	-----	----- 1 -----			
(colour)	-----	----- 1 -----			
	{	{			
	36 threads.	36 threads.			

15's reed 4's, 68 in. in the reed.

Weft : 2-fold 44's grey worsted 1 — — — } 138 picks in the pattern.
 " " black " 1 2 2 2 }
 10½ skeins black woollen 1 1 1 1 } 135 picks.

72 picks per inch.

(137) LOOMING AND FINISHED DATA OF EXAMPLES IN COMPOUND WORSTED CLOTHS.

The following are the looming and finished data for the above examples :—

TABLE XX.—YARN AND FABRIC WEIGHT CALCULATIONS (COMPOUND WORSTEDS).

	Width in in. Reed.	Counts of Reed.	Picks per inch.	Length of Warp.	Length of Piece from Loom.	Weight of Warp Yarns.	Weight of Weft Yarns.	Loss of Weight in Finishing.	Weight of Piece Finished.	Length of Piece Finished.	Weight per yard.	Plan or Weave.
A Welf-backed Worsted.	1 { 68 in.	16's 4's	99	64 yd.	60 yd.	4 lb. 14 oz.	{ Face: 18 lb. Back: 56 lb. 6 oz.	12% _o	87 lb. 5 oz.	54 yd.	{ 26 to 26½ oz.	Fig. 108
	2 { 64 in.	20's 4's	144	60 yd.	57 yd.	23 lb.	{ Face: 19 " 9 " Back: 51 " 5 "	10% _o	84 lb. 7 oz.	52 yd.	{ 26 oz.	Fig. 109
	3 { 68 in.	15's 4's	96	73 yd.	67½ yd.	26 lb. 9 oz.	{ Face: 26 " 4 " Back: 47 " 13 "	10% _o	90 lb. 9 oz.	60 yd.	{ 24 oz.	Fig. 110
	4 { 68 in.	16's 4's	91	68 yd.	64 yd.	26 lb. 6 oz.	{ Face: 24 lb. 8 " Back: 42 lb. 8 "	8% _o	85 lb. 8 oz.	58 yd.	{ 23½ to 24 oz.	Fig. 111
	5 { 64 in.	16's 6's	96	70 yd.	64 yd.	32 lb.	{ Face: 11 " 12 " Back: 76 " 9 "	Worsted = 5% _o Woolen = 15% _o	106 lb. 10 oz.	60 yd.	{ 28½ to 29 oz.	Fig. L, Plate III
	6 { 72 in.	24's 2's	72	70 yd.	65 yd.	14 lb. 6 oz.	{ Face: 33 " 7 " Back: 43 " 14 "	Worsted = 5% _o Woolen = 12½ to 15% _o	82 lb. 10 oz.	62 yd.	{ 21 to 21½ oz.	Fig. 112
B Warp-backed Worsted.	7 { 61 in.	16's 8's	59	60 yd.	56 yd.	52 lb. 4 oz.	18 lb.	5% _o	66 lb. 12 oz.	54 yd.	{ 19½ to 20 oz.	Fig. D, Plate IV
	8 { 64 in.	24's 4's	52	70 yd.	66 yd.	48 lb. 2/36's = 40 lb. 3 oz. 2/40's = 2 lb. 10 oz.	24 lb. 8 oz.	7% _o	67 lb. 4 oz.	62 yd.	{ 17½ oz.	Fig. C, Plate IV
	9 { 65 in.	15's 8's	61	68 yd.	64 yd.	2/2/48's = 7 lb. 10 oz. 2/48's = 2 lb. 11 oz. 60/2 = 11 oz.	37 lb. 12 oz.	5-6% _o	85-86 lb.	60 yd.	{ 22½ to 23 oz.	Fig. 113
	10 { 64 in.	17's 6's	64	66 yd.	61 yd.	2/36's = 28 lb. 8 oz. 2/28's = 18 lb. 4 oz.	24 lb. 12 oz.	6% _o	67 lb. 4 oz.	56 yd.	{ 19½ to 20 oz.	Fig. 114

11	64 in.	18's 8's	148	75 yd.	70 yd.	49 lb. 5 oz.	39 lb. 7 oz.	6%	83 lb. 7 oz.	65 yd.	{ 20 to 20½ oz.	Fig. M, Plate IV.
12	65 in.	15's 8's	96	70 yd.	65½ yd.	48 lb. 12 oz.	36 lb. 7 oz.	7%	79 lb. 4 oz.	61 yd.	{ 21½ oz.	Fig. M, Plate IV.
13	66 in.	14's 8's	112	70 yd.	765 yd.	46 lb. 3 oz.	45 lb. 3 oz.	7%	85 lb.	61 yd.	{ 22 to 22½ oz.	Fig. M, Plate IV.
14	66 in.	18's 4's	72	72 yd.	67 yd.	2/48's = 12 lb. 12 oz. 2/32's = 17 lb. 5 oz. 60's/2 = 5 oz.	2/26's cotton = 14 lb. 9 oz. 13 skeins woollen = 47 lb. 13 oz.	13%	80 lb. 11 oz.	60 yd.	{ 21½ oz.	Fig. 115
15	63 in.	16's 8's	68	72 yd.	67 yd.	57 lb. 9 oz.	28 lb. 8 oz.	6%	80 lb. 15 oz.	64 yd.	{ 20 to 20½ oz.	Fig. 116
16	68 in.	15½'s 8's	75	60 yd.	56 yd.	37 lb. 10 oz.	2/48's = 14 lb. 3 oz. 19 skeins woollen = 19 lb. 8 oz.	10%	64 lb. 3 oz.	50 yd.	{ 20 to 21½ oz.	Fig. 117
17	65 in.	16's 6's	96	Face: 72 yd. Back: 74 yd.	67 yd.	2/50's = 20 lb. 12 oz. 2/60/60's/2 = 13 oz. 2/40's = 12 lb. 5 oz.	2/50's = 19 lb. 14 oz. 2/40's = 12 lb. 7 oz.	6%	62 lb. 4 oz.	65 yd.	{ 15 to 15½ oz.	Fig. P, Plate IV.
18	68 in.	15's 4's	72	70 yd.	66 yd.	2/32's = 26 lb. 3 oz. 2/50's = 5 lb. 2/48's = 3½ oz. 2/60's mercerised cotton = 4 oz.	2/44's = 17 lb. 8 oz. 10½ skeins woollen = 40 lb. 1 oz.	worsted 7% woollen 20%	77 lb. 12 oz.	61 yd.	{ 20 to 20½ oz.	Fig. 119

1 For Figs. 108 to 119 see Plate VI.

(138) ANALYTICAL CONTRASTS IN SETTING AND FABRIC COMPOSITIONS.

Fundamentally it is clear that the setting and manufacture of medium-weight worsted fabrics differ in principle from the setting and manufacture of medium-weight woollen fabrics. Weave structure has, in the former, a more varied function than in the latter. Compound weaves are essential to the production of fine-face textures in which the measure of width and length contraction is reduced to a minimum, providing for the application of comparatively thick and heavy yarns to the underside of the cloth: Examples Nos. 1 to 18 illustrate standard schemes of construction. A feature common to each—with the exception of No. 6—is the average reed width, 62 in. to 68 in. Example 6 is, on account of its yarn composition—cotton warp, worsted face, and woollen backing weft—set in accordance with the ordinary class of woollen fabric. Two-thirds of the weight in this specimen are produced in the woollen weft. Felting is therefore practised to develop soundness of cloth with improved softness of handle, and a fibrous cohesion which conceals the cotton yarn. The measure of shrinkage, applied in this instance, would be detrimental to the worsted qualities of the general types of worsted unions, in which the face texture, or surface, should, as closely as possible, correspond with that of a “solid” worsted production.

Briefly analysing these examples in the order in which they are stated, it will be noted that in the weft-backed structures, Types 1 and 2 differ in wefting from Types 3 and 4, though the cloths are similar in warp setting. Thus the counts of the yarns for the face warp and weft are identical in both groups of specimens; but, whereas 3 and 4 have the smaller number of picks per inch, they are better balanced as to warp and weft threads than 1 and 2. Fabrics made on the principle of the first two examples should contain $\frac{1}{3}$ or more picks than threads per \square . This adds to the cost of weaving as seen from Example 2, woven with 144 picks per inch, resulting in the face texture containing 80 threads of warp and 72 picks of weft per inch. Nos. 3 and 4, being wefted 2 picks of face to 1 pick of backing

yarn, yield more satisfactory face structures, the proportion of warp to weft being approximately the same on the face in each cloth, and yet with a reduced number of picks per inch in weaving. Both principles of fabric construction are useful and have distinctive applications. The one-and-one scheme (Figs. 108 and 109) give, when the ratio of face threads in the warp and weft is similar, a finer make or quality of cloth than obtainable by the methods of manufacture applied to the two-and-one scheme of construction exemplified in Figs. 110 and 111. As a rule, the closer the relation of the counts of the face to the counts of the backing yarn in this group of fabrics, the finer and firmer both surfaces of the texture. For attaining this condition, the one-and-one system of backing—either in the weft or the warp—is preferable to the two-and-one system. Backing on the first principle involves the two surfaces of the texture—though made of different yarns—containing the same number of picks; but backing on the second principle, and also 3 picks face and 1 pick backing, necessitates the use of a weft yarn several counts thicker for the under than the face side of the cloth. Unless this is done, the number of backing picks possible is insufficient to produce a compact surface, and a fabric of correct wearing strength.

(139) UNION WORSTEDS PARTIALLY CONSISTING OF COTTON
YARNS.

Examples 5 and 6 are typical of “union” worsteds having a “cover” of worsted face yarns in which cotton and woollen yarns are also used. They are illustrative of the lower grades of these fabrics, only a small proportion of the number of threads per square inch of the texture being worsted. Scheme No. 5 is the more commonly adopted. The face of the cloth is a fine twill or similar effect, and in appearance resembles a pure worsted manufacture; the back of the cloth is a thick woollen yarn usually of a low quality—mungo or shoddy forming the principal material. A characteristic of both types of texture is the acquirement of weight per yard, and cloth-like substance, with the backing weft. Structurally they are differently arranged.

The worsted warp in Type 5 binds the cotton and woollen wefts together, but in Type 6 the cotton warp is utilized in stitching the worsted and woollen wefts to each other. By the first of these methods of weaving, the worsted warp yarns—fine in counts—are compactly set, so as to conceal the cotton face weft and also to cover the woollen backing weft. Special weave structures are employed, namely, warp-face twills (e.g. Figs. K and L, Plate III), giving $\frac{2}{3}$ or $\frac{3}{4}$ of warp floats to weft floats on the face of the fabric. The closeness of the warp threads, and their relative density or number, as compared with the two kinds of weft yarn, further emphasizes and distinguishes the effect of the worsted yarns to the concealment of the stitchings of the cotton yarns. To obtain a compact under surface of woollen yarn, the backing weave is of the sateen construction, in Fig. K the 9-shaft and in Fig. L, Plate III, the 12-shaft make. This build of fabric is interesting as forming the most economical class of worsted “union”.

Example 6 is less satisfactory in the weave formation and also in the method of combining the three groups of threads. It is chiefly applied to the inferior classes of serge overcoating cloths. Elementary twills and weaves are employed not floating the warp over more than 1 face pick, or of the type given in Fig. 112. The backing weave must accord with the face plan and produce a compact, firm structure. Pieces of this character are set fairly wide in the loom which makes it practicable, by felting, to obtain a full cover of pile or fibre on the back, and to impart to the face a *frisé* quality. When the face yarn is of a fine Crossbred nature the milling is reduced, and the cloths are made firmer in the loom. This results in the weave pattern developed in the worsted weft being clearly defined in the finishing routine.

(140) MANUFACTURE AND SETTING OF WARP-BACKED TEXTURES (Table XIX).

Worsted structures of the class comprised in Group B are the reverse in arrangement and methods of manufacture from those typed in Group A. Increased weight is here obtained by supplementary warp yarns. A primary effect of this is a lower

ratio of picks than threads, and a secondary effect the construction of a finer grade of cloths, and in which, if required, the back of the fabric may be striped with colour (Example 9) as well as the face. Weight being acquired by the employment of an extra warp, implies the use for the underside of the cloth of a sound quality of comparatively fine counts of yarn. It would be contrary to practice and correct principles of manufacture to utilize in Group A the same or similar yarn counts for the reverse as the right side of the texture. As observed in Examples 1 to 6, the backing yarn in these weaves is of a thicker diameter and of different structure to the yarn applied to the face. Moreover, in Examples 1 and 2 the woollen backing com-

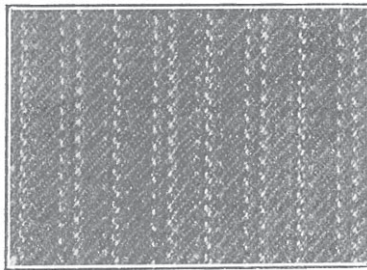


FIG. 113a.—Stripe effect in warp-backed angled 3/3 twill.

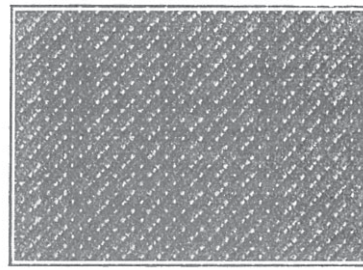


FIG. 115a.—Double-cassimere effect with backing warp showing over face twills.

poses nearly two-thirds of the material used, and in Example 5 the proportion of face to backing yarns is, in weight, as 76 is to 45. On the system of fabric construction exemplified in Group B, these relative weights of face and backing yarns would not be satisfactory—the cloths would be defective in fineness and strength of construction. The two essential advantages of this scheme of manufacture are the acquirement of one-third, or thereabouts, additional weight to that in the single-make fabric, combined with like qualities of material, yarns, and pattern features on both sides of the cloth. A further point to be noted is the relative number of threads and picks in the respective builds of these two groups of “unions”. Compare, for instance, the weaving particulars for Examples 3 and 9. Both fabrics are

of corresponding weight per yard, but No. 9 is woven with 61 and No. 3 with 96 picks per inch. This technical detail in favour of warp-backed compounds applies in a greater or lesser degree to all classes of these fabrics.

(141) EXAMPLES IN DOUBLE-MAKE MANUFACTURES
(Table XIX).

The third principle of construction combines the elements of the two systems of manufacture included in groups A and B. By this compound method of weaving exactly the same characteristics in texture, effect, and colour pattern may be developed on the face and on the reverse side of the cloth. The number of the threads per \square " of the back fabric may be reduced as in the first and second schemes of construction, by the plan of grouping the two sets of yarns. To do this, however, necessarily alters the fineness of the backing surface. Thus, employing the principles of weave structure applied to Examples 11 (Plan M, Plate IV), 12, and 13, or the 1 thread face and 1 thread backing arrangement, produces a fabric of the same character on the face and on the back, but by using weaves arranged 2 threads face and 1 thread back, as in Example 17 (Plan P, Plate IV), the effect on the right side of the cloth is finer in quality than the effect on the underside. In both types the face and backing yarns form distinct textures, but in the first instance the two textures combined are identical in yarns and setting, and in the second instance they are in all points dissimilar. The $2/2$ twill forms the respective textures (face and backing) in Examples 11, 12, and 13; the prunelle warp twill in Example 15, and the $2/2$ twill face texture in Fig. 118 possesses a plain woven fabric on the back. Another type is illustrated in Fig. 117. This weave is arranged one-and-one in the warp and two-and-one in the weft with the $2/1$ twill forming the face and backing structures. The arrangement admits of (a) the number of picks per inch being reduced without modifying the closeness of the face fabric; and (b) the use of a thicker backing yarn for increasing the weight per yard of the compound cloth. Obviously, the principle of manufacture illustrated in Examples 16 and 17 (weaves, Figs. 116 and O, Plate IV) is the more practicable in the production of cloths economical

in yarn cost. Moreover, heavier fabrics are producible in these weave types than in weaves derived from the one-and-one method of formation acquiring a corresponding fineness of surface with a smaller proportion of backing threads and picks per inch (compare the settings of Examples 12 and 13 with those of Examples 16 and 17). On this latter system the wefting and number of the threads in the cloth are reduced, and yet the ounces per yard increased by the thicker backing warp and weft employed.

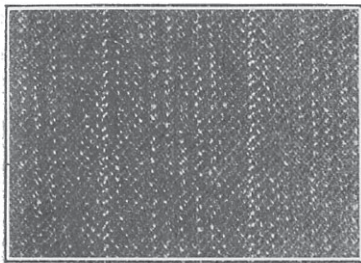


FIG. 118.—Stripe pattern produced in a double weave, 2/2 twill face and plain back.

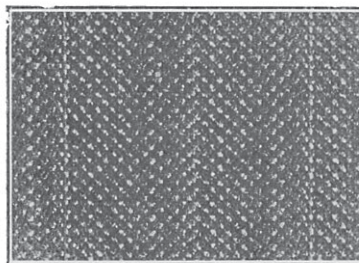


FIG. 119a.—Pattern obtained in an irregular compound weave, Fig. 119.

(142) SETTING COMPARISONS.

It will be understood that the examples analysed are suggestive of the principal standard methods of setting and weaving compound worsted fabrics, but are not illustrative of the numerous variations to which each type is subjected in practical manufacturing. They are indicative of the diversity of scope available in the production of these cloths by the yarn counts combined, and by the degrees of compactness of the warp and weft threads. An object to be attained in each group of fabrics is the construction of a face texture of the requisite fineness combined with a backing texture sound and firm in construction. The grade or style of the cloth has primarily to be taken into account. Having determined this, and also the weave construction, the systems of settings defined should be compared with the weights of cloth they severally yield, adapting the one applicable to the nature and cost of the fabric required.