$(\frac{1}{159}+\frac{1}{205})\div 2=\frac{1}{178}$ and $\frac{1}{178}\times 1{\cdot}732=178\div 1{\cdot}732=\frac{1}{102}$ of an inch for base of triangle, and $\frac{1}{102}+\frac{1}{102}+\frac{1}{159}=\frac{1}{51}+\frac{1}{159}=\frac{51+159}{8109}=\frac{210}{8109}=$ about $\frac{1}{39}$ and $39\times 3=117$ ends per inch.

This latter result is very far from correct, while the former is practically correct, for the practical sett given, i.e. 64 threads per inch, is for the loom, while the 66-70 ends found by calculation is for the finished state, so that they practically coincide. The following is a clear statement of all the results for this cloth :—

Ends per inch ascertained by adding diameters together -	89
Ends per inch ascertained by equal bending of warp and weft and angle of 30° - - - - - - - - -	117
Ends per inch ascertained by warp straight, weft bending, and angle of 30° - - - - - - - - -	66
Ends per inch used in practice in loom - - - - - -	64

It is evident, then, that an adherence to the principles laid down gives results of marked practical utility.

Warp-rib Cloths.—The treatment of warp-rib cloths will be exactly the reverse of weft-rib cloths, so there is practically no need to exemplify them here, since our space is somewhat limited.

Difficulties in Applying the Foregoing Principles.—A type of fabric very difficult to deal with is the Bradford plain lustre previously mentioned, this coming under none of the foregoing treatments.

These fabrics are usually woven with a fine cotton warp and comparatively thick mohair weft, which should thus give a warp rib type of structure, i.e. the finer material should bend; and in the loom it actually does, but during finishing the warp is pulled quite straight and the weft then doing all the bending produces a weft rib type of structure.

For which cloth, then, should the calculation be made, the cloth as woven or the cloth as finished? Neither calculation will give the desired result, simply because the cloth being woven approximately on the square (to keep the figures square) [1] has not sufficient warp in for a warp rib, while the threads are also much too close together to produce the structure shown in Fig. 31 should the necessary picks have been put in. A compromise therefore takes place between warp and weft. The warp becomes straight, in finishing, but in so doing flattens out the weft upon itself, bending it to the correct angle at the same time.

[1] Note.—Usually with rather more picks to compensate for the extension in finishing.

A suitable sett for plain lustre goods, from which the above deductions may be made, is as follows :—

Warp.

All 2/90's cotton.
33's reed 2's, or
66's reeds 1's.

Weft.

All 32's mohair.
70 picks per inch.

Respecting the setting of woollens, unless unshrinkable goods are required, an open sett should be employed, particularly if the yarn is woolly and thus liable to choke the shed. Under these circumstances the milling-up of the piece may be depended upon, and thus the required width obtained in the finishing. With linen and other solid yarns it is desirable to weave as close in the loom as possible, since shrinkage by bending of warp and weft *only* ensues.

It will thus be evident that although certain principles obtain in the setting of all kinds of cloths, still common sense is a most necessary adjunct.

Changes in Counts and Setts.—There are two simple yet important calculations which are likely to occur frequently, and which should be fully comprehended. They may be exemplified by the following examples :—

Example 1.—A cloth is woven with a 2/40's warp, 72 ends per inch, and yields the required structure. What counts will be required to preserve the same balance of structure with 80 threads per inch?

Example 2.—A cloth is woven with a 2/40's warp, 72 ends per inch, and yields the required structure. What number of ends per inch will be required to preserve the same balance of structure with 2/50's warp.

Example 1 may be reasoned out as follows: There are two lots of threads given, therefore the change in counts at first sight will be as 72 : 80, since with more threads a finer yarn, i.e. a higher count, is required. But since the diameter of the yarn must change in proportion to the addition or subtraction of threads, and since the $\sqrt{}$ of the counts = the diameter, the sum will be—

$$\text{As } 72 : 80 :: \sqrt{2/40\text{'s}} : \sqrt{x}, \text{ or}$$
$$(\text{As } 72 : 80 :: \sqrt{2/40\text{'s}} : \sqrt{x})^2 =$$
$$\text{As } 72^2 : 80^2 :: 2/40\text{'s} : x = 25\text{'s or } 2/50\text{'s counts required.}$$

Similarly in the second case the number of threads will be regulated by the diameters, therefore

$$\text{As } \sqrt{2/40\text{'s}} : \sqrt{2/50\text{'s}} :: 72 : x, \text{ or}$$
$$(\text{As } \sqrt{2/40\text{'s}} : \sqrt{2/50\text{'s}} :: 72 : x)^2 =$$
$$\text{As } 2/40\text{'s} : 2/50\text{'s} :: 72^2 : x^2 = 80 \text{ ends per inch.}$$

The above two calculations may then be worked by the following general rule :—

Rule.—Place the proportions as for a rule of three sums, and work by the $\sqrt{\ }$ of counts or the threads squared.

The foregoing remarks and rule are equally applicable to calculations for weft.

CHAPTER VI.

WEAVE ANALYSIS.

SINCE any further calculations than those already dealt with will relate definitely to the cloths that happen to be under consideration, the next step will be to obtain the weave, or order of interlacing of the warp and weft threads, since this, as will be shown later, besides being necessary may prove of great service in the subsequent analysis—such as in determining the threads and picks per inch.

Two Methods.—Practically there are two methods of determining the make or weave of any given cloth, viz. by analysis and by synthesis. By the former method is implied pulling a cloth to pieces, thread from thread, pick from pick; and by the latter, building a cloth up according to the principles of interlacing which experience enables the designer to detect in the cloth that it is desired to reproduce.

The second method is quite out of the reach of the uninitiated. They must fulfil the laborious task of following every end and pick throughout the cloth, whereas the experienced analyst would pull a thread or pick out to confirm his surmise respecting the make, and proceed at once to build up his cloth. More often than not the experienced judge the make of a cloth from the appearance alone: thus the fallacy of would-be analysts simply pulling cloths to pieces is fully demonstrated. Of infinitely greater service is the experience gained by experiment with the various principles of textile design.

General Consideration.—Let the reader now suppose there is before him a pattern which it is desired to reproduce, and of which nothing is known. Then the first consideration will be—is it a single, a backed, or a double cloth? This, as a rule, can readily be decided by pulling out a few threads and picks, and observing whether any of them keep to one side of the fabric or not. If one series, say of threads, form the face, and another series of threads the back, while the picks interweave both face and back, then the fabric is backed with warp, and it will be necessary to find not only the face weave but also the backing ties. Weft might be used as backing instead of warp, when there would be two series of weft threads, or picks as they are termed, and one of warp, and the interweaving of each must be obtained as in the case of warp backing. Should there be both backing warp and weft, then the fabric will usually be a double cloth, in which case three points must be decided: firstly, the face weave; secondly, the back weave; and thirdly, the system of tying the back cloth to the face. Having decided by brief examination under which heading

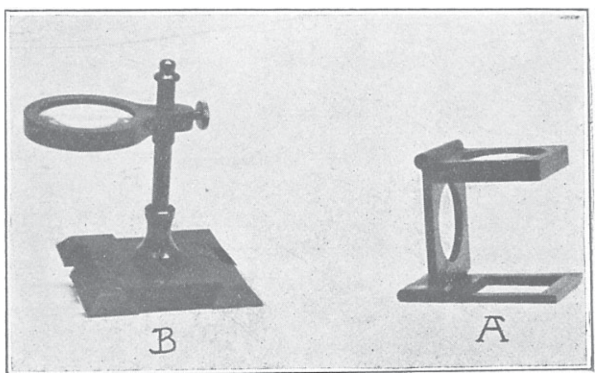

Fig. 33.—Piece glasses.

the pattern to be analysed comes, the analyst should proceed in the manner laid down in the following pages.

Instruments Required.—It would be no difficult matter to draw up a list of instruments serviceable to the analyst costing pounds; but instruments will never make a successful analyst; therefore, the following should prove all that are necessary.

The first necessity is a piece-glass, i.e. magnifying glass of the forms shown in Fig. 33*a* and 33*b*, which will cost from 1s. up to 15s., or even more. The glass should possess fair magnifying power, and in order to ensure this in purchasing, the glasses presented for examination should be compared with one of known excellence, or at least with others which the vendor shows. In the type of glass, Fig. 33*a*, to ensure a good light on the fabric during analysis the supports should be cut away as far as is compatible with strength. The measure is made in three forms as shown in A, B, and C (Fig. 34), A being the square form, either 2, 1, or $\frac{1}{2}$ an inch; and B the oblong, usually made $\frac{1}{2} \times \frac{1}{4}$ or $1 \times \frac{1}{2}$, and C the combined form. A useful form of piece glass is illustrated in Fig. 33*b*. The lens may be moved up or down to suit all ranges of vision, and at the same time moved round to any of the measurements cut into the base, as indicated at D (Fig. 34).

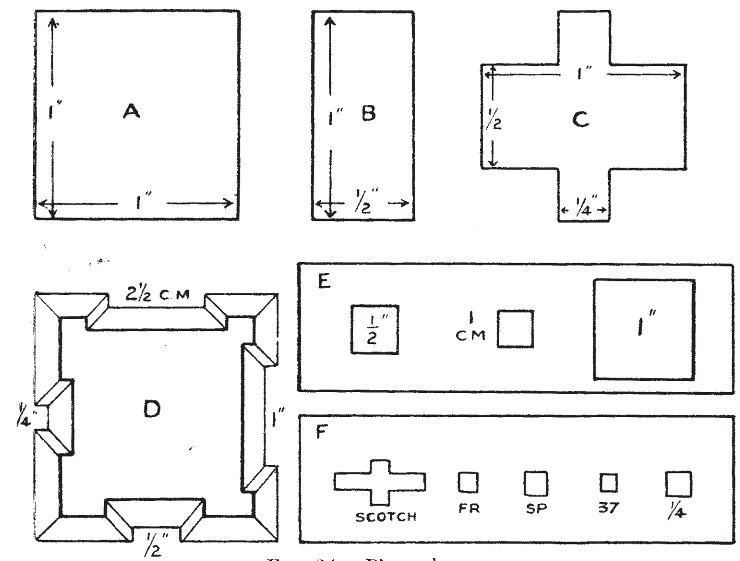

FIG. 34.—Piece glasses.

In order to examine with precision the interlacing of the threads, two needles fixed in wood handles should either be made or procured from some instrument maker, the usual charge being 2d. each. Corks should be fitted on the needles when not in work, to prevent damage to the points, and also to prevent accidents.

A pair of curved or straight scissors, a sharp knife, and a pair of tweezers to catch hold of any required thread, along with white cardboard upon which to firmly hold the pattern, design paper, drawing pins, black and white thread, pencils of two or three colours, and gum, complete the outfit.

Other apparatus such as the reflectroscope, Smith's scale, etc., is not really necessary and would only occasionally be employed.

Gill's apparatus is perhaps the most useful apparatus of this type yet put on the market. This consists of a box, on the top of which is fixed a piece of ground glass and a lens. The cloth is placed on the glass and light may be transmitted through the fabric by means of an electric light, situated inside the box. A second electric bulb throws light on to the surface of the fabric. By means of slides marked E and F (Fig. 34), the number of threads and picks may be counted in any of the given measurements.

Means of Distinguishing Warp from Weft in Woven Fabrics.—(1) *By Material.*—In such structures as twills, sateens, coverts, etc., in which one system of threads is two-fold and the other single; the two-fold is warp.

If one system of threads be softer in twist than the other, the softer material is usually weft. Often the weft is not only softer in twist than the warp but is also thicker.

When one material is found to be cotton and the other wool as in cashmere dress fabrics (cotton warp and botany weft): bright goods (lustres, mohairs, alpacas), low meltons, beavers, and tweeds, the cotton material is with few exceptions (motor cloths) the warp. The conditions of weaving are such that the yarn employed as warp must possess sufficient strength and elasticity to stand the strain imposed, whereas any material may be employed for weft which will hold together whilst the shuttle is carrying it across the open warp threads. Therefore, if one system of threads are stronger than the other, although alike in other respects, the stronger material will almost invariably be the warp.

(2) *Appearance of Fabric.*—In most cloths the warp threads appear to be straighter than the weft. During both weaving and finishing the weft is allowed to contract more than the warp on account of tension being more readily applied lengthwise to the piece.

The nap of faced finished cloths such as amazons, coverts, beavers, etc., is as a rule in the direction of the warp.

If the portion of cloth under consideration contains part of the "list," "edge," or "selvedge," the direction of this will indicate the warp.

In grey cloths it is possible to distinguish the warp on account of a handle and appearance due to sizing.

The weave and order of colouring often indicate the direction of the warp.

In almost all cloths of a twill character the direction of the twill is more towards the upright or warp direction than to the horizontal.

As coloured threads are more economically introduced into a cloth as warp than weft, if a cloth contains a coloured stripe the direction of the warp is thus indicated. In both colour and weave check fabrics the length is usually greater than the width.

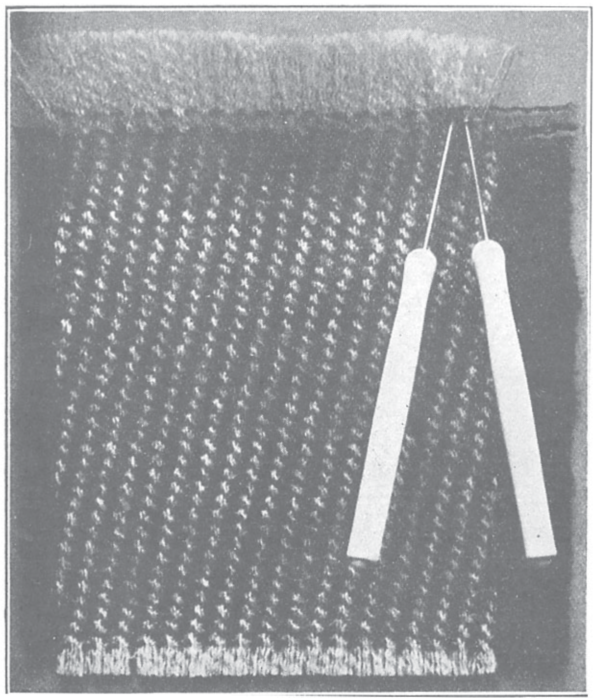

FIG. 35.—Preparing cloth for dissecting.

Method of Dissecting for Weave.—Having decided which is warp and which is weft, the analyst should proceed as follows: First, pull out a few picks, so that any thread may be pulled out at pleasure: second, pull out a few threads so that any pick may be pulled out at pleasure. Now placing the pattern upon a white ground if dark or black, or a black ground if light or white, then with the aid of the dissecting needles endeavour to separate the first thread or pick from its neighbour, but still let it remain interlacing with the warp or weft, as shown in Fig. 35, when the order of interlacings may possibly be transferred to design paper by examining with the naked eye: or a magnifying glass may be placed over and the order of interlacings read off to an assistant.

Having recorded the interlacing of thread or pick 1, liberate it

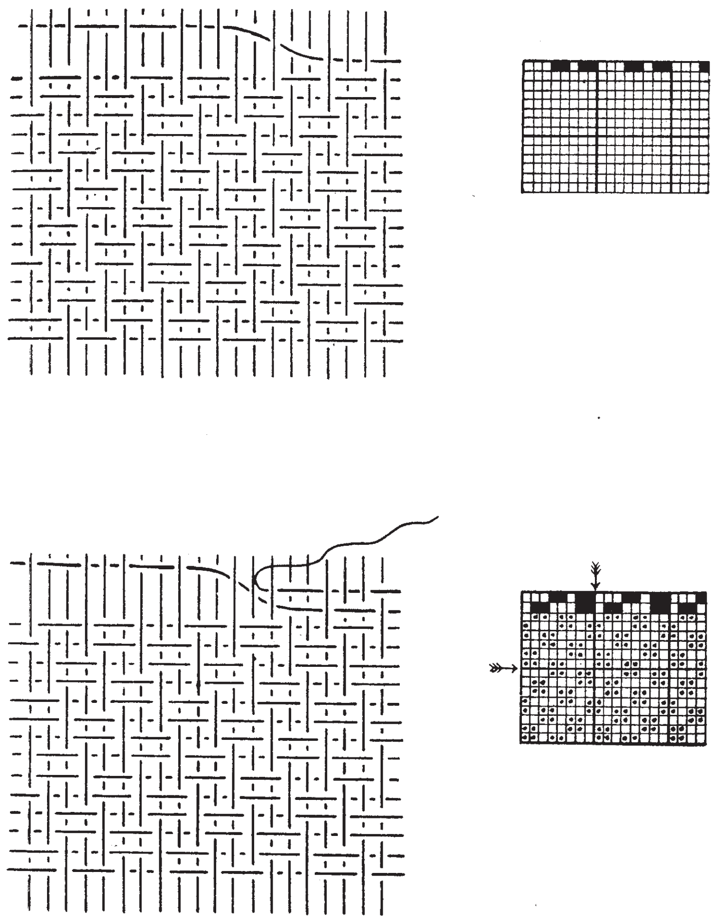

Fig. 36.—Method of dissecting cloth for weave.

from the cloth and proceed in a similar way with threads or picks 2, 3, 4, etc. Care must be taken that when once a given thread or pick has been decided upon for the commencement of the weave, each subsequent and consecutive reading must be started on this particular thread or pick.

As to which material—warp or weft—is the most convenient to take from the cloth no definite rule can be laid down. In the case of cloths containing about an equal number of threads and picks per inch with the same amount of warp and weft on the surface of the cloth, then the taking out of the weft might be established as the rule. Where the warp threads are much closer set than the picks of weft it will be found most convenient to read the interlacing by drawing the warp over weft, and where there are more picks than threads the interlacings of weft should be read off.

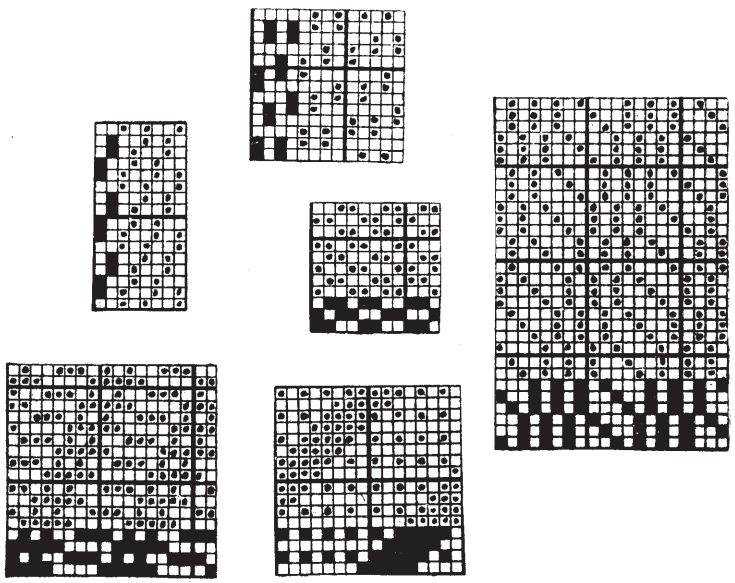

Fig. 37.—Completing weaves from sections.

Repetition of Weaves.—With many weaves, if the analyst is well grounded in the principles of design, after taking out three or four threads or picks, he will probably be able to complete the weave as illustrated in Fig. 37.

Figure Analysis.—In analysing figured textiles for precise reproduction the unit or repeat of the figure must be first ascertained. Should a full repeat, or more than a repeat, of the pattern be obtainable, several methods may be adopted. A simple plan, frequently resorted to by professional analysts, is to pin the pattern on cardboard and prick with a needle round its edge, thus obtaining a representation in outline of the figure. In some figured cloths it is not a difficult matter to obtain the outline by placing a piece of tracing paper on the pattern, the design of which can be clearly seen through and traced on to the paper, or a sheet of glass may be substituted for the tracing paper and the outline of the design painted on the glass as shown in Fig. 39 (Fig. 38 being the figured fabric). After having transferred the sketch on to ordinary paper the repeat must then be enclosed in a square or oblong, and this be divided into squares representing 8, 16, or 24 threads and picks, as required. Another method is to paste the cloth upon cardboard and divide it into spaces by wrapping threads round it,

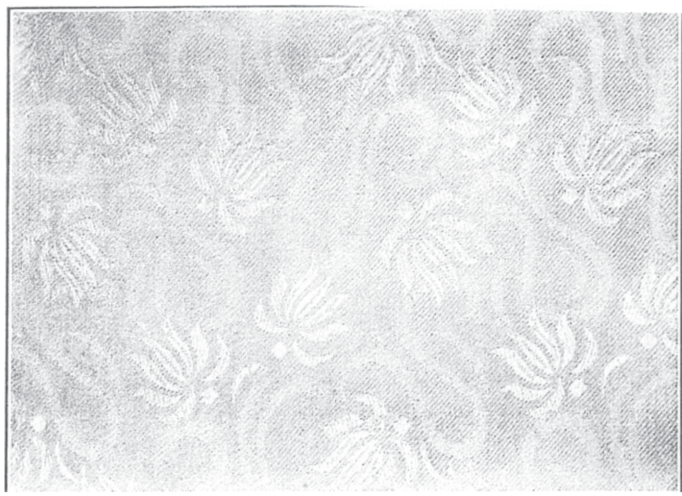

FIG. 38.—Analysis of figured fabrics.

equidistant from each other, as shown in Fig. 40. Each of these squares may then be taken to represent 8, 12, 16, or 24 threads and picks, as required. Thus, taking each square to represent 24 threads and picks, $24 \times 12 = 288$ ends and picks for the full repeat of the design. A useful means for dividing the repeat of any figure into any desired number of squares is shown in Fig. 41. By ruling a paper similar to this, and doubling until the repeat of the pattern is divided into the required number of divisions, any figure may be squared out as desired. In Fig. 41 there are 25 divisions; thus, dividing any given figure according to this, if each division is taken to mean 8 threads or picks, $25 \times 8 = 200$ threads or picks for repeat of the pattern; if 16 threads or picks, then $25 \times 16 = 400$ ends. For a 288 jacquard, only 18 divisions should be employed; thus, $288 \div 18 = 16$ threads or picks to each division, and so on. The lines should be ruled from the space likely to be occupied by the smallest figure to that occupied by the largest

FIG. 39.—Design painted on glass.

figure. Thus, in Fig. 41 the divisions were drawn to $\frac{1}{12}$th of an inch; thus $\frac{25}{10} = 2\frac{1}{2}$ in. to $\frac{25}{5} = 5$ in.; but, in drawing up a diagram for actual use, this latter space should be doubled, i.e. $\frac{50}{5} = 10$ in., when it will include all save abnormal figures.

Other modifications of the above principles are in use, according to the fancy of the particular analyst. Nevertheless, whatever system be adopted, it should be remembered that what is required is simply the division of one repeat of the figure into squares or oblongs, each representing a certain number of threads and picks on the design paper.

When only a portion of a pattern is obtainable the difficulties are greater, since no further advance can be made unless there is sufficient of the figure to decide the method of arrangement adopted, and even then the analyst can often go no further unless he possess considerable artistic insight and culture.

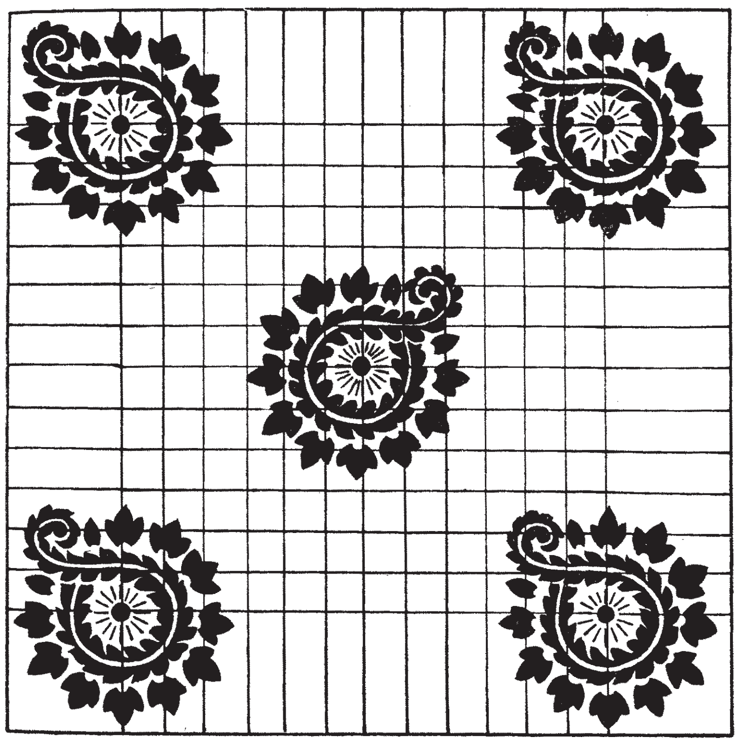

FIG. 40.—Sketch squared for point-paper.

Having obtained a satisfactory sketch of the design of the cloth and squared the same to represent the required number of threads and picks, the design may be transferred to point paper by working on the following lines, i.e. :—

1. Select a suitable size and correct ratio of point paper, according to the threads and picks per inch and in one repeat of the design.
2. Transfer the outline of the sketch on to point paper.

3. Paint in the outline of the figures with a solid yet transparent colour; shape off as well as possible and then "block in".

4. Insert the necessary weaves as systematically as possible;

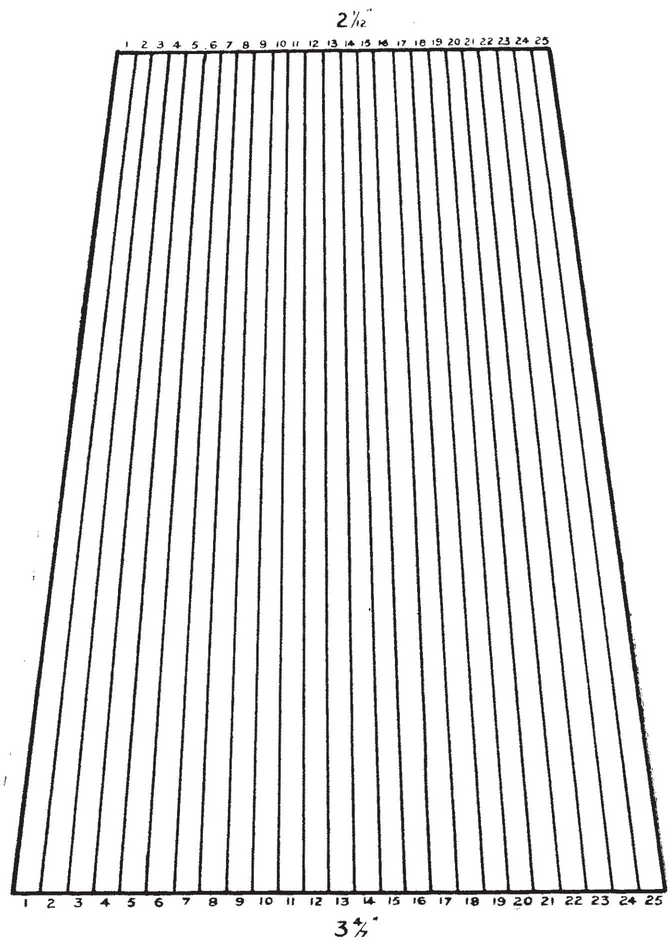

Fig. 41.—Dividing sketch into square.

carefully examining the original pattern and observing all detail regarding weave development, etc.

As already pointed out, it may not be necessary to either pull the pattern in pieces to ascertain the weave or, in the case of simple figured styles, to first obtain a sketch of the design. In some makes of cloths, especially figured styles where the ground weave is a simple one, a very effective method is to place an ordinary piece glass on the face of the cloth, when probably individual threads and picks may be followed throughout the repeat space.

The Counting of Threads and Picks.—It is of the utmost importance that these particulars should be absolutely correct, as an error of 3 or 4 threads or picks per inch would be responsible for making the resultant and reproduced fabric a higher or lower quality than the one imitated.

In fine goods, such as cashmeres and linings in which there are 65 or more threads per inch and often over 140 picks, an error of 2 or 3 would not be of as much importance to the result, as in cloths, such as mohair sicilians or botany twilled coatings where the threads and picks per inch are comparatively low and where abnormal "slipping" may result.

There are two distinct methods of counting, viz. :—

1. By counting the individual number of threads in $\frac{1}{4}$, $\frac{1}{2}$, or 1 in. by means of a piece glass.

2. By counting the repeats of the weave or colouring within a given space.

To obtain the highest degree of accuracy the latter method is commended wherever applicable.

Example 1.—A 3/3 twill cloth counts 26 repeats of the weave across $3\frac{1}{4}$ in. of the fabric. How many threads per inch are there in the cloth?

$$26 \times 6 = 156 \text{ threads in } 3\tfrac{1}{4} \text{ in.}$$
$$156 \div 3\tfrac{1}{4} = 48 \text{ threads per inch.}$$

Example 2.—(Fig. 42.)

Warping Plan.

8	threads	white
8	,,	black
8	,,	white
8	,,	black
16	,,	white
16	,,	black
64	threads per pattern.	

3 repeats of pattern and 16 threads black, 16 threads white measure 3 in.

$$64 \times 3 = 192 + 32 = 224 \text{ threads in 3 in.}$$
$$224 \div 3 = 75 \text{ threads per inch.}$$

The piece glass is most useful for counting finer set fabrics, where it is difficult to follow the repeat of design or colouring.

It is possible to calculate the threads or picks per inch by placing the piece glass longitudinally with the twill, but as the calculation involves trigonometrical ratios it is not here given. This method, however, is very useful in making comparisons between the fineness of twill in twilled fabrics.

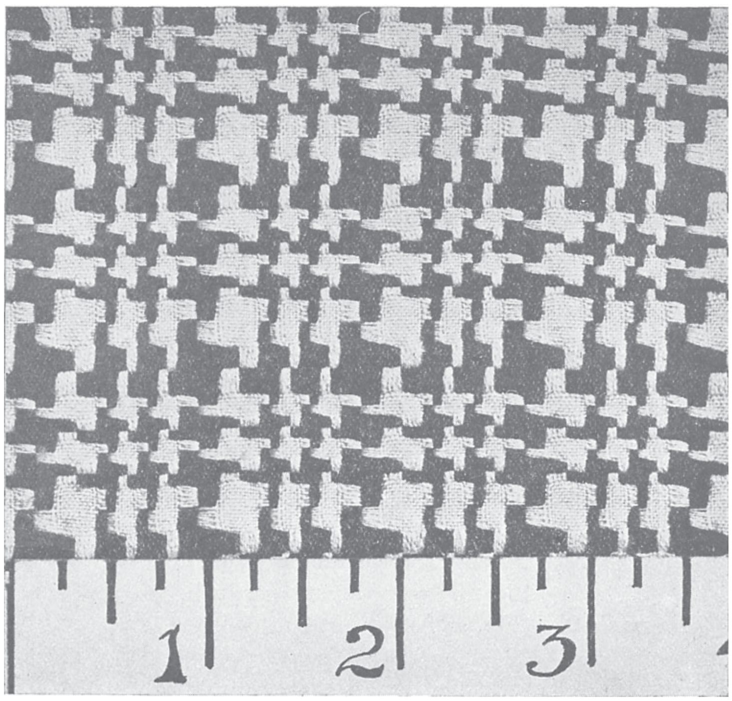

FIG. 42.—Method of counting threads and picks per inch.

Classification of Woven Structures.—In addition to the nature and quality of material and yarn employed to make a woven fabric, the contraction of warp and weft is largely controlled by the structure of the cloth. The widths and lengths of fabrics vary according to the weave, the thickness of the warp and weft, and the set of the threads and picks.

Interesting examples of the influence of weave are illustrated in Fig. 43. Here it will be noted that a similarly sett and picked cloth varies in width according to the weave applied.

The cloths contained in Fig. 43 are made to the following loom particulars :—

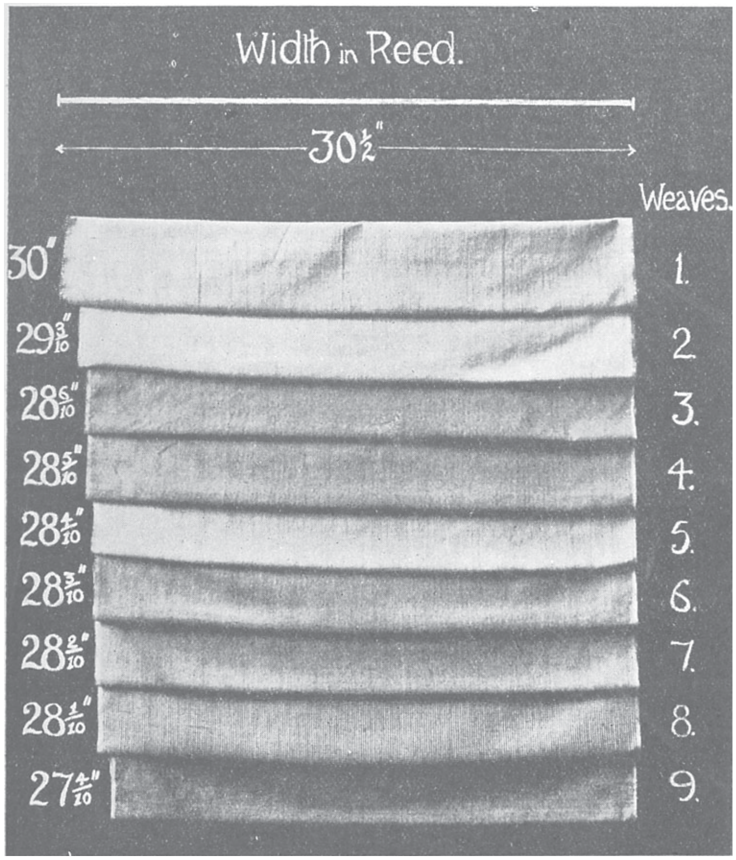

FIG. 43.—Influence of different weaves on the width of a woven fabric.

Warp.
2/56's botany worsted,
64 threads per inch.
Weft.
1/30's botany worsted,
64 picks per inch.

Fig. 44 illustrates the various weaves employed.

It is therefore obviously necessary to carefully consider the various types of interlacing as a knowledge of such may be useful in many ways.

Single Cloths.—As the name implies, single cloths are those in which only one series of warp and one series of weft are interlaced.

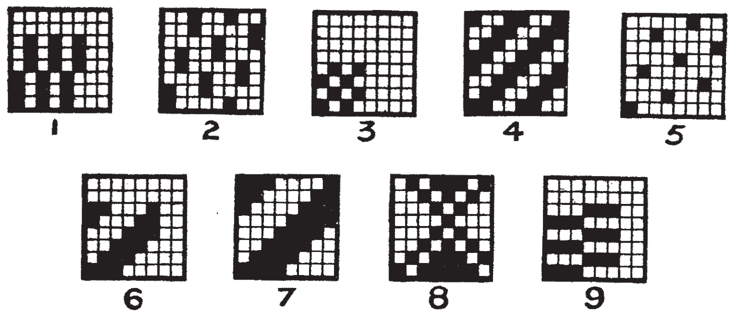

FIG. 44.—Varying widths of cloth (weaves employed).

The cloths made under this heading may be divided into two distinct classes, i.e. (*a*) ordinary structures, (*b*) ribbed structures.

Ordinary Structures are those in which the warp and weft threads are alike in thickness and number. The order of inter-

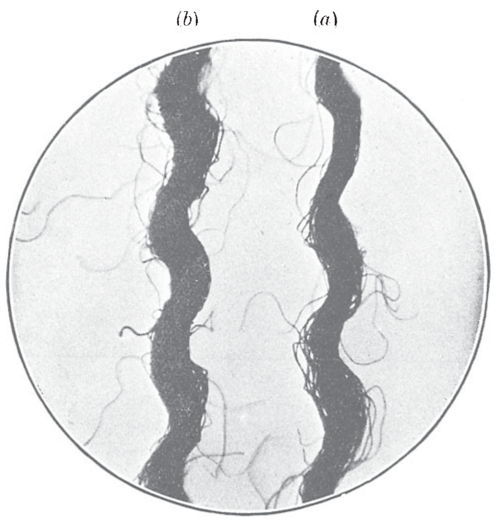

FIG. 45.—Micrograph of thread (*a*) and pick (*b*) from a 2/2 twill cloth.

lacing is also of such a character as to require about an equal amount of warp and weft on the face and back, which will cause both series of threads (warp and weft), provided they are of the same quality of material, to bend, contract, and shrink alike from being warp and weft to becoming a woven structure.

Fig. 45 is a micro-photographic reproduction of a thread and pick taken out of a 2/2 twill cloth, as shown in Fig. 45*a*. Notice first that the curves are equal, this being a necessary condition where each thread is up and down an equal number of times; and, secondly, that the deflections in warp and weft coincide, thus proving that, whatever the weave is, equal quantities of warp and weft are on the surface.

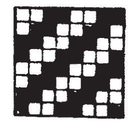

FIG. 45*a*.—2/2 twill.

The above conditions are considerably modified if one system of yarns is thicker or stronger than the other or the threads and picks per inch are not of an equal number. Although in both the above-mentioned modifications both warp and weft may show some curvature and contraction, yet the curves of warp and weft will not be equal. Such conditions will indicate varying widths and lengths. An illustration as to the extent to which the width of a cloth may be varied by modifying the number of picks or thickness of weft is indicated in Fig. 46.

Cloth.	Picks per inch.	Weft.		
1	64	2/36's	worsted,	botany.
2	64	2/54's	,,	,,
3	40	1/30's	,,	,,
4	64	1/30's	,,	,,
5	64	2/56's	,,	,,
6	64	1/64's	,,	,,
7	84	1/64's	,,	,,
8	84	1/30's	,,	,,

Loom particulars:—

Warp.
2/56's botany worsted,
64 threads per inch.
Weave.—2/2 twill,
reed width $30\frac{1}{2}$ inches.

Rib Structures.—Ribbed structures are those in which there is a predominance of one of the two series of threads which constitute the fabric, such as corkscrews, warp and weft ribs, etc., and are produced by (1) a certain order of interlacings, such as ribbed weaves; (2) warp and weft of different thickness; (3) a different number of threads to picks, or vice versa.

Warp Ribs.—The first method of constructing a ribbed weave is illustrated in flat view warp and weft sections, in Fig. 47. It will be observed that about equal thickness of warp and weft, with an equal number of threads and picks, produces a structure in which, when woven, the weft is entirely hidden, warp predominating on both face and back of the fabric, owing to the order of interlacing causing the picks of weft to be straight, and the warp threads only to bend.

The particulars are as follows :—

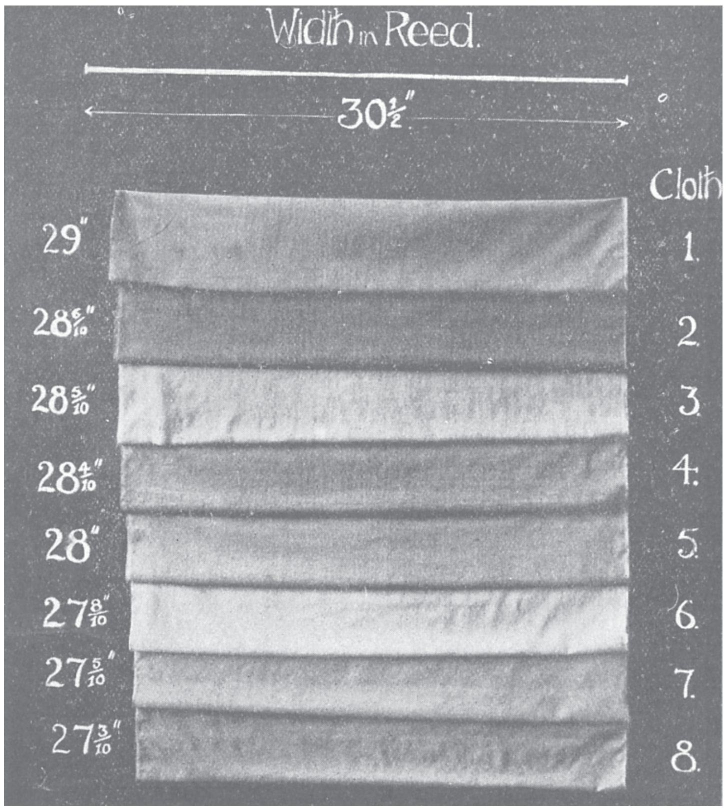

FIG. 46.—Variation in width by modifying the number of picks or counts of weft.

Warp.
2/36's botany,
76 threads per inch.

Weft.
1/20's botany,
76 picks per inch.

Weave.—3/3 warp rib.

Such conditions are responsible for little variation in width from loom to finished cloth, and great variation in length, although the warp and weft are composed of fibre of great contracting property. If a 3/3 weft rib weave be applied to the same structure, the result will be vice versa, i.e. the warp will be straight and the weft only bending.

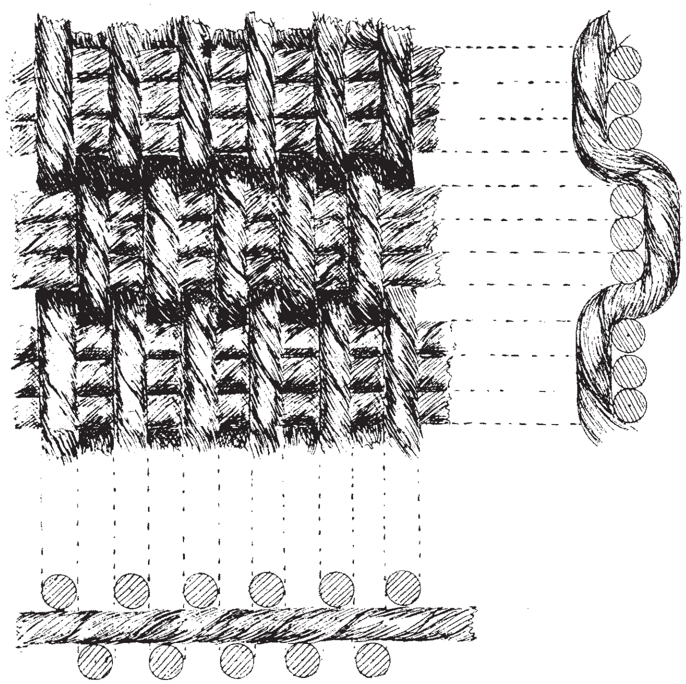

FIG. 47.

A second example of a warp rib structure is shown in Fig. 48 and Fig. 48*a*. Fig. 48 shows clearly (*a*) a warp thread, and (*b*) a pick of weft from a corkscrew cloth of which Fig. 48*a* is the weave. The warp thread (*a*) indicates the warp bending according to the floats and the pick of weft (*b*) practically in a straight condition.

Fig. 49 illustrates the flat view and warp and weft sections of a worsted poplin dress fabric made as follows :—

Warp.

2/80's botany,

135 threads per inch.

Weft.
1/12's botany,
47 picks per inch.
Weave.—Plain.

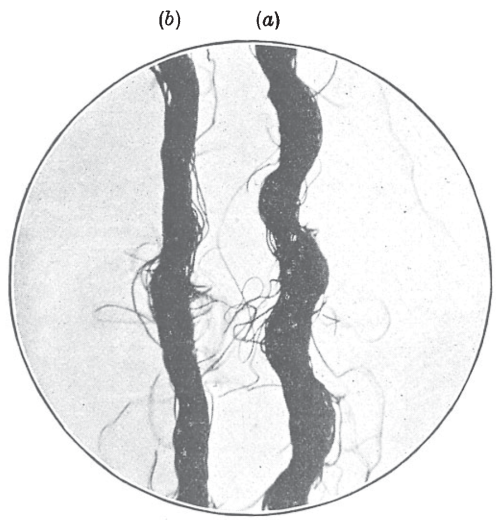

FIG. 48.—Micrograph of thread (*a*) and pick (*b*) from corkscrew cloth.

The structure (although produced from plain weave which usually results in an ordinary structure) is one of a purely warp rib character, due to the difference in the sett of the threads and picks, and the relative thickness of the warp and weft.

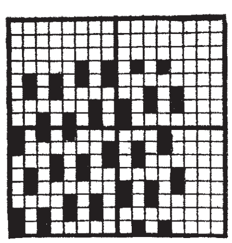

FIG. 48*a*.—13 shaft corkscrew.

Weft Ribs.—The only difference between these and warp ribs is that the weft bends and the warp lies straight. Fig. 50*a* is the 2/1 or cashmere twill of which a micrographic reproduction of actual threads is given in Fig. 50. It is noticed at once that the thick warp thread (*a*) is comparatively straight, and that the fine weft (*b*) practically does all the bending. The fact that the threads and picks are not up and down for an equal number of picks and threads is also clearly indicated by the wave of the pick here represented indicating the pick floating over two threads and where it is down for one. It is very evident, then, that if there is any doubt as to whether the ribs or twills in

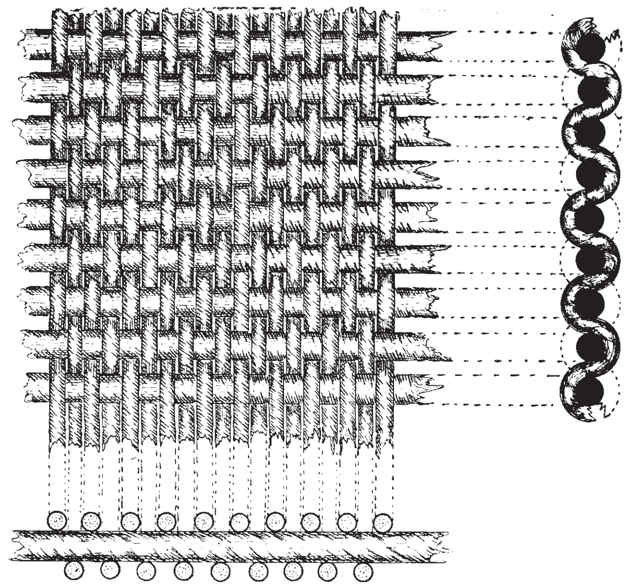

Fig. 49.—Poplin Dress Fabric.

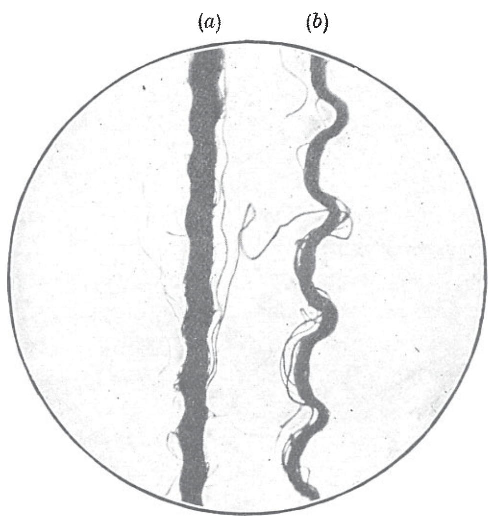

Fig. 50.—Micrograph of thread (*a*) and pick (*b*) from cashmere twill cloth.

a pattern are of the same breadth, a careful examination of the curvature of a pick will solve the question.

Backed Cloths.—Attention must now be directed to fabrics backed with warp or weft for the purpose of obtaining extra weight, warmth, and handle. In the first case we shall have two series of warp threads and one series of weft; and, in the latter case, one series of warp threads, and two series of weft threads. The following procedure should be adopted in analysing these cloths:—

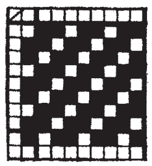

FIG. 50*a*.—Cashmere twill weave.

1. Ascertain whether backed with warp or weft.
2. Ascertain the relative proportions of face and backing threads or picks, and counts of the same.
3. Ascertain the face weave as a single cloth.
4. Ascertain the backing ties.

To decide whether a piece is backed with warp or weft may be rather a difficult matter if there is no list on the pattern submitted for analysis, and the only means of deciding will be the quality of the extra material. If it is a good quality—say a two-fold yarn—the backing has probably been warp, while if the material is single and short it has probably been weft, since it would not have the strength necessary for weaving as warp. Backing warp is nearly always finer than backing weft.

In ascertaining the relative quantities of backing yarns the safest method is to separate carefully the threads from the picks, classifying them as backing and face according to thickness, colour, material, or position in the cloth. The relative numbers will thus be ascertained with certainty.

Possibly the question may arise—Which is the most economical, warp or weft backing? With a poor material, evidently weft backing; but with a good material, warp backing, since, although there will be the trouble of beaming and fixing the backing warp independently of the face warp, yet in the case of a 1/1 backing the cloth will be woven in about half the time, and there will be little extra weaving expense.

No further reference to the third item in the above procedure is really requisite, since generally a portion of the backing may be taken off, leaving the face intact; but the fourth may profitably be considered more fully. In tying the backing to the face, of course, under any circumstances the conditions of perfect tying must, if possible, be observed, whether warp or weft be employed.

In Fig. 51 is shown an interesting fact concerning the backing of the 2/2 twill: (*a*) is a thread taken from the face, weaving as already indicated 2/2 twill, indicating two up and two down; (*b*) is the backing thread, indicating the tie. It will be observed that there are two repeats of the weave on the face thread to one on the backing. This leads us at once to decide that the backing is tied to the face in eight sateen order, since, as shown in flat view and sections Fig. 51*a* and design Fig. 51*b*, this sateen ties on every other twill.

It need scarcely be noted that it is almost impossible to analyse

(*a*) (*b*)

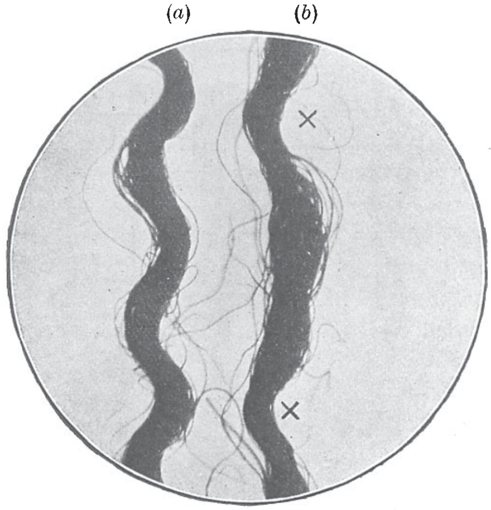

FIG. 51.—Micrograph of face (*a*) and back (*b*) warp threads from 2/2 twill cloth backed with warp.

these cloths successfully without a complete theoretical knowledge of the underlying principles, and some practical experience. For example, in addition to the foregoing difficulties, it is found in practice that, at times, such a small matter as the method of tying has quite a remarkable influence on the resultant cloth, a slight variation in the position materially influencing the result.

Double Cloths.—The principles governing the construction of these are very similar to those governing backed cloths, the only difference being that there is a distinct back cloth formed. The analyst should proceed as follows:—

1. Find the face weave or design.
2. Find the back weave or design.

3. Find the relative quantities of face warp and weft to the backing warp and weft, along with the counts of yarn, and

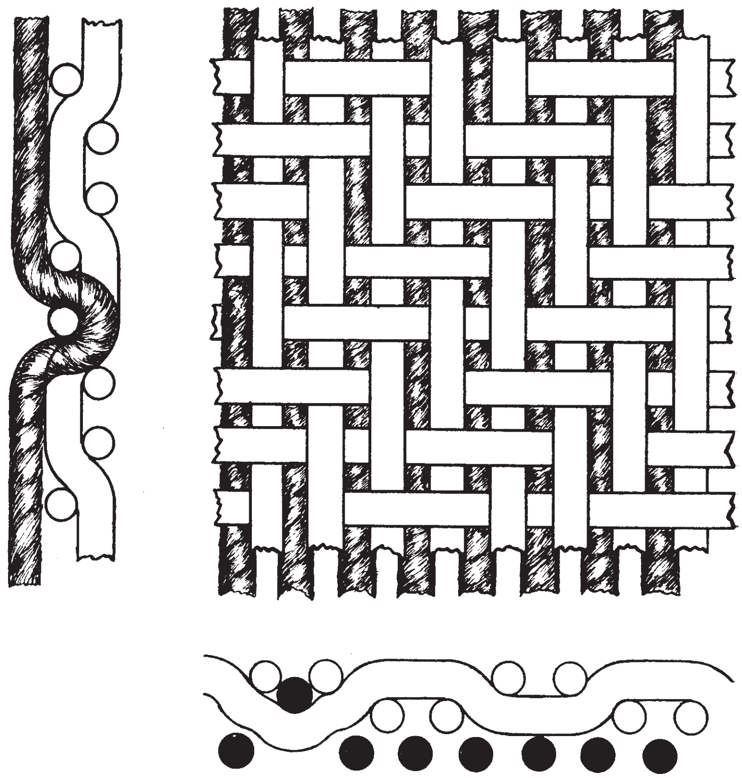

Fig. 51*a*.—Flat view and section of 2/2 twill cloth backed with warp.

4. Find the method of tying, whether with warp or weft, and the system of distribution.

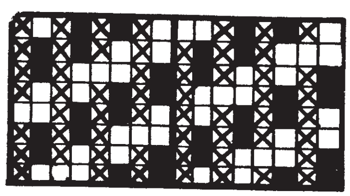

Fig. 51*b*.—Design for 2/2 twill, backed with warp. Marks = weft.

With reference to this latter proceeding Fig. 52 demonstrates a very useful point. Here (*a*) is a thread taken from the face of a double 2/2 twill cloth. (*b*) represents a thread taken from the back. It will at once be observed that, owing to the face being similar to the back cloth, the curves of the 2/2 twill coincide. Further, it is evident from an examination of the curve of the backing thread that the back cloth has been tied to the face by means of the backing warp, B indicating this tie,

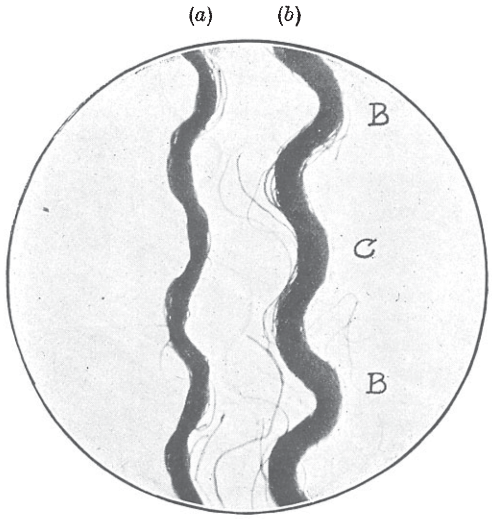

FIG. 52.—Micrograph of face (a) and back (b) threads from a double 2/2 twill cloth.

which is a much more marked curve than is C, where no such tie has taken place. In this way the system of tying may be ascertained, since if a backing thread rises over a face pick the curvature of the backing thread will show the tie; while if a backing pick rises over a face thread the curvature of the backing picks will show the tie. Fig. 52*a* is the plan employed and Fig. 52*b* illustrates the flat view and sections.

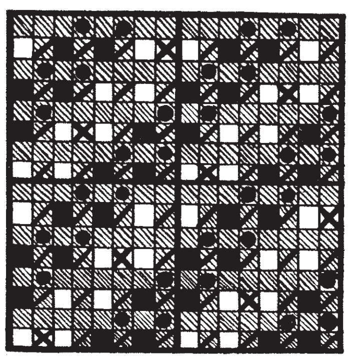

FIG. 52*a*.—Design for double 2/2 twill cloth.

Backing threads and picks.
Face weave inserted in face threads and picks.
Back weave inserted on back threads and picks.
Back threads held down when face picks enter the cloth.
Binding places, backing threads over face picks.

Marks = weft.

The Tying of Backed and Double Cloths.—The principle upon which backed cloths are tied will readily be realized by careful examination of Fig. 52*b*, in which the warp system of tying is illustrated.

The chief points to attend to are the following: First, whether warp or weft ties, all ties should be effected in such a manner that there is nothing perceptible upon the face of the

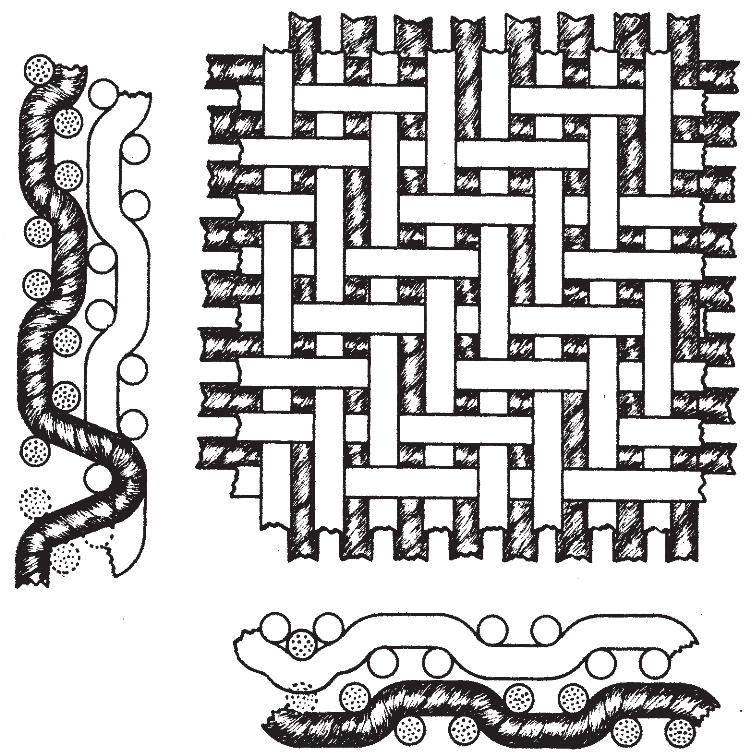

FIG. 52*b*.—Flat view and sections of double 2/2 twill cloth.

cloth; second, endeavours should be directed towards placing a tie upon every thread and every pick; third, in the case of double cloths the finer material, whether warp or weft, should as a rule be selected for tying purposes.

The first point is well demonstrated in Fig. 52*b*, a careful examination of which shows that the backing warp tie is effected between *two floating face warp threads.*

The second point will be duly attended to if the ties are arranged in sateen order. In Fig. 52*b* the eight sateen distribution is employed, since the face readily admits of this. If, however, a two of face to one of back scheme of arrangement, or any other arrangement, be adopted, the difficulties will be greater, and often cannot be entirely overcome. Note should be made that in a warp-backed cloth the backing threads should if possible rise over every face pick; while in a weft-backed cloth a backing pick should, if possible, rise over every face thread. In the case of double cloths precisely the same principles apply, according to the system of tying adopted.

This leads up to the third point—the selection of the material to tie with. In the case of backed cloths there is no choice here, but in the case of double cloths either warp or weft tying, as just noted, may be used. Evidently if the face weave gives no advantage to either system, the finer material, usually the warp, should be employed, but if the face weave favours the weft then it may be advisable to tie by the weft. For example, in a 3/1 weft twill face cloth there is evidently no perfect tying place for a warp tie, but for a weft tie the conditions could hardly be more favourable; therefore a weft tie should undoubtedly be employed. At times it may be advisable to use both the warp and weft systems of tying, but this will be of rare occurrence. In this, as with textile designing throughout, the analyst should work upon the basis that "that which is not best is wrong".

CHAPTER VII.

DRAFTS AND PEGGING PLANS.

By means of drafting the number of heald shafts necessary to produce many designs may be considerably reduced, and thus the use of a higher capacity dobby or jacquard be avoided. Take as an example Fig. 53: this extends over 48 threads, but it is not necessary to employ 48 shafts for its production, since a brief examination will show that certain threads are always lifted together and depressed together throughout the repeat, and consequently may be drawn on to one shaft.

Method of Drafting.—Carefully examine each succeeding thread in the design; all the threads rising and falling on similar picks may be drawn on one shaft.

Example.—As shown in Fig. 53 the design may be drafted on to 8 shafts with an equal number of threads, i.e. 6 per shaft. For example, threads 1 and 6 are up and down together for the same picks, therefore one shaft will work both threads exactly as required; and similarly with the other threads.

Pegging Plan.—This, as a rule, will be the plan upon which any small number of shafts are worked to produce a large repeat in the cloth. It will consist of every kind of thread in the given pattern. For example, in Fig. 53 there are only 8 kinds of threads, which 8 shafts can conveniently work; thus each shaft must be worked *according to the requirements of the threads drawn upon it.* Examination of Fig. 53 with its draft and pegging plan will demonstrate all that is necessary respecting this matter.

Calculation for Mails per Shafts in Plain and Fancy Drafts.—Another matter the cloth analysts should thoroughly understand is the arrangement of the mails on each shaft employed in the mounting.

When the warp threads are drawn through the healds in arithmetical order and similarly repeated, or straight drafted, then the calculation is simple.

Example.—A 2/2 twill cloth is woven 64 in. wide in the reed

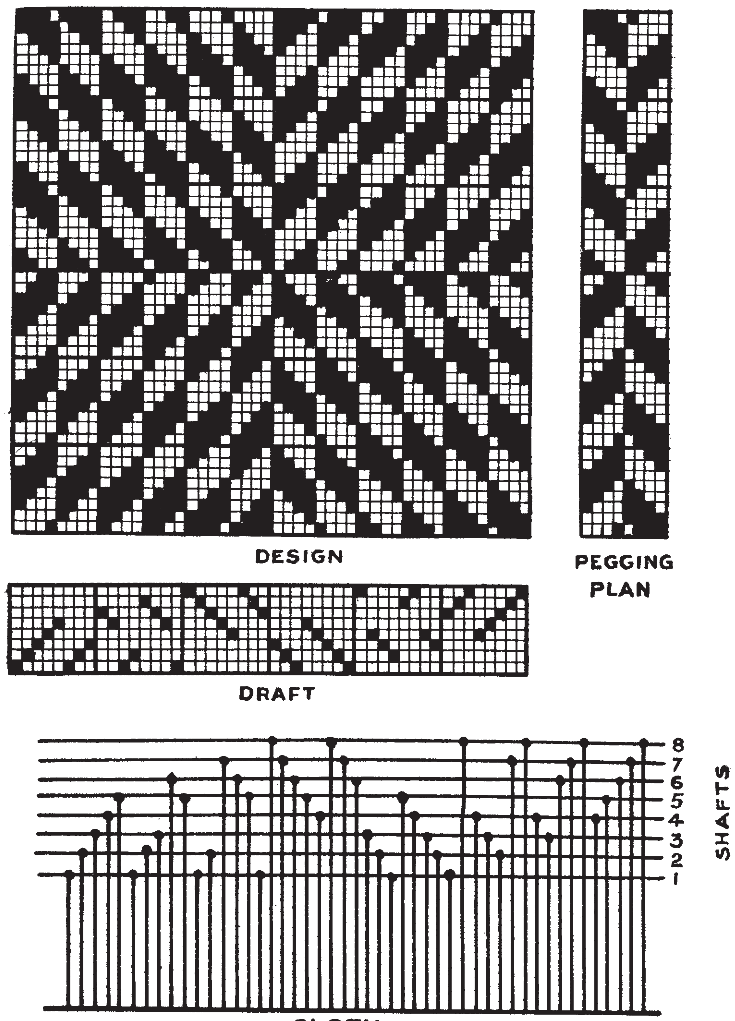

FIG. 53.—Method of drafting.

with 60 threads per inch, what number of mails upon each heald shaft is required?

Then, since 4 heald shafts are necessary to weave the 2/2 twill weave, the number of mails per heald shaft will necessarily be

$$\frac{60 \text{ (threads per inch)} \times 64 \text{ (in. wide)}}{4 \text{ (heald shafts)}} = 960 \text{ mails per shaft.}$$

In the case of fine setts it is often found expedient to employ double the number of shafts and consequently only half the number of warp threads on each shaft. In this case two shafts are usually linked together and so worked by the same tappet.

Example.—A plain weave cotton warp and mohair weft lustre cloth has to be woven with 70 threads per inch: employing 2

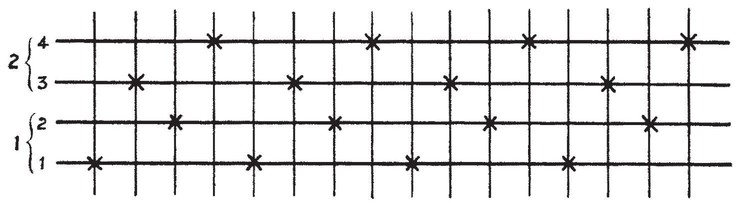

Fig. 54.

heald shafts the mails per inch upon each shaft will be :—

$$\frac{70 \text{ (threads per inch)}}{2 \text{ (heald shafts)}} = 35 \text{ mails per inch per shaft.}$$

Better conditions for weaving would be to reduce the number of mails per shaft by employing 4 shafts in place of 2, with the following result :—

$$\frac{70 \text{ (threads per inch)}}{4 \text{ (heald shafts)}} = 17\tfrac{1}{2} \text{ mails per inch per shaft.}$$

To obviate the employment of 4 tappets to actuate the shafts, the well-known "Hop-shaft" draft is employed, as illustrated in Fig. 54 : during weaving, the front two shafts and the back two shafts are linked together, the mounting thus requiring only 2 tappets. The tappet plan is for ordinary plain weave. It will be observed that the front two shafts will lift or depress the odd threads in the warp and back two shafts will actuate the even threads.

Fancy Drafts.—In the case of fancy drafts the same principle applies but there is rather more complication.

Example.—What number of mails per shaft will be required to employ the draft given at Fig. 55, in a cloth with 64 threads per inch, 60 in. wide ?

$$\frac{64 \text{ (threads per inch)} \times 60 \text{ (in. wide)}}{16 \text{ (number of threads in draft)}} = 240 \text{ repeats of the draft.}$$

240×2 (threads per repeat of draft) $= 480$ mails for shafts 1 to 4.
240×1 ,, ,, ,, $= 240$,, ,, ,, 5 to 12.

Casting-out is frequently resorted to as a means whereby a set of gears arranged for a given pattern may be re-adapted to another pattern, thus saving the expense of procuring a fresh set. Casting-out is accomplished in two ways, with two distinct objects :

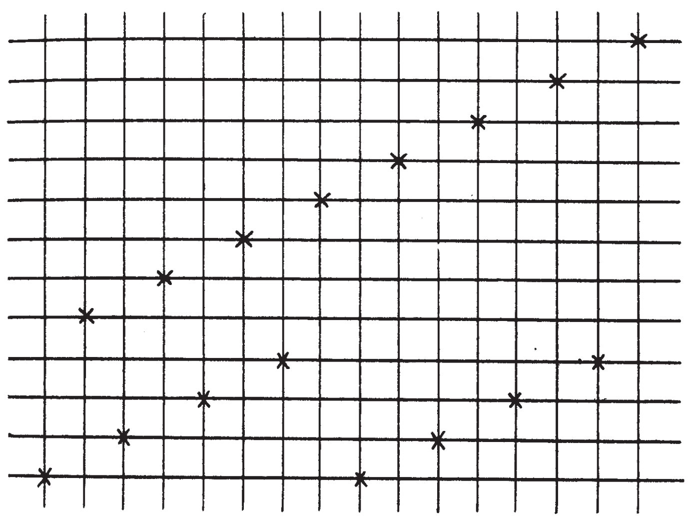

FIG. 55.

(*a*) for the reduction of the sett or ends per inch ; (*b*) for weaving a design repeating on a different number of ends.

Example.—A set of 8 shafts is arranged to give 64 threads per inch, therefore

$$64 \div 8 = 8 \text{ mails per inch per shaft.}$$

(*a*) *To Reduce the Sett.*—Cast out every other gait, i.e. draw threads upon 4 mails per inch per shaft only, leaving the others free ; thus

$$8 \text{ shafts} \times 4 = 32 \text{ threads per inch.}$$

If a less reduction is required, draw in 6 and cast out 2 gaits per inch per shaft, thus

$$8 \text{ shafts} \times 6 = 48 \text{ threads per inch,}$$

and so on.

In casting-out on the jacquard to reduce the sett it is usual to cast out uprights, since while casting-out in the harness leaves the full figuring capacity of the jacquard, yet the threads will be so extended in the reed, and the wear *caused by the empty harness working with the full* will be so great that, unless really necessary, this system should not be resorted to.

Example.—A 400 jacquard with 100 ends per inch = a 4-inch pattern.

To cast out in the harness to 50 ends per inch may then be effected as shown in Fig. 56 by drawing in 4 in. or one repeat of the mails A and missing 4 in. or one repeat B. The sley will then place the threads in their correct position in the cloth, but it will be realized that there is considerable friction on the threads,

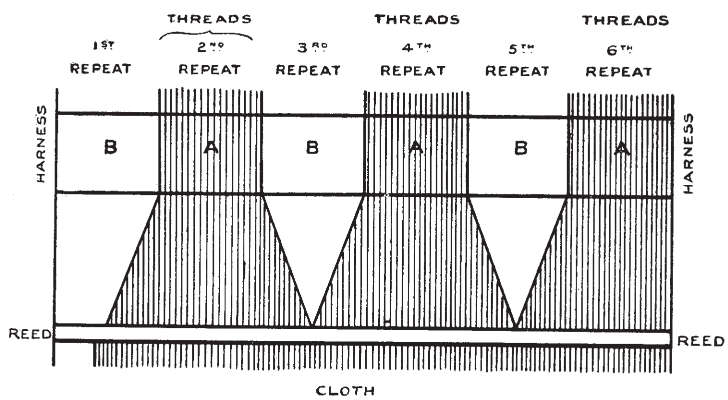

FIG. 56.—Casting out in harness.

while the wear of the harness in sections B B will be considerable, since it will work similarly to sections A A, which are forming the figure, but, since there are no threads through the mails in B B, the oscillation is liable to be very great.

(*b*) *For Weaving a Design Repeating on a Different Number of Ends.*—Take the example already given, viz. 8 shafts, 8 mails per inch = 64 threads per inch. Then to weave a 7-shaft plan one shaft may be cast off, for a 6-shaft plan two shafts may be cast off, and so on. Under these circumstances, however, the ends per inch will be reduced in direct proportion; thus, for 7 shafts the ends per inch will be :—

As 8 : 7 : : 64 : 56 ends per inch,

and for the 6 shafts—

As 8 : 6 : : 64 : 48 ends per inch, and so on.

The same principle obtains in the jacquard, uprights taking the place of shafts. Thus, to weave a 300 plan upon a 400 jacquard 100 uprights must be cast out, and so on. The set will, of course, be reduced in this proportion, for if 400 uprights give 100 ends per inch, then—

As 400 : 300 : : 100 : 75 ends per inch.

This system also may result in the threads being slightly drawn across if the uprights are all cast out together instead of say one row out of every four; but since the uprights are cast out the empty harness may remain stationary and thus obviate the wear resulting from working empty harness.

Inversely, to obtain a given set in a jacquard, uprights may be cast out in proportion as required, since, taking the foregoing as an example, to reduce from 100 ends per inch to 75 ends per inch will be

As 100 : 75 : : 400 : 300 uprights to be employed.

With these particulars the analyst should be able to overcome any difficulties arising, even should the conditions be more complicated.

Crammed Stripes.—Still more intricate calculations relate to mails per shaft for crammed stripes. Under these circumstances two or more distinct sets of healds will be employed, one set to weave the ground, and the other the figure or crammed stripe. Then—

(*a*) The number of shafts in each set will depend upon the respective weaves.

Example.—For a plain ground with an eight sateen crammed stripe, two or four shafts for the ground and eight for the stripe will be required.

(*b*) The absence of mails on the ground shafts and the presence of mails on the stripe shafts must be arranged for, according to the extent of the figure.

Example.—Fig. 57 is a sketch of a crammed stripe produced from the following loom particulars :—

Warp.

32	threads	2/56's botany	(at 64 threads per inch)
16	,,	40/2's spun silk	(at 128 ,, ,,)
24	,,	,, ,, ,,	(at 96 ,, ,,)
16	,,	,, ,, ,,	(at 128 ,, ,,)

32 dents per inch in reed.

Weft.

1/30's botany,
64 picks per inch

The Weave: Sleying plan, Drafts A and B, and Pegging plans A and B to produce this style are given in Fig. 57*a*.

In draft A it will be observed that 4 shafts are required whilst in draft B the "hop-shaft" draft is employed, requiring half the weaving capacity of draft A.

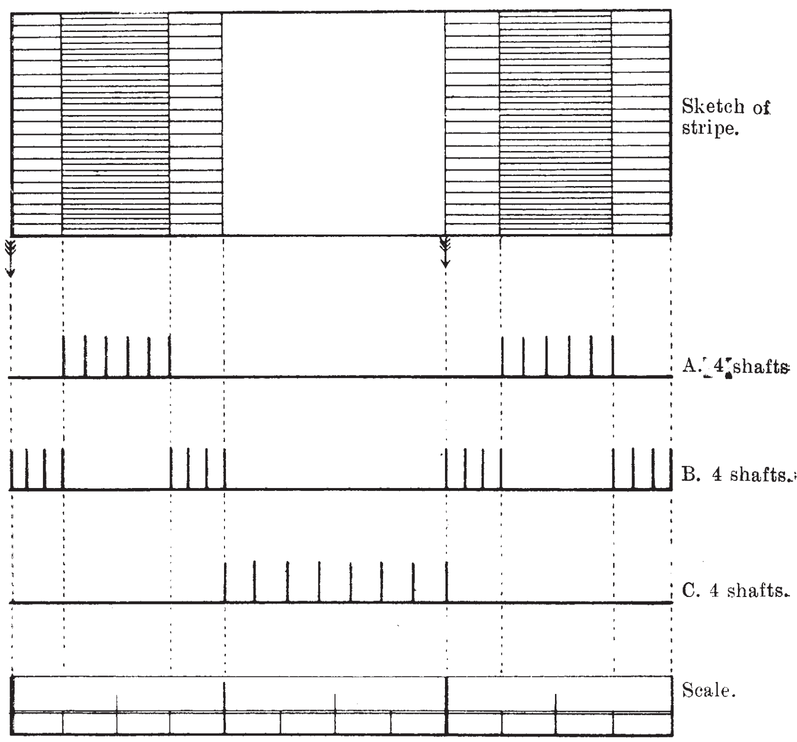

Fig. 57.

For this type of healds, where the warp threads are set finer in some parts than in others it is desirable to knit the healds according to the pattern. When this plan is adopted the finest set is taken as the pitch at which the knitting machine is made to knit the healds. All the remaining healds are then knitted to this same rate according to their relative fineness and spaced as indicated by the requisite draft pattern.

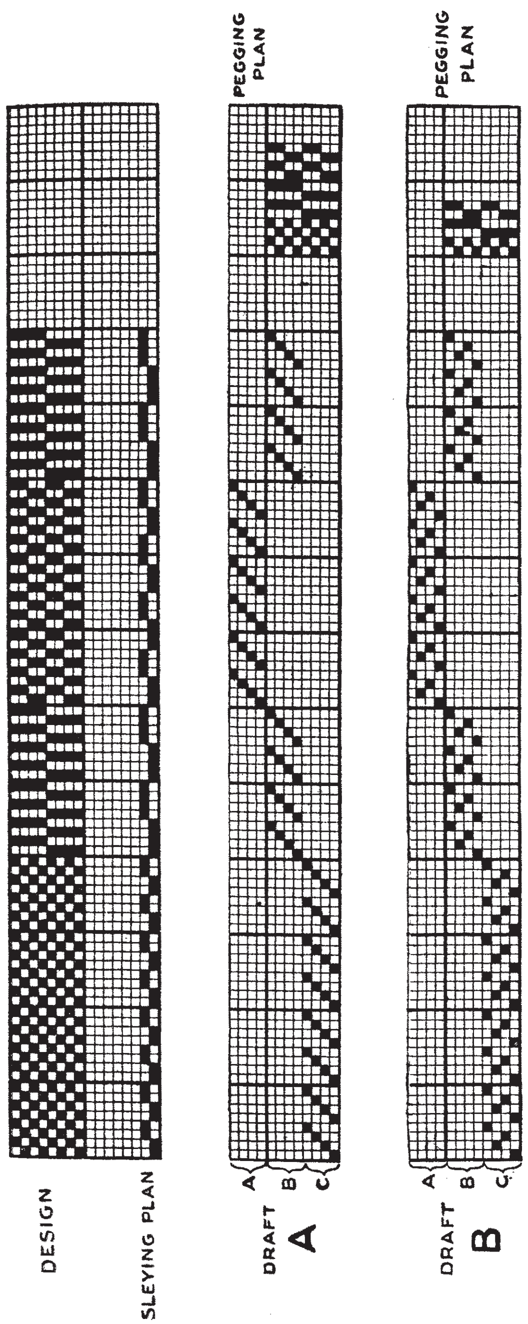

Fig. 57*a*.—Crammed stripe, design, sleying plan, drafts and pegging plans.

Note.—In B the shafts are linked together in pairs (see Fig. 54, p. 108).

Without entering into the details of the construction of the heald knitting machine, suffice it to say that it is usually constructed to automatically knit or miss, at will, any cord or number of cords in succession on each shaft.

Example.—In Figs. 57 and 57*a*, three sets of heald shafts are required to be spaced according to pattern and knitted as follows :—

Shafts A at 128	per inch	÷ 4	shafts	= at 32	per shaft	per inch.
„ B at 96	„	÷ 4	„	= at 24	„	„
„ C at 64	„	÷ 4	„	= at 16	„	„

With the heald knitting machine arranged to knit 32 mails

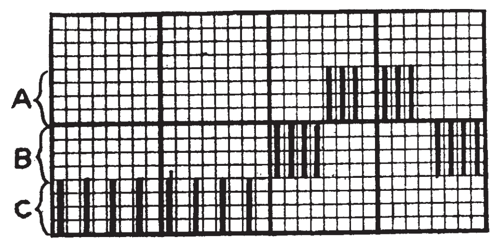

Fig. 57*b*.—Crammed stripe, heald knitting plan.

cords per inch, the order of knitting will be as shown in Fig. 57*b* which corresponds to the following :—

4 heald shafts A miss 20
knit 3
miss 1
knit 3
miss 5
miss 20
} x times

4 heald shafts B miss 16
knit 4
miss 8
knit 4
miss 16
} x times

4 heald shafts C knit 1
miss 1
} 8 times
miss 16
} x times
knit 1
miss 1
} 8 times

Another method of illustrating the heald order is by graphically indicating the position of the mails per shaft as illustrated in Fig. 57 according to the pattern.

In the case of ascertaining the total number of mails per shaft, the following calculation is involved.

Example.—What will be the total number of mails per shaft in producing the crammed strip (Fig. 57) 40 in. wide in the reed?

32 (dents per inch) × 40 (inches wide) = 1280 dents.

1280 (dents) ÷ 32 (dents per pattern) = 40 repeats of pattern.

Shafts A 6 (mails per shaft) × 40 (repeats) = 240 mails per shaft.
,, B 8 (,, ,,) × 40 (,,) = 320 ,, ,,
,, C 8 (,, ,,) × 40 (,,) = 320 ,, ,,

Note.—It will be well to balance this by finishing on the right hand list with an extra repeat of 8 mails per shaft on C; thus C will be 328 mails per shaft.

CHAPTER VIII.

EFFECTS OF DYEING AND FINISHING ON WOOL CLOTHS.

General Conditions.—It may be laid down as a general rule that all classes of woven fabrics alter in appearance, handle, weight, dimensions, strength, and elasticity in the processes of dyeing and finishing. The degree of alteration is entirely dependent on the following factors:—

(*a*) Type and quality of material or materials employed.

(*b*) Type and structure of the yarns employed.

(*c*) Build or structure of the fabric.

(*d*) Treatments and degrees of treatments imparted to the cloth during dyeing and finishing.

Fabrics made from materials with the greatest shrinking and felting properties vary most from the loom to becoming finished cloth. Since wool is the fibre possessing most of the above-mentioned properties, and also as the shrinking and felting properties of wools vary according to their quality, wool fabrics are influenced to a greater degree, and also vary differently, by the finishing processes as compared with fabrics made from other materials.

When a cloth made from all-wool yarns is subjected to the milling and raising processes, the thready appearance so characteristic of the fabric as it leaves the loom totally disappears and it may purely resemble a felt structure, with a pile or nap of fibre drawn from the body of the cloth. Consequently wool cloths which have been submitted to a "face" finish, such as amazons, vicunas, beavers, meltons, etc., have few features common to the fabric as it left the loom.

In a finished worsted coating there is not that distinctive alteration noticeable in other types of all-wool cloths. Here the character of the weave or effect is not only maintained, but smartly developed. In the case of a coloured worsted, where the finished cloth may appear very similar to the same fabric as in the loom, it is still not difficult to distinguish the unfinished and finished fabrics. The latter has a very much improved handle and smarter appearance generally, this latter being brought about by all the loose and straggling fibre having been removed from the texture by the cropping or cutting operation.

Wool is spun into two types of yarn, (*a*) worsted and (*b*) woollen. In preparing and spinning a worsted yarn the usual aim is to arrange the fibres parallel to each other. The woollen yarn, however, is spun so that the fibres are in all possible directions, with the result that this yarn presents more loose fibre than the former and appears rougher. This fibre assists the shrinking and felting of the fabric, as these fibres are more subject to any desired treatment than those which compose the worsted thread. Thus the contraction of a woollen cloth is usually markedly greater than in the cloth made of worsted yarns, although both may be made from the same raw material.

The amount of twist or twine put into a yarn has also its influence on the contracting properties of the cloth into which it is made. The fibres of a yarn which are loosely twisted together, are more subjected to any shrinking influence, than the fibres of the yarn, which are tightly twisted. Consequently the variation during finishing such dress cloths as crépons, voiles, crêpe-de-chines (which are made from hard twisted yarns) will be different from that of dress fabrics composed of ordinary twisted yarns of the same material.

There is also a difference in the shrinking property of yarns in the undyed and scoured or dyed condition, although spun from identical material. The yarn composed of coloured fibres has already been subjected to some fibre shrinkage whilst being dyed in the top or yarn state: thus it is necessary when making a piece dyed cloth, which is to be equal to a mixture cloth, or one composed of solid coloured yarns, to make a suitable allowance. For example a fabric composed of undyed yarns would be 66 in. wide in the loom, whilst the cloth composed of coloured yarns would be set 64 in. wide in the loom, both structures to finish 56 in. wide.

In cotton, linen, and ramie fabrics the above influences are almost *nil*, consequently there is but slight variation from the fabric in the loom to becoming finished. Variation is likely to occur in silks, according to the state of the fibre of the yarn when woven: if the gum has been "boiled off" the fibre before weaving, little variation is likely to occur: but if the fibre of the yarn is in its gummed condition, loss of weight may be expected, as the finishing operations will extract the gum.

Finishing All-wool Cloths.—In the first instance it should be pointed out that different firms will employ different methods of finishing the same type of structure: it is also important to remember that each type of cloth requires that kind of treatment which will yield the best result.

No. 1. *Vicuna Coating.*

Loom particulars:—

Warp.

2/56's grey botany.
60's quality.
104 threads per inch.
7254 ends in warp.
70 yds. of warp per cut.

Weft.

40 skeins woollen.
100 picks per inch.
$69\frac{3}{4}$ in. wide.

Weave.—Double 2/2 twill.

The grey cloth is delivered to the dyer and finisher 66 in. wide, $62\frac{1}{2}$ yds. long, and weighing 78 lb.: the instructions being:—

Vicuna finish,
Indigo blue dye,

deliver the finished fabric 58 in. wide.

The finisher having been instructed to impart a "Vicuna" type of finish indicates that the treatment must be of such a character as to give the fabric a fibrous appearance and a soft full handle.

Routine of Finishing Processes.—Knotting and mending, crabbing or blowing with steam to set the fabric, scouring, milling, dyeing, washing off, tentering, raising (wet), cutting, brushing, steaming or dewing, shrinking and pressing (rotary machine).

An alternative routine is to raise the cloth prior to milling, as the raising process facilitates the latter. Generally it may be said that the order of operations is varied and repeated according to particular requirements.

To illustrate in what way and to what degree the above-mentioned finishing processes affect the structure in question, investigations made after each process reveal the variations indicated in Table X.

No. 2. Clear Finished.

Loom particulars :—

As No. 1.

The grey cloth is delivered to the dyer and finisher, the same dimensions and weight as No. 1, with the following instructions :—

Clear finish,
Indigo blue dye

deliver the finished fabric 58 in. wide.

The routine of the finishing processes and the influence of each are indicated in Table XI.

On comparing the variation of these dimensions and weights, it will be observed that the dimensions are about identical, but there is a difference in the weights of the two cloths. The clear finished cloth weighs $72\frac{1}{4}$ lb., whilst the vicuna finished cloth weighs $71\frac{3}{4}$ lb. The difference in weight is equal to the amount of fibre which has been drawn from the body of the vicuna cloth during raising and cut away during cutting.

No. 3. Dyeing and Finishing a Worsted Coating.—The following example illustrates the effects of the various dyeing and finishing processes on a cloth composed of worsted yarns.

Loom particulars :—

Warp.

1 thread 2/36's grey botany 60's quality (face cloth).
1 ,, 2/40's ,, ,, ,, ,, (back cloth).

20's reed 6's.

Weft.

1/20's grey botany.
60 picks per inch.
$65\frac{1}{4}$ in. wide in loom.
3920 ends (face warp).
3920 ,, (back ,,).
70 yds. of warp per cut.

Weave.—2/2 twill backed with warp.

TABLE X.—VARIATION OF AN "ALL WOOL" FABRIC AFTER THE VARIOUS FINISHING OPERATIONS. DYED, INDIGO BLUE. VICUNA FINISH.

	Counts of Warp.	Threads per Inch.	Length of Warp.	Width.	Counts of Weft	Picks per Inch.	Weight of Warp and Weft.	Total Weight.
Loom particulars	2/56's botany	104	70 yds.	$69\frac{3}{4}$ in.	40 sk. woollen	91	—	—
As received by the finisher . . .	2/50	111	$62\frac{1}{2}$,, of cloth	66 ,,	36 sk.	102	$32\frac{1}{2}$ lb. warp $45\frac{1}{2}$,, weft	78 lb.
After crabbing and scouring . . .	2/52	122	60 yds.	60 ,,	35 ,,	107	30 ,, warp 43 ,, weft	73 ,,
,, milling	2/54	124	60 ,,	59 ,,	35 ,,	107	29 ,, warp $42\frac{1}{2}$,, weft	$71\frac{1}{2}$,,
,, raising (wet) and cutting . .	2/54	124	$60\frac{1}{2}$,,	59 ,,	36 ,,	106	29 ,, warp 41 ,, weft	70 ,,
,, dyeing and tentering . . .	2/51	126	60 ,,	58 ,,	35 ,,	107	$30\frac{1}{2}$,, warp 42 ,, weft	$72\frac{1}{2}$,,
,, cutting	2/51	126	60 ,,	58 ,,	35·5 ,,	107	$30\frac{1}{2}$,, warp $41\frac{1}{4}$,, weft	$71\frac{3}{4}$,,
,, pressing	2/53	126	$61\frac{1}{2}$,,	58 ,,	35 ,,	104	$30\frac{1}{2}$,, warp $41\frac{1}{4}$,, weft	$71\frac{3}{4}$,,

Observations:—

Total loss in weight = 8 per cent { **6 per cent loss of worsted**
10 ,, ,, woollen } **Shrinkage in width = 17 per cent**
,, length = 12 ,,

TABLE XI.—VARIATION OF AN "ALL WOOL" FABRIC AFTER THE VARIOUS FINISHING OPERATIONS. DYED, INDIGO BLUE. CLEAR FINISH.

	Counts of Warp.	Threads per Inch.	Length of Warp.	Width.	Counts of Weft.	Picks per Inch.	Weight of Warp and Weft.	Total Weight.
Loom particulars	2/56's botany	104	70 yds.	$69\frac{3}{4}$ in.	40 sk. woollen	91	—	—
As received by the finisher . . .	2/50	111	$62\frac{1}{2}$ yds. of cloth	66 ,,	36 sk.	102	$32\frac{1}{2}$ lb. warp $45\frac{1}{2}$,, weft	78 lb.
After crabbing and scouring . . .	2/52	122	60 yds.	60 ,,	35 ,,	107	30 ,, warp 43 ,, weft	73 ,,
,, milling	2/54	124	60 ,,	59 ,,	35 ,,	107	29 ,, warp $42\frac{1}{2}$,, weft	$71\frac{1}{2}$,,
,, dyeing and tentering . . .	2/51	126	60 ,,	58 ,,	34 ,,	107	$30\frac{1}{2}$,, warp $43\frac{1}{2}$,, weft	74 ,,
,, raising (dry) and cutting . .	2/52	126	$60\frac{1}{2}$,,	58 ,,	34·5 ,,	106	$30\frac{1}{2}$,, warp $42\frac{1}{2}$,, weft	73 ,,
,, pressing	2/53	126	$61\frac{3}{4}$,,	58 ,,	35 ,,	104	$30\frac{1}{2}$,, warp $41\frac{3}{4}$,, weft	$72\frac{1}{4}$,,

Observations :—

Total loss in weight = 7 per cent

5 per cent loss in worsted
9 ,, ,, woollen

Shrinkage in width = 17 per cent
,, length = 12 ,,

The cloth is delivered to the dyer and finisher, 61 in. wide, 65 yds. long, weighing $76\frac{1}{2}$ lb. The instructions being :—

Dye Black,
Clear finish

deliver fabric after finishing 56 in. wide.

The following are the treatments to which the cloth has been subjected and may be taken to be typical of those applied to cloths made from worsted yarns and intended to have a clear appearance.

Knotting and mending, scouring, dyeing, tentering, raising (dry), cutting, brushing, steaming, and pressing. In the above processes it will be observed that the operation of crabbing or fixing is omitted. This omission is justifiable as the quality of the material employed in the cloth is 60's quality of botany wool, the fibres of this material being of an average length and diameter, their shrinking properties will be regular. When warp and weft are composed of such fibre there is little risk of irregular shrinkage taking place during finishing. What little irregular shrinkage may have been developed during finishing, owing to irregular soaping or scouring, is eliminated in the blowing or steaming process prior to pressing. Such treatments as milling and raising (wet), both of which have a tendency to obliterate the weave, are also noticeable omissions from the above treatments.

Table XII indicates the influences of the processes on the fabric.

Grey and Finished Cloths.—To the analyst it is not difficult to ascertain the particulars of most cloths in a finished condition, but to state the loom particulars for reproducing the same is another matter. The amount of variation in the particulars of cloths finished and in the loom is dependent entirely on two factors, i.e. (1) loss in weight incurred during finishing, (2) contraction and shrinkage of the yarns from being in the loom to becoming a finished cloth.

Loss in Weight (Worsteds).—Worsted cloths which are submitted to a "clear" finish lose very little in weight. This loss occurs chiefly during the scouring, milling, raising, and shearing processes. The amount of loss varies slightly according to the severity of the processes and the structure and quality of the yarns. The "clear" finished cloth is not subjected to

TABLE XII.—VARIATION OF A WORSTED COATING AFTER THE VARIOUS FINISHING OPERATIONS. DYED BLACK. CLEAR FINISH.

	Counts of Warp.	Threads per Inch.	Length of Warp.	Width.	Counts of Weft.	Picks per Inch.	Total Weight.
Loom particulars	2/36's, 2/40's botany	120	70 yds.	65½ in.	1/20's botany	58	—
As received by the finisher	2/33, 2/36	130	65 yds. of cloth	61 ,,	1/18	62	76½ lb.
After scouring	2/32, 2/34	134	62½ yds.	58 ,,	1/18	63	74½ ,,
,, dyeing and tentering	2/30, 2/33	138	60 ,,	56½ ,,	1/17·5	67	76½ ,,
,, raising (dry)	2/31, 2/33	140	60 ,,	56 ,,	1/17·5	67	76 ,,
,, cutting and brushing	2/31, 2/34	140	60 ,,	56 ,,	1 18	67	75 ,,
,, steaming or blowing	2/32, 2/34	140	60 ,,	56 ,,	1/18·5	67	73½ ,,
,, pressing	2/32, 2/35	140	61 ,,	56 ,,	1/18·5	66	73 ,,

Observations :—

Total loss in weight = 6 per cent

Shrinkage in width = 14 per cent
,, length = 13 ,,

milling, raising (wet) as in producing a "face" finish such as a melton or a vicuna. As the operations named produce an appreciable loss of fibre, the loss in weight, during finishing a clear worsted, is not so great as when compared with the same type of cloth subjected to a face finish.

In worsteds submitted to a "clear" finish the chief loss in weight occurs during the process of scouring, in which treatment the impurities are expelled. The impurities consist of the oil —usually about 3 per cent—which is applied to the fibre to facilitate the preparing, combing, and spinning processes, and the sizing agent which is often applied to the warp to improve its weaving properties; also the filth which has been contracted during manufacture.

After scouring there is very little further loss in weight. The small amount of fibre which is taken from the cloth during cutting and brushing has practically no influence on the weight of the fabric.

Fabrics made from dyed yarns and "dry" spun yarns are free from oil; in the former the oil applied for spinning purposes having been extracted when the yarn was being dyed whilst "dry" spun yarns are spun without the assistance of a lubricant although they always hold a fractional percentage. Consequently there is not the loss of weight during the finishing of this type of fabric which occurs in finishing cloths composed of grey or undyed yarns.

Table XIII indicates the grey and finished weights of a number of standard worsted cloths which have been submitted to a "clear" finish. As all worsted cloths contain about the same amount of impurities and are subjected to about the same treatments during finishing, the amount of weight lost during finishing can be standarized.

Table XIII states an average loss in weight of 5·7 per cent, which for all practical and cloth analysis purposes may be taken at 6 per cent. Hence the conclusion arrived at, is that all worsted cloths which are "clear" finished and *not subjected to any weighting, adulteration, or loading,* will sustain a loss in weight of 6 per cent.

Woollens.—The weight of grey and finished cloths composed of woollen yarns vary more than in any other type of woven textures.

TABLE XIII.—LOSS OF WEIGHT IN WORSTEDS SUBMITTED TO A CLEAR FINISH.

Style of Fabric.	Material.	Grey Weight.	Finished Weight.	Loss per cent in Weight.
Grey cloth to be dyed . .	Botany	80 lb.	74·8 lb.	6·5
Mixture fabric	,,	80 ,,	75·5 ,,	5·6
Grey cloth scoured only . .	,,	80 ,,	75·9 ,,	5·2
,, ,, to be dyed . .	Crossbred	44½ ,,	42 ,,	5·6
Fancy coating, coloured yarns .	Botany	56 ,,	53 ,,	5·4
Voile dress fabric . . .	,,	19¾ ,,	18½ ,,	6
Covert cloth (coloured yarns) .	,,	68 ,,	64½ ,,	5
Dress cloth, grey cloth to be dyed	,,	24 ,,	22 ,,	6·6
				8)45·9
	Average loss per cent			5·7

Conclusion: Loss in weight = 6 per cent.

To facilitate the preparing and spinning of a woollen thread from 5 to 15 per cent of oil is required to lubricate the fibre. This large variation is primarily due to the quality of the material, and to a certain extent to the indiscriminate manner in which oil is applied. As a rule the best quality of woollen yarns contain the least amount of oil and the lowest qualities—such as mungoes, etc.—the largest amount.

The treatment imparted to a woollen cloth during finishing is much more severe than that given to the average worsted cloth. Further it must be borne in mind that the structure of a woollen thread is different from that of a worsted, this being responsible for the finishing processes producing different effects upon woollen and worsted cloths. For example during the process of milling, the fibres of the woollen cloth are much more readily felted than the fibres of the worsted fabric: also during the same operation much more fibre, and consequently weight, is taken from the woollen structure. The fibres, which constitute a woollen yarn, are much more readily separated from the body of the yarn or cloth than in the case of worsteds. On this account the loss of fibre during finishing a woollen is in excess of the fibre lost in finishing a worsted, although both may be subjected to identical treatments.

The total amount of weight lost in finishing a woollen will depend upon the amount of impurities present and the degree of finishing treatment applied. As already stated, the amount of impurities varies almost directly with the quality of the material; thus the fabric composed of low quality of woollen material will lose more weight during scouring than the cloth which is composed of better quality of material. Owing to the varying constituents of woollen cloths and to the many treatments and degrees of treatment to which they are subjected to obtain different types of finish it is impossible to standardize the amount of loss in weight involved during finishing.

A perusal of the makes of cloths and respective losses during finishing tabulated in Table XIV provides a suitable illustration. Fabrics Nos. 1 and 7 lose 24 and 27 per cent respectively in weight. This apparent enormous decrease is due to the low woollen yarn, containing about 15 per cent of oil which is extracted during scouring; also to the severe treatment imparted to the cloth to obtain the vicuna and melton appearance. The cloths numbered two and three are typical Colne Valley structures. In considering the structures and type of finish, i.e. worsted and cotton twist warp and low woollen weft and " clear " finish—it is obvious that most of the loss is due to the impurities of the woollen weft, as the treatments to obtain a clear finish are comparatively light. The losses in weight of cloths Nos. 4, 5, 6 are stated to be equal to 10 per cent of weight. This amount is a minimum when compared with the other results. As the cloths are composed of mixture and coloured yarns of good quality, it is reasonable to estimate the amount of oil at about 5 per cent. In all the three examples the treatment during finishing is of a light character and, as the loss of fibre is according to the degree of treatment, the comparative slight loss in weight will be understood.

The lack of any previously published particulars relating to the loss in weight during the finishing of woollens, also the lack in uniformity of the results, makes Table XIV useful for reference in the analysis of woollen patterns.

Contraction and Shrinkage of Yarns.—There are two distinct stages of contraction and shrinkage of yarns from being in the loom to becoming finished cloths. The first being from loom to grey cloth and the other from grey to finished cloth. In both cases the influences are:—

(*a*) *Nature of Material and Structure of Yarns.*—A worsted

TABLE XIV.—TABLE ILLUSTRATING THE LOSS OF WEIGHT INCURRED DURING FINISHING "WOOLLENS".

Type of Cloth.	Finish.	Warp.	Weft.	Weight.	Loss in Weight.
Vicuna	Heavily milled	Woollen yarn, low quality	As warp	21½ oz.	24 per cent
Trousering	Clean finish	Coloured worsted and cotton twist	Black woollen, low quality	16 ,,	17 ,,
,, ...	Ditto	Ditto	Ditto	16 ,,	16½ ,,
Mixture coating	Tweed finish	24 cut Gala (mixture), 44 threads per inch	As warp	17 ,,	10 ,,
,, ,, ...	Ditto	2/24 cut Gala (mixture), 30 threads per inch	Ditto	18 ,,	10 ,,
Trousering	Slightly milled	30 skein coloured woollen, good quality, 68 threads per inch	As warp, 64 picks per inch	17 ,,	10 ,,
Low melton	Heavily milled	2/40 cotton, 40 threads per inch	6 skein low quality, 60 picks per inch	18 ,,	27 ,,
Carriage rug	Velvet finish	2/20 cotton, 18 threads per inch	Coloured 5 skein woollen, medium quality	3½ lb.	20 ,,
,, ,, ...	Ditto	Coloured woollen yarn, low quality	As warp	4 ,,	22 ,,
Amazon dress fabric . . .	Milled and raised	1/36 mule spun worsted, 72 threads per inch	40 skein woollen, fair quality, 36 picks per inch	—	13 ,,

yarn composed of fine botany wool possesses more natural shrinking property than any other type of worsted yarn. A case in point is as follows :—

A cotton warp leno piece, very open in set, was woven with mohair and botany weft of the same counts. The widths of the two materials in the same structure of fabric are :—

	Mohair Weft.	Botany Weft.
Loom width . .	27 in.	27 in.
Grey cloth width .	25 ,,	20 ,,
Finished cloth width .	20 ,,	17 ,,

Thus a difference of 5 in. in the grey and 3 in. in the finished cloth is due to difference in the quality of worsted weft employed.

(*b*) *Structure of Cloth.*—(Counts of yarn, weave, threads, and picks per inch.) The fibres and yarns of an open set cloth have much more opportunity to shrink than those of a tightly woven texture, as the development of shrinkage is largely controlled by the freedom of the fibres. For example the fibres of an open set cloth are much more subjected to the shrinking action of scouring and milling than the fibres of a close set texture : also a tightly twisted yarn will tend to diminish the amount of shrinkage which might be otherwise developed.

A thick weft will bend or contract the warp, during weaving, more than a fine weft and vice versa.

The order of interlacings of warp and weft are largely responsible for the amount of shrinkage developed during finishing and entirely responsible for the amount of take up or contraction during weaving. As previously stated in ordinary structures, twills, hopsacks, etc., the warp and weft bend about alike and any modification in weave, thickness of warp and weft, number of threads and picks per inch, will cause warp and weft to take up differently.

Warp-faced cloths such as ribs, corkscrews, etc., have a greater take up in length during weaving than in width, whereas weft-faced cloths take up less in length than in width. The conditions of weaving are such, that cloths, which are identical in structure, may vary in dimensions to some degree ; the amount of tension applied to the warp beam and to the weft by means of the shuttle and by templing will account for the lengths and widths of pieces, which are expected to be alike, varying to some extent.

(*c*) *Finishing Treatments.*—The amount of shrinkage or contraction is primarily due to the factors already mentioned, but wet finishing processes although carried out with other objects invariably develop the natural shrinking property of the raw material, so far as the structure of yarn, fabric, etc., will allow.

Scouring for example, although intended to be a cleansing process, is responsible for more fibre shrinkage than any other process in manufacture. The cloth finisher may vary the shrinkage of identical fabrics. Differences in length of time, degree of temperature, type of soap employed during scouring and milling may be responsible for enormous variations in the shrinkage of the length and width and also of the weight of cloths composed of good quality of wool and identical in structure.

Comparison of Dimensions of Grey and Finished Cloths.—Interesting studies in cloth structure and the influence of materials, structure, and type of finish on the varying dimensions of a number of worsted fabrics are given in Tables XV, XVI, and XVII, a perusal of the various shrinkages, at once indicating that standardization is impossible. In the absence of recorded particulars of cloths actually woven, the particulars stated in this table will be found useful to the cloth analyst, especially when estimating the lengths and widths of grey cloths from certain loom dimensions. Such estimation without the aid of recorded results entails the application of an extensive practical experience in addition to an application of knowledge of materials, structure, and effects of finishing.

Table XV indicates : (*a*) Contraction from loom to grey cloth, (*b*) shrinkage from grey to finished cloth, of a number of standard worsted fabrics of different structure submitted to a clear finish.

In Table XVI the loom particulars and amount of shrinkage are given of the same cloth in four different weights. These may be taken as an example of the extreme amount of shrinkage which may be developed in a worsted cloth submitted to a clear finish. To obtain this enormous variation from loom to finished cloth the following factors are essential : First, the employment of raw material possessing great shrinking properties ; second, a loosely built grey cloth to facilitate shrinkage during finishing ;

TABLE XV.—VARIATIONS IN THE DIMENSIONS OF WORSTED CLOTHS, DYED AND SUBMITTED TO A CLEAR FINISH.

Style of Fabric.	Quality of Material.	Weight per Yard.	Widths.			Lengths.		
			Loom.	Grey.	Finished.	Warp.	Grey.	Finished.
11-shaft whipcord . . .	Botany	18 oz.	70¼ in.	66 in.	56 in.	70 yds.	60 yds.	54 yds.
2/2 twill coating . . .	,,	21 ,,	65 ,,	62 ,,	56 ,,	,,	63 ,,	58 ,,
,, ,, ,, . . .	,,	13 ,,	65 ,,	62 ,,	56 ,,	,,	65 ,,	60 ,,
,, ,, ,, . . .	Crossbred	12 ,,	62 ,,	59 ,,	56 ,,	,,	65 ,,	62 ,,
,, ,, ,, . . .	Botany	21 ,,	76½ ,,	70 ,,	58 ,,	,,	61½ ,,	57 ,,
Voile light dress cloth . .	,,	—	47 ,,	45 ,,	41 ,,	,,	64 ,,	64 ,,
Poplin dress cloth . . .	,,	—	46 ,,	45¾ ,,	44 ,,	,,	60 ,,	58 ,,
3/3 warp rib	,,	14 oz.	58½ ,,	57½ ,,	56 ,,	,,	62 ,,	60 ,,
Covert cloth	,,	Light weight	65 ,,	62½ ,,	56 ,,	,,	60 ,,	58 ,,
13-shaft corkscrew . . .	,,	17 oz.	64 ,,	62 ,,	56 ,,	,,	61 ,,	58 ,,

TABLE XVI.—WORSTED 2/2 TWILLS, CLEAR FINISH, DYED BLACK.

Weight. per Yard Finished.	Loom Particulars.					Widths.			Lengths.		
	Counts of Warp.	Threads per Inch.	Ends in Warp.	Counts of Weft.	Picks per Inch.	Loom.	Grey Cloth.	Finished Cloth.	Warp.	Grey Cloth.	Finished Cloth.
13 oz.	2/42's botany	52	3930	As warp	60	75½ in.	70 in.	58 in.	70 yds.	63 yds.	60 yds.
21 ,,	2/26's ,,	52	3980	,,	58	76½ ,,	70 ,,	58 ,,	70 ,,	61½ ,,	57 ,,
19 ,,	2/30's ,,	52	4030	,,	60	77½ ,,	70 ,,	58 ,,	70 ,,	61½ ,,	58 ,,
22 ,,	2/16's ,,	39	2850	,,	39	73 ,,	68 ,,	57 ,,	70 ,,	62 ,,	57 ,,

third, treatment during finishing, particularly scouring, to develop the amount of shrinkage required.

In perusing the makes of these cloths it is noticeable that there are usually a greater number of picks per inch than threads per inch. The different amount of shrinkage allotted to warp and weft is such as to counteract this feature, the finished cloth containing about an equal number of threads and picks per inch.

Table XVII gives particulars of three makes of union covert cloths, with the varying dimensions of warp and weft. A noticeable feature is the influence of the various thicknesses of weft on the take-up of the warp during weaving. Cloth No. 1 gives the least length owing to the fact that the thickest weft is employed.

TABLE XVII.—WORSTED COVERT FABRICS, CLEAR FINISH, DYED COLOURS.

Loom Particulars.					Widths.			Lengths.		
Counts of Warp.	Threads per Inch.	Ends in Warp.	Counts of Weft.	Picks per Inch.	Loom.	Grey Cloth.	Finished Cloth.	Warp.	Grey Cloth.	Finished Cloth.
2/48's	78	5070	1/18	64	65 in.	62-63 in.	56-57 in.	70 yd.	60 yd.	58 yd.
2/66's	92	6040	1/30	64	$65\frac{1}{2}$,,	62-63 ,,	56-57 ,,	70 ,,	61 ,,	59 ,,
2/60's	100	6520	1/40	64	$65\frac{1}{4}$,,	62-63 ,,	56-57 ,,	70 ,,	62 ,,	60 ,,

Union cloth (Warp, cotton, and worstedtwist, Weft all botany worsted); Weave, 5-end covert.

Effects of Shrinkage.—The influence of shrinkage on the length and width of a cloth is to increase :—

1. Weight per yard.
2. Counts of warp and weft.
3. The number of threads and picks per inch, and decrease :—
4. The width and length of cloth.

Before any allowance or deduction can be made on finished cloth particulars to obtain the loom particulars, each of the above features must be dealt with in detail, and then, to render thorough comprehension easy, a typical example must be fully considered.

1. *Weight per Yard.*—As cloths are sold by the weight per

yard almost any and every width, it is evident that contraction in width has no influence on the desired weight whatever. Certain standard widths, however, being recognized in the various branches of the trade, this uniformity must be exactly obtained by tentering.

Contraction in length, however, has a direct influence on the weight per yard of a cloth. For example, if a grey cloth 40 yds. long weighs 1 lb. per yard, the whole cloth will weigh 40 lb. If this is shrunk during scouring and milling up to 20 yds., supposing there is no loss in weight, the piece will still weigh 40 lb., i.e. 2 lb. to the yard, or

As 20 yds. : 40 yds. : : 1 lb. : 2 lb. per yard.

From this, however, a deduction must be made for the loss in weight involved during finishing. The best examples of this are given in the cloths dealt with in Tables X, XI, and XII.

Example 1.—(Table X) a cloth composed of worsted warp and woollen weft is dyed indigo blue and submitted to a vicuna finish.

Weight of cloth, grey 78 lb.; finished $71\frac{3}{4}$ lb.
Length of cloth, grey $62\frac{1}{2}$ yds.; finished $61\frac{1}{2}$ yds.
78 lb. $\div$ $62\frac{1}{2}$ yds. = 20 oz. per yard grey.
$71\frac{3}{4}$,, $\div$ $61\frac{1}{2}$,, = 18·6 ,, ,, finished.

Example 2.—(Table XI). The same cloth as in example 1: dyed indigo blue and submitted to a clear finish.

Weight of cloth, grey 78 lb.; finished $72\frac{1}{4}$ lb.
Length of cloth, grey $62\frac{1}{2}$ yds.; finished $61\frac{3}{4}$ yds.
78 lb. $\div$ $62\frac{1}{2}$ yds. = 20 oz. per yard grey.
$72\frac{1}{4}$,, $\div$ $61\frac{3}{4}$,, = 18·72 ,, ,, finished.

Example 3.—(Table XII). A worsted coating cloth, dyed black and submitted to a clear finish.

Weight of cloth, grey $76\frac{1}{2}$ lb.; finished 73 lb.
Length of cloth, grey 65 yds.; finished 61 yds.
$76\frac{1}{2}$ lb. $\div$ 65 yds. = 18·8 oz. per yard grey.
73 ,, $\div$ 61 ,, = 19 ,, ,, finished.

Hence it is evident that the weights per yard of cloths grey and finished increase according to the shrinkage in length, and decrease according to the weight lost during finishing.

2. *Counts of Warp and Weft.*—As the shrinkage of a cloth and the loss in weight involved during finishing is responsible for

the variation in the weight per yard of a cloth, so the same two factors create a similar and relative variation in the counts of the yarns which constitute the cloth. The loss in weight will in consequence cause the yarn to become lighter or thinner, and the shrinkage will be responsible for a thicker count of yarn, a balancing up of the two taking place.

An illustration of this is given in Tables X, XI, XII, where the counts of warp and weft in the loom and in the finished cloth are as follows :—

No.	Warp.		Weft.	
	Loom.	Finished.	Loom.	Finished.
Table X	2/56	2/53	40 skeins	35 skeins
,, XI	2/56	2/53	40 ,,	35 ,,
,, XII	2/36 2/40	2/32 2/35	1/20	1/18·5

Figs. 58 and 59 graphically illustrate the conditions of warp and weft of the cloth given in Tables X and XII from being in the loom to becoming a finished cloth, from which it is evident, that as the warp and weft, which is perfectly straight during weaving, begins to contract or shrink, so the counts of the yarns become thicker.

Example.—A worsted cloth is made from : 2/60's botany warp and 1/30's botany weft. The dimensions from loom to finished cloth are :—

70 yds. warp. 66 in. wide in loom.
65 ,, grey cloth. 63 ,, width of grey cloth.
61 ,, finished cloth. 56 ,, ,, finished cloth.

Assuming there has been no loss in weight during finishing: what is the count of warp and weft in the grey and finished cloths?

Warp.

$70 : 65 :: 2/60 : x = 2/55{\cdot}7$ grey cloth.
$70 : 61 :: 2/60 : x = 2/52{\cdot}3$ finished cloth.

Weft.

$66 : 63 :: 1/30 : x = 1/28{\cdot}6$ grey cloth.
$66 : 56 :: 1/30 : x = 1/25{\cdot}5$ finished cloth.

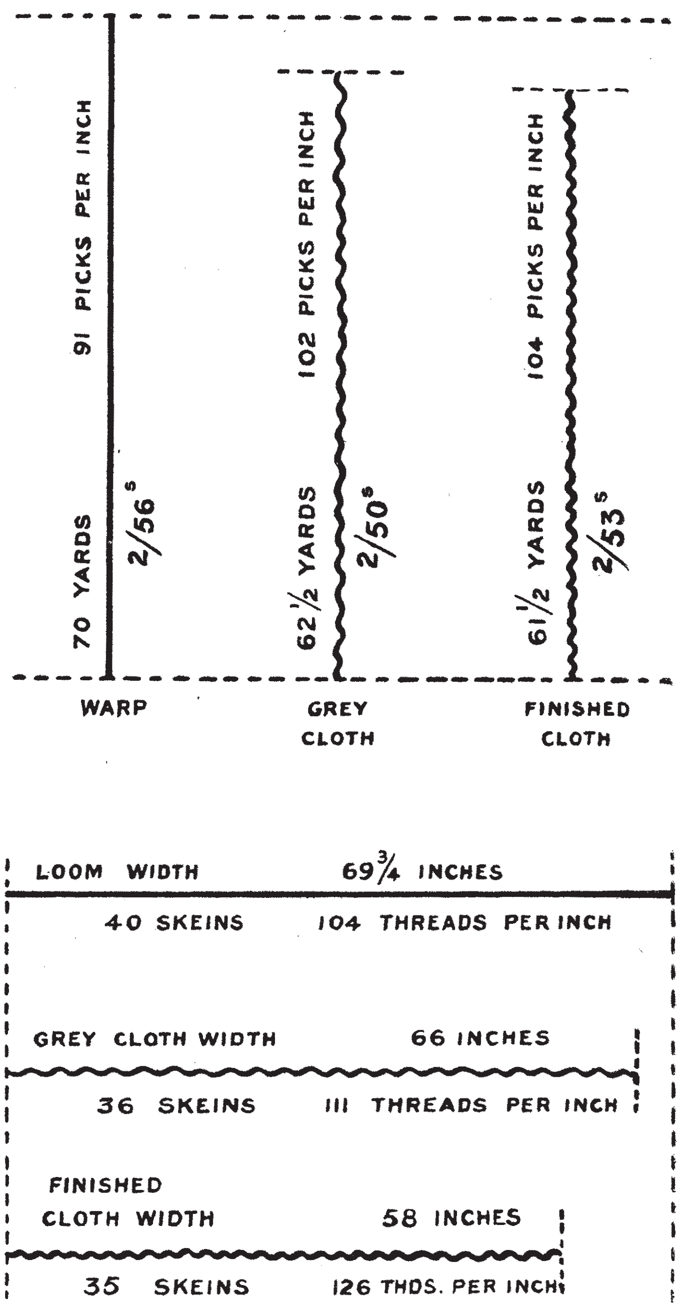

Fig. 58.—Variation from Loom to Finished Cloth (Vicuna).

3. *Threads and Picks per Inch.*—For the same reason that the count of warp and weft becomes thicker as the contraction and shrinkage is being developed, so the number of threads and picks per inch will increase.

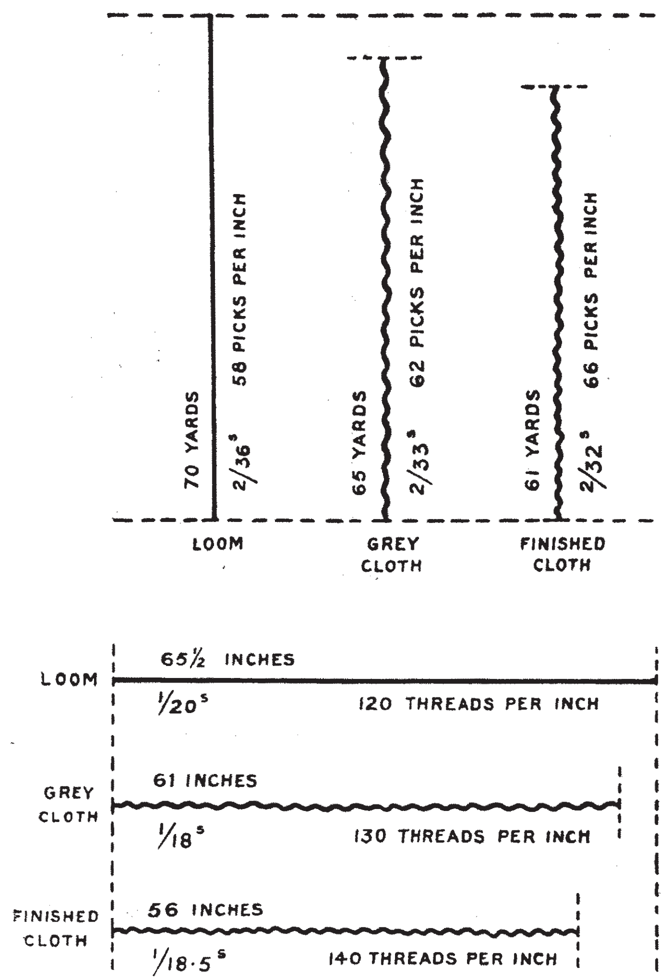

Fig. 59.—Variation from Loom to Finished Cloth (Worsted Coating).

Figs. 58 and 59, indicate that the picks per inch will increase in direct proportion to the shrinkage of the warp, and the threads per inch in proportion to the weft.

Example.—Taking the same cloth as given in the previous example: what will be the number of threads and picks per inch if in the loom there are sixty threads per inch in the reed and sixty picks per inch of warp.

Threads per Inch.

63 : 66 : : 60 : 63 grey cloth.
56 : 66 : : 60 : 71 finished cloth.

Picks per Inch.

65 : 70 : : 60 : 64 grey cloth.
61 : 70 : : 60 : 69 finished cloth.

CHAPTER IX.

EFFECTS OF DYEING AND FINISHING ON UNION DRESS AND LINING AND COTTON CLOTHS.

General Conditions.—Union or mixed cloths are of a most varied character, wool and cotton fibre may be intermingled to form the warp or the weft of a fabric or, as is usually the case, each fibre may be confined to separate threads, forming part or whole of the warp or weft.

A large class of dress goods comprising cashmeres, sicilians, brilliantines, glacés, alpacas, italians, etc., and low woollens such as presidents, meltons, beavers, etc., come under the heading of union cloths and are usually compounded of cotton warp and worsted or woollen weft.

To the dyer and finisher cloths composed of two or more materials require special consideration and treatment as compared with fabrics which are composed of only one material. The combination of materials such as cotton and wool forms a compound structure of different hygroscopic, chemical, and physical properties. The chemical properties of wool and cotton are so different that the agents which are satisfactorily employed in the dyeing and finishing of an all-wool fabric are totally unsuitable for the same purpose in the case of fabrics containing cotton.

For example, all-wool cloths and even raw wool, very often contain a certain amount of vegetable matter, such as burrs, the chemical composition of which is similar to that of cotton, and it is very desirable to extract this vegetable matter. For this purpose the cloth or fibre is subjected to a process known as carbonizing. The material is passed into a bath containing sulphuric acid of a suitable strength and temperature. Upon drying the acid concentrates upon the vegetable matter converting it into hydrocellulose, which, being in the form of powder, is easily removed, while the wool, not being acted upon by the acid to any considerable extent, remains intact.

For the same reason some agents which are successfully employed in the finishing of all-wool cloths must be avoided in the treatment of cloths containing cotton.

Cotton warp and wool wefted goods are woven under the following conditions :—

1. The cotton warp may be dyed the requisite colour and be interlaced with weft which is in a grey or undyed condition. In this case only the weft is subsequently dyed. This method is known as "cross dyeing".

2. When light shades are required in the fabric, the cotton warp and wool weft are woven in a grey or undyed condition and then both are dyed in the fabric. This method is styled, dyeing in the grey. In some cases the wool and cotton are treated separately; in other cases union dyes are employed.

Cross dyeing is preferred as it is then possible to dye both the cotton warp and the weft with a greater choice of colouring matters and processes, and at the same time the most suitable treatment for each fibre may be employed. For example the cotton warp may be dyed with such colours as will withstand the action of acid colours which may be used in the dyeing of the wool weft.

When the cloth is dyed for both cotton and wool, the mordanting and dyeing necessary for the cotton often interferes with the brightness of the colour dyed on the wool. Further, it is considered that cross dyed fabrics possess a better handle than those which are dyed for both wool and cotton. When fabrics are dyed for both materials much judgment and practice are called for on the part of the dyer to make the colour of the cotton and of the wool as identical as possible in tone and intensity, should solid shades, as is usually the case, be required.

Finishing a Plain Lustre Dress Fabric.—A plain weave lustre cloth is made to the following loom particulars :—

Warp.

2/80's fast black cotton.
40's reed 1's.
49$\frac{3}{4}$ in. reed width.

Weft.

1/14's mohair (worsted).
51 picks per inch (grey cloth).
70 yds. of warp per cut.

The cloth is delivered to the dyer and finisher 49 in. wide and 61 yds. long; the instructions being: dye black, bright finish, and deliver the cloth 44 in. wide finished.

As in all cloths the particular finishing treatments are determined by the finisher after considering the following factors: (*a*) The quality and type of the raw materials employed; (*b*) the structure and colour of the yarns employed; (*c*) the build of the fabric; (*d*) the particular appearance and handle required in the finished cloth.

A consideration of the above factors reveals to the finisher the following features:—

(*a*) *The Raw Materials Employed.*—As warp and weft are composed of different fibres possessing distinctive chemical properties and physical features, the dye-taking, shrinking, lustrous, felting, and elastic properties of warp and weft will be different. The warp is non-lustrous and the weft is highly lustrous. These features have an important bearing on the particular treatments and methods employed to obtain the requested "bright" finish.

(*b*) *The Structure and Colour of the Yarns.*—As the cotton is already dyed a fast black, and the mohair weft is the only material in an undyed condition, it is only necessary—to obtain the requisite colour of cloth—to submit the structure to a wool-dyeing process, this being usually of an acid character. The mohair weft yarn has been spun so as to contain as few turns or twists as possible, and the fibres may be said to be in a straight and parallel position. This parallelism of the fibres enhances the lustrous appearance of the yarn, as the fibres present a comparatively flat surface, and so reflect large quantities of light.

(*c*) *The Structure of the Cloth.*—The order of interlacing, in conjunction with the fine cotton warp and thick mohair weft, has resulted in a grey cloth of a warp rib structure, the weft being so much thicker than the warp, that in the cloth as it leaves the loom the weft is practically straight and the warp is made to do all the bending. These conditions account for the slight variation in loom width to grey width and the excessive take-up of warp during weaving. A grey cloth of 61 yds. long and 49 in. wide is produced from 70 yds. of warp set $49\frac{3}{4}$ in. wide in the loom.

(*d*) *The Type of Finish and Appearance Required.*—The instructions given are to produce a "bright" or lustrous appearance, and in consequence the treatments during finishing must be of such a character as to develop the natural lustrous properties contained in the fabric.

Alteration of Structure.—The grey cloth in its grey condition possesses a visible appearance of non-lustrous cotton. If the maximum amount of lustre is to be produced, the appearance of cotton must be eliminated as much as possible. With this idea

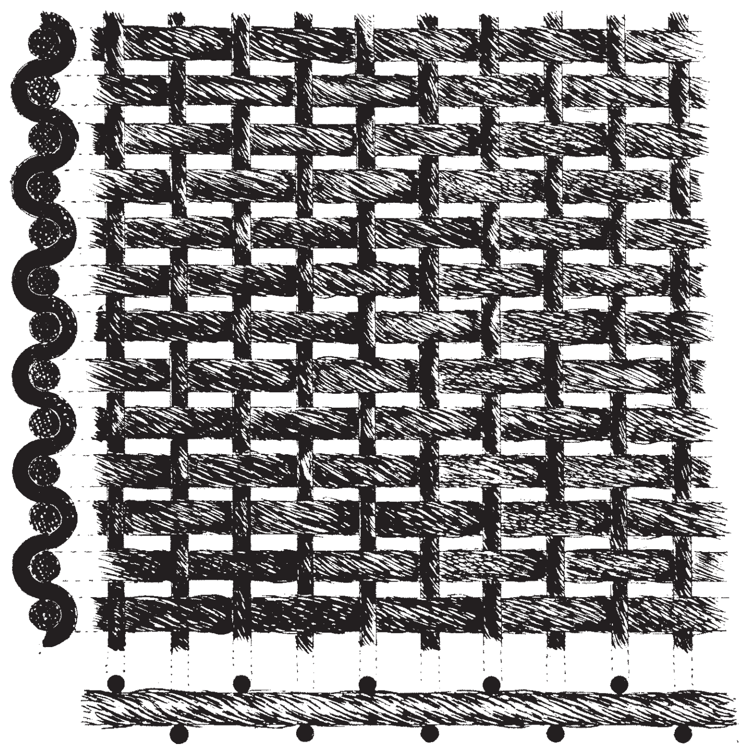

FIG. 60*a*.—Lustre Cloth (before crabbing).

in mind the primary treatment in finishing union cloths is to take away the appearance of cotton from the cloth by developing the mohair or wool. To attain this the fabric is drawn out in the direction of the cotton material during the process known as crabbing, the aim being to make the cotton warp as straight as the conditions will allow and so enable it to become embedded in the cloth: such action throws the lustrous weft on to the surface of the cloth and greatly aids in the attainment of the desired finished appearance.

This process of pulling out the cloth in length totally alters its build: what was originally a warp rib structure is converted during the crabbing process into a weft rib structure. The influence of the pulling-out treatment is illustrated in Figs. 60*a* and 60*b*. Fig. 60*a* illustrates the flat view, warp and weft sections of the grey cloth, and is of the following set and dimensions:—

Warp.
2/80 cotton.
40 threads per inch.
49 in. wide.
Weft.
1/14 mohair.
51 picks per inch.
61 yds. long.

Fig. 60*b* illustrates the same after the crabbing process, the set and dimensions being:—

Warp.
45 threads per inch.
44 in. wide.
Weft.
46 picks per inch.
67 yds. long.

Crabbing Union Cloths.—As the crabbing process alters in structure the build of union cloths, it is not out of place at this stage to deal with the process and its effect on fabrics.

There are two distinct objects in crabbing, i.e. drawing out the cloth in length and fixing warp and weft at right angles. The stretching and fixing of a union cloth forms one of the most important processes that the cloth is subjected to during manufacture. A cloth may be made or marred during this treatment; excessive or insufficient pulling out and fixing of the fabric will cause it to be unmarketable. When over-tensioned during treatment there is a great risk of the warp threads being broken and creating what are known as "cracked ends". On the other hand, insufficient tension or pulling out will result in the cotton remaining to some degree on the surface of the cloth, this being detrimental to the lustrous appearance required. The amount of tension that may be applied is dependent upon the quality and thickness of warp and weft and the number of threads and picks per inch. The care and foresight required will be realized from the fact that a cloth composed of single twist cotton warp may be stretched to a greater length than an identical build of cloth composed of two-fold warp.

Contraction in Width and Elongation in Length.—A study of the variation of the dimensions of union cloths (cotton warp and wool weft) from the loom to the finished cloth forms a most interesting subject. All fabrics vary in this respect according to

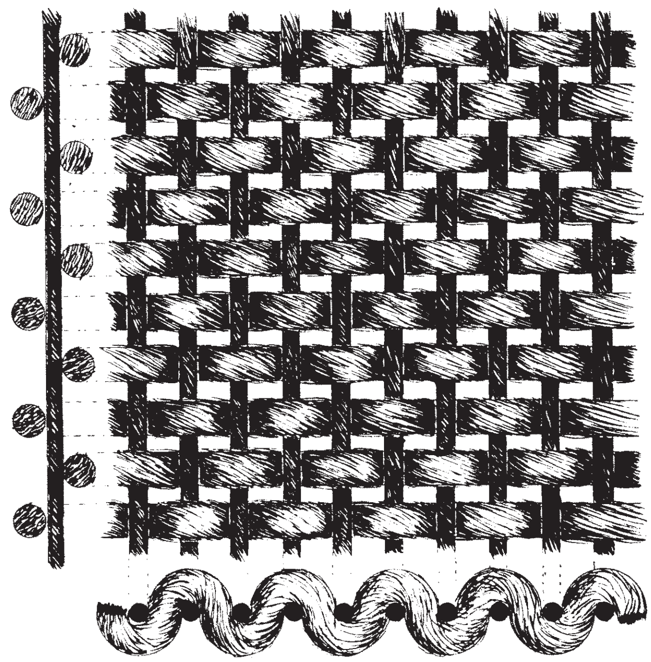

FIG. 60*b*.—Lustre Cloth (after crabbing).

the contracting or shrinking properties of the materials and yarns employed, the structure of the fabric, and the treatments applied during finishing. In the case of all-wool cloths each of the above-mentioned factors comprises many features which influence the shrinkage of the fabric, and these are so numerous that the variation of length and width from loom to finished cloth varies considerably. On the other hand, the various types of union cloths when classified will be found to be somewhat similar in construction, and subjected to about the same finishing processes; in consequence there will be a more uniform variation in dimensions.

Union dress fabrics may be classified under three distinct headings, as tabulated in Table XVIII. In each of the three classes the same conditions prevail regarding materials, yarns, and weave of fabric, so far as their shrinking properties are concerned; and in the case of this class of goods it is the features mentioned which control the variation in dimensions from loom to finished cloth. Therefore, when standard materials, yarns, weaves, and finishing treatments are employed in the production of cloths, it is within the realms of possibility to create standard loom widths and lengths resulting in certain dimensions of finished fabrics.

TABLE XVIII.—CLASSIFICATION OF UNION DRESS FABRICS.

Class.	Style.	Warp.	Weft.	Weave.
1	Brilliantines	Cotton	Mohair	Plain
	Glacés	,,	,,	,,
	Sicilians	,,	,,	,,
	Alpacas	,,	Alpaca	Plain or twill
	Lustres	,,	Lustre or demi-lustre	,, ,,
2	Italians or linings	,,	Fine botany	5-shaft weft sateen
3	Cashmeres	,,	,,	2/1 weft twill

Tables XIX and XX illustrate the dimensions and weights of two lustre cloths after each stage of finishing. A striking feature in both examples is that the dimensions remain practically stationary after the crabbing process. As this treatment is a combined one of pulling out and fixing of the warp and weft, it is obvious that the length of the cloth will be increased, and (assuming the weft possesses no natural shrinking property) the width will contract a corresponding amount. Further, it is apparent that the fixing has been thorough, as the dimensions obtained remain stationary.

TABLE XIX.—VARIATION OF A CROSS-DYED LUSTRE CLOTH AFTER THE VARIOUS FINISHING OPERATIONS.

In loom: 70 yds. warp, $49\frac{3}{4}$ in. wide.

As received by finisher	61 yd. cloth	49 in. wide	24 lb.
After crabbing	67 ,,	44 ,,	22 ,,
,, dyeing and tentering	67 ,,	44 ,,	22·6 ,,
,, singeing	67 ,,	44 ,,	22 ,,
,, pressing	67 ,,	44 ,,	22 ,,

Loom particulars :—

Warp.

2/80's black cotton.

40's reed 1's.

Weft.

1/14's mohair.

50 picks per inch.

(Grey cloth in loom.)

Dye.—Black.

Finish.—Bright.

Weave.—Plain.

TABLE XX.—VARIATION OF A BLEACHED LUSTRE CLOTH AFTER THE VARIOUS FINISHING OPERATIONS.

In loom : 70 yds. warp, 49¾ in. wide.

As received by finisher	58 yd. cloth	49 in. wide	26¼ lb.
After crabbing	68 ,,	45 ,,	25¼ ,,
,, singeing	68 ,,	45 ,,	25 ,,
,, scouring and stoving . . .	68 ,,	44 ,,	24½ ,,
,, tentering	68 ,,	45 ,,	24½ ,,
,, pressing	68 ,,	44 ,,	24 ,,

Loom particulars :—

Warp.

2/80's bleached cotton.

40's reed 1's.

Weft.

1/12's mohair.

48 picks per inch.

(Grey cloth in loom.)

Colour.—Stoved white.

Finish.—Bright.

Weave.—Plain.

Standardization of Dimensions.—By means of the particulars tabulated in Table XXI an effort is made to standarize the dimensions of the cloths under consideration. In this list twenty cloths of different make have been taken, and their respective widths and lengths indicated. For utility each is based on a length of 70 yds. of warp per cut and a finished width of 44 in.

TABLE XXI.—VARIATION OF THE DIMENSIONS IN UNION CLOTHS (COTTON WARP AND LUSTRE WEFT) SUBMITTED TO A "BRIGHT" FINISH.

Style of Fabric.	Widths.			Lengths.		
	Loom.	Grey.	Finished.	Warp.	Grey.	Finished.
Demi-lustre lining	50½ in.	49½ in.	44 in.	70 yd.	60½ yd.	66 yd.
	50 „	48 „	44 „	70 „	62 „	67 „
„ „ . . .	52½ „	49 „	44 „	70 „	60½ „	66½ „
Mohair sicilian . .	50 „	48 „	44 „	70 „	59 „	66¾ „
„ brilliantine .	50 „	49 „	44 „	70 „	60 „	68 „
„ glacé . .	50 „	48 „	44 „	70 „	61 „	68½ „
„ lustre . .	48 „	47 „	44 „	70 „	61 „	67 „
Alpaca lining . .	49 „	48 „	44 „	70 „	62½ „	67 „
Fancy mohair . .	49½ „	48½ „	44 „	70 „	57 „	67¾ „
Fancy English lustre .	51 „	49 „	44 „	70 „	58 „	66 „
Mohair sicilian . .	48 „	47 „	44 „	70 „	58 „	68 „
Lustre „ . .	49¾ „	48 „	44 „	70 „	61 „	67 „
„ „ . .	49 „	47¼ „	44 „	70 „	60 „	70* „
Melange . . .	48 „	47½ „	44 „	70 „	60½ „	68½ „
Demi-lustre lining .	50 „	49½ „	44 „	70 „	62 „	69* „
Mohair brilliantine .	50 „	49 „	44 „	70 „	61 „	69½* „
„ sicilian . .	50 „	49 „	44 „	70 „	60 „	67½ „
„ „ . .	50 „	48¾ „	44 „	70 „	60 „	67½ „
„ brilliantine .	50½ „	49½ „	44 „	70 „	59 „	67 „
„ sicilian . .	53 „	52½ „	44 „	70 „	59 „	67 „
Average . . .	50 „	48½ „	44 „	70 „	60¼ „	67½ „

RESULT: (1) A contraction from loom to finished width of 12 per cent.
(2) An elongation from grey to finished length of 12 per cent.

The particulars of the three cloths marked with an asterisk in Table XXI were not obtained without broken threads. The damage on being investigated was declared to be due to excessive tensioning during the finishing processes; consequently these lengths must not be considered for standard purposes.

As the extreme length to which these cloths can be pulled without risk of broken or cracked ends is the best condition for developing the utmost degree of lustre, then the standard length of finished cloth from 70 yds. of warp must be taken at 67 to 68 yds.

The conclusion arrived at from these results is that the elongation from grey to finished cloth is 12 per cent, and a corresponding contraction is developed from the width in the loom to that of the finished cloth. Fig. 61 illustrates the standard variation in dimensions of a lustre cloth from being in the loom to becoming a finished cloth; also the influence of the various dimensions on

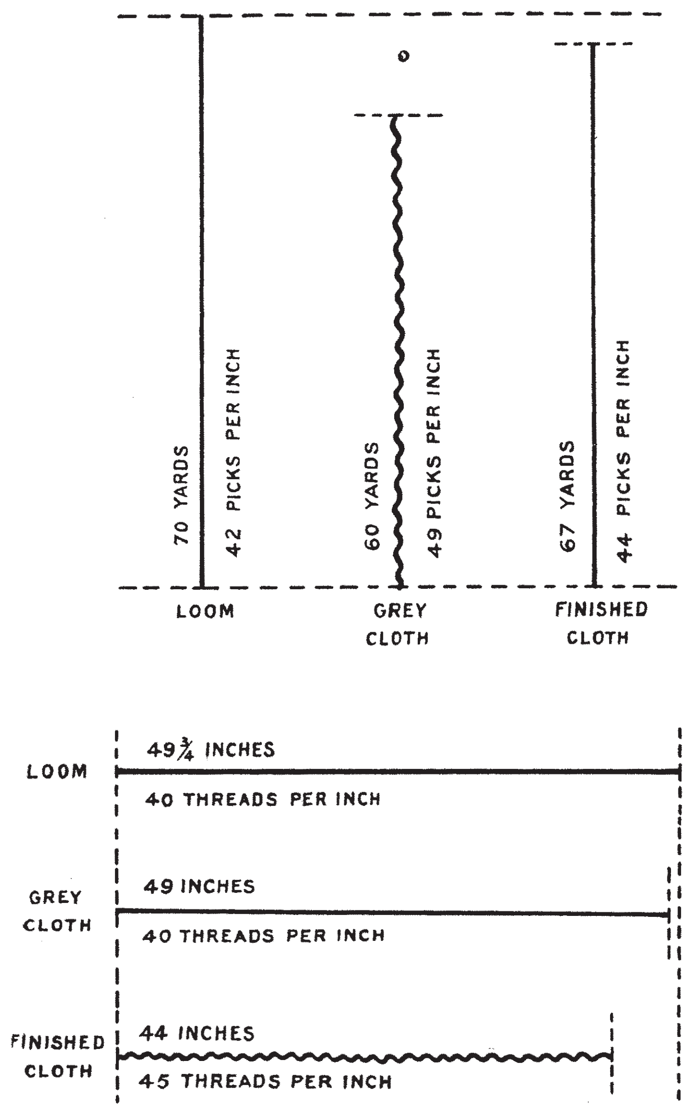

FIG. 61.—Variation from Loom to Finished Cloth (Mohair Lustre).

the number of threads and picks per inch. Fig. 61 shows the widths in the loom, the grey cloth and the finished cloth respectively, the number of threads per inch being given in each case, also the length of the warp in the loom, and in the grey and finished cloth. The number of picks per inch is indicated under each condition.

Variation in Threads and Picks per Inch.—During the weaving and finishing of most woven fabrics there is a contraction in length and width which is responsible for a corresponding increase in the number of picks and threads per inch.

Example.—An all-wool grey (unfinished) cloth is 64 yds. long and 66 in. wide, containing 104 threads and 100 picks per inch. After finishing, the dimensions of the cloth are 60 yds. and 58 in. What are the number of threads and picks per inch in the finished cloth?

60 yds. (finished) : 64 yds. (grey) : : 100 picks (grey) : 107 picks per inch finished cloth.

58 in. (finished) : 66 in. (grey) : : 104 threads (grey) : 118 threads per inch finished cloth.

There is an exception, however, in the case of union dress fabrics. As illustrated in Fig. 61 there is actually an elongation in length and a corresponding contraction in width. Consequently, during the finishing of these goods the picks per inch will be decreased and the threads per inch increased in direct proportion to the elongation and the contraction.

To the cloth analyst whose experience has been limited to all-wool goods, these conditions present a difficulty. However, when the conditions are realized, and the amount of elongation in length and contraction in width is standardized, the difficulty is eliminated. An application of the results given in Table XXI and Fig. 60 will be found of great assistance in ascertaining, from the finished cloth, the number of threads and picks per inch in the grey cloth.

Example.—A finished lustre cloth contains 100 threads and picks per inch. How many of each will there be in the grey cloth? As the amount of elongation is equal to 12 per cent, then :—

As 100 yds. grey cloth : 112 yds. finished cloth : : 100 picks finished cloth : 112 picks per inch grey cloth.

As the contraction in width is 12 per cent, then :—

As 100 in. grey cloth : 88 in. finished cloth : : 100 threads finished cloth : 88 threads per inch grey cloth.

Loss in Weight.—The loss in weight that occurs during the finishing of a union lustre dress fabric is chiefly during the crabbing and scouring processes, which expel the impurities contained in the cloth. The chief impurities contained in this class of fabric are oil—usually about 3 per cent—which is added to the mohair fibre to assist the spinning of the weft yarns, the sizing agent which is applied to single twist cotton warps to improve the weaving properties, and the filth which has been contracted during manufacture. As indicated in Tables XIX and XX, there is little loss incurred after the crabbing and scouring processes. The amount of fibre which is burnt away during singeing has no appreciable influence on the weight of the fabric.

TABLE XXII.—LOSS OF WEIGHT IN UNION CLOTHS (COTTON WARP AND LUSTRE WEFT) SUBMITTED TO A "BRIGHT" FINISH.

Style of Fabric.	Use.	Warp.	Weft.	Grey Weight.	Finished Weight.	Loss per cent in Weight.
Beatrice twill .	Lining	Cotton	Demi-lustre	25 lb.	23¼ lb.	6·6
Mable or Hilda twill . .	,,	,,	,,	25½ ,,	24 ,,	6
Beatrice twill .	,,	,,	English	15 ,,	14½ ,,	6·2
Plain lustre .	Dress goods	,,	Mohair	24 ,,	22 ,,	8
,, .	,,	,,	,,	26¾ ,,	25 ,,	6
Glacé . .	,,	,,	,,	14½ ,,	13½ ,,	7
Brilliantine .	,,	,,	,,	19½ ,,	18 ,,	7·7
Sicilian . .	,,	,,	,,	33 ,,	31 ,,	7·5
Brilliantine .	,,	,,	,,	16¼ ,,	15 ,,	7·7
,, . .	,,	,,	,,	15 ,,	14 ,,	6·8
			Average loss per cent			6·9

Lustre cloths composed of dyed yarns, such as melanges, are practically free from oil, this having been extracted when the sliver or yarn has been printed or dyed. Consequently, there is not the loss in weight during the finishing of this class of fabric which occurs in finishing cloths composed of undyed yarns. As lustre cloths are composed of the same material, and the method of finishing is about the same for the several classes, the loss of weight involved may be standarized. In Table XXII a number of these goods are tabulated, with their respective weights, before and after finishing. On perusing the results indicated it will be found that the amount of variation is from 6 to 8 per cent. With such a slight variation there is no difficulty in arriving at the conclusion that this class of fabric, submitted to a "bright" finish and *not subjected to any weight adulteration*, will sustain a loss in weight equal to 7 per cent.

Italian Linings.—As the manufacture of Italian linings forms an important part of the union dress goods trade, the influence of the various dyeing and finishing processes on these structures will provide useful information. The cloth to be taken as an example is made to the following loom particulars:—

Warp.

2/66's fast black cotton.
100 threads per inch.
3800 threads in warp.
70 yds. of warp per cut.

Weft.

1/66's botany worsted.
161 picks per inch (grey cloth).
38 in., reed width.

Weave.—Five end weft sateen.

Dye.—Black.

In the general finishing treatments of this type of cloth, the principles laid down regarding the finishing of other types of union cloths are observed. For example during the process of crabbing or fixing the length of the cloth is increased and remains practically stationary during the subsequent treatments.

Table XXIII indicates the various processes and the action of

TABLE XXIII.—VARIATION OF A LINING CLOTH AFTER THE VARIOUS FINISHING PROCESSES.

	Widths.	Threads per Inch.	Picks per Inch.	Counts.		Weight.	Length.
				Warp.	Weft.		
Grey cloth . . .	35 in.	108	161	2/60	1/62	21·5 lb.	64 yd.
After crabbing . .	32 ,,	120	154	2 70	1/54	20·7 ,,	67 ,,
,, singeing . .	32 ,,	120	154	2/70	1/56	20·24 ,,	67 ,,
,, dyeing, blue black	31 ,,	122	154	2/68	1/54	21 ,,	67 ,,
,, singeing, tentering, and pressing	32 ,,	120	154	2/68	1/56	20·3 ,,	67 ,,
After dyeing full black	31¼ ,,	122	154	2/68	1/53	20·7 ,,	67 ,,
,, singeing, tentering, and pressing	32 ,,	120	154	2/66	1/52	20·4 ,,	67 ,,

finishing on the dimensions, weight, counts of warp and weft, etc., of the cloth.

As Italian lining cloths are made from standard materials, i.e. cotton warp and botany weft, identical in structure and subjected to about the same finishing treatments, there is a possibility of establishing a definite length of finished cloth from a given length of warp. In Table XXIV the warp and the grey and finished cloth lengths of five makes of cloth are given, the average of which indicates a drawing out in length during finishing of under three yards.

TABLE XXIV.—LENGTHS OF ITALIAN LINING CLOTHS.

	Warp.	Grey Cloth.	Finished Cloth.
1	70 yd.	64 yd.	66 yd.
2	70 ,,	64½ ,,	66½ ,,
3	70 ,,	64 ,,	67 ,,
4	70 ,,	63 ,,	65½ ,,
5	70 ,,	63 ,,	65 ,,
Average	70 ,,	63¾ ,,	66 ,,

Fig. 62 illustrates the variation in the dimensions of the type of cloth under consideration from the loom to the finished fabric; also the influence of the varying dimensions on the number of threads and picks per inch. It also shows the widths in the loom, grey cloth and the finished cloth respectively along with the number of threads per inch for each dimension. Fig. 62 also illustrates the length of warp per cut, and length of grey and finished cloth, with the number of picks per inch under each condition.

Loss in Weight incurred during Dyeing and Finishing Cotton Yarns and Fabrics.—Where cotton yarns or cloths are not subjected to any loading or filling during the processes involved in dyeing and finishing, slight variation is to be observed in grey and finished weights.

It is recognized that in grey or untreated cotton fibres and yarns, there are about 3 per cent of impurities or substances other than cotton cellulose. Of this amount about ·6 per cent is wax and the remainder is composed of natural oil and colouring matter.

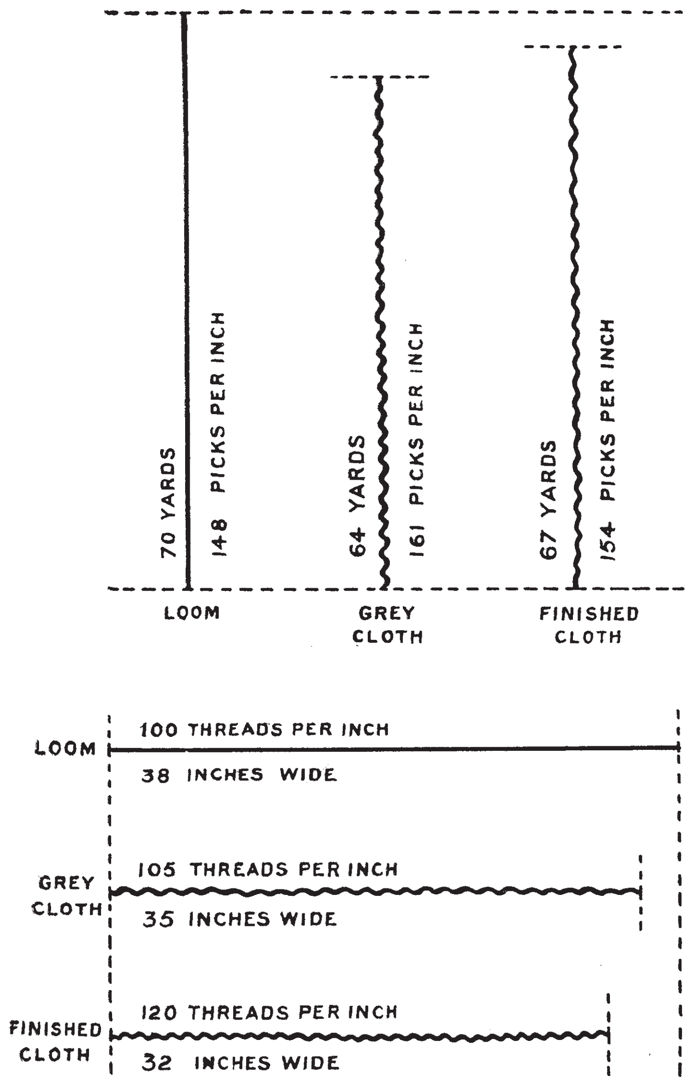

Fig. 62.—Variation from Loom to Finished Cloth (Italian Lining).

To give some idea of the variation which does occur various tests have been carried out with the results as tabulated in Table XXV.

TABLE XXV.—DETERMINATION OF VARIATION IN WEIGHT OF COTTON YARNS AFTER UNDERGOING VARIOUS TREATMENTS.

Treatment.	Original Weight.	After Treatment.						
		2/40 American.	2/120 Sea Island.	1/50 Egyptian.	2/40 Egyptian.	2/60 Egyptian.	1/40 Egyptian.	Mean.
Boiling water . .	100	96	95	95	97	97	97	96
Bleached . . .	100	95	·93	93	93	95	95	94
Mercerised . . .	100	98	96	96	98	98	97	97
Aniline black . .	100	105	103	103	104	104	104	104
Logwood black . .	100	105	105	107	105	106	107	106

CHAPTER X.

OBTAINING THE LOOM PARTICULARS FROM A SMALL SAMPLE OF FINISHED CLOTH.

WHEN the analyst has decided upon the quality of the material or materials, and the structure of yarn or yarns, of the sample submitted for analysis; when he has also determined the order of interlacing and counted the number of threads and picks per inch the following operations must be successively carried out:—

1. Cut the pattern a suitable size.
2. Weigh the sample and calculate the weight per yard.
3. Obtain as great a length as convenient of each of the yarns; weigh and calculate the count of each yarn.

1. Cutting the Pattern a Suitable Size.—After having determined successfully the warp and weft ways of the fabric, and marked the cloth in the direction of the warp to prevent further doubt, it is then necessary to cut a sample of the cloth some suitable size. If the sample is large enough a square of cloth which is exactly 3 in. on each side will be found to be most convenient. This size may be obtained with the aid of a pair of scissors and a clearly marked measure taking care that the cutting is exactly to the thread in both directions. A better method, however, is to employ a steel cutter, such cutters being obtainable in almost all sizes. A very useful shape of cutter, especially for very small patterns, is that shaped as shown in Fig. 63.

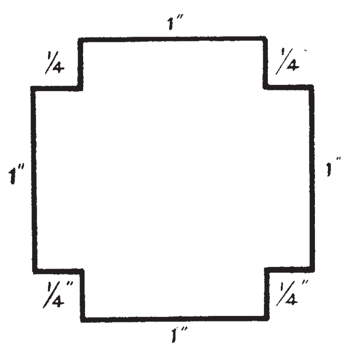

FIG. 63.—Cross-shaped Cutter.

This cutter gives an area which is exactly 2 sq. in. and the length and breadth of the middle section is $1\frac{1}{2}$ in. As the sides are 1 in. each way, the cloth so cut will contain an inch of threads and picks which will facilitate the counting of the number of threads and picks per inch, especially in the case of fine set structures.

2. Weight per Yard.—A useful method of arriving at the weight per yard of a sample of cloth submitted for analysis, is to weigh a given number of square inches, and from this to ascertain the weight by direct proportion of 1 yd. of cloth the required width.

Example.—

1. By carefully weighing 3×3 in. (i.e. 9 sq. in.) of worsted cloth $= 33{\cdot}6$ grains.

2. $36 \times 56 = 2016$ sq. in. in 1 yd. of cloth 56 in. wide.

3. As $9 : 2016 :: 33{\cdot}6 : x = 7526{\cdot}4$ grains or $17{\cdot}2$ oz. per yard (36×56 in.)

Or perhaps a better statement is :—

$$\text{As } 3 \times 3 \text{ in.} : 36 \times 56 \text{ in.} :: 33{\cdot}6 \text{ grains} : \frac{x \times 16 \text{ (oz. per lb.)}}{7000 \text{ grains (per lb.)}}$$

$$= 17{\cdot}2 \text{ oz. per yd. } (36 \times 56 \text{ in}).$$

In order to test the accuracy of this calculation, from the counts of warp and weft, and threads and picks per inch, contained in the sample of cloth, the weight per yard of material may be calculated as follows :—

(For method of ascertaining counts of yarn from a small piece of cloth see Chap. III, p. 38).

1. 36 threads of warp, 3 in. long ($36 \times 3 = 108$ in. or 3 yds.), weighs $2{\cdot}64$ grains.

$$\text{As } 2{\cdot}64 : 12{\cdot}5 :: 3 : x = 14{\cdot}2 \text{ worsted counts.}$$

2. 36 picks of weft 3 in. long ($36 \times 3 = 108$ in. or 3 yds.) weighs $3{\cdot}1$ grains.

$$\text{As } 3{\cdot}1 : 12{\cdot}5 :: 3 : x = 12 \text{ worsted counts.}$$

3. 78 threads per inch.
   63 picks per inch.

Weight of Warp.—

$$\frac{78 \times 56 \times 16}{14{\cdot}2 \times 560} = 8{\cdot}78 \text{ oz.}$$

Weight of Weft.—

$$\frac{63 \times 56 \times 16}{12 \times 560} = 8{\cdot}4 \text{ oz.}$$

$$\text{Total weight} = 17{\cdot}18 \text{ oz. per yard.}$$

In Fig. 64 a graph is given which enables the designer at a glance to get the total weight of material in a piece, weight per yard and length being given.

Having ascertained the counts of warp and weft the particulars of the finished cloth are now decided, from which it is

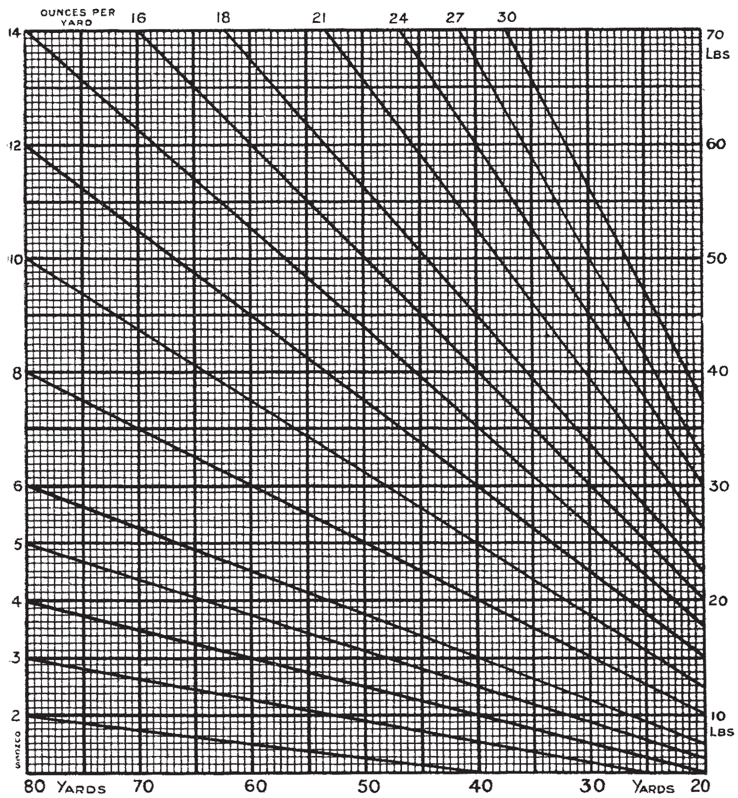

Fig. 64.—Graphic Illustration for finding Weight per piece from Length and ounces per yards.

necessary to make suitable allowances and deductions before the loom particulars can be ascertained.

As previously stated the variation from loom to finished cloth is entirely dependent upon the two factors, i.e. loss in weight and contraction of warp and weft.

Loss in Weight.—In Chaps. VIII and IX (Influence of dyeing and finishing on all-wool, union dress and lining cloths) an attempt has been made to standardize the loss of weight involved during the dyeing and finishing of a number of styles of standard cloths, with the following results :—

1. Worsteds submitted to a "clear" finish (Table XIII, p. 125) = 6 per cent loss.

2. Cloth containing woollen yarns (Table XIV, p. 127) = from 10 to 30 per cent loss.

3. Union cloths (cotton warp, worsted weft) (Table XXII, p. 149) = 6·9 per cent loss.

4. Cotton yarns and fabrics submitted to bleaching or mercerizing or both (Table XXV, p. 153) = 5 per cent loss.

Ascertaining the Contraction of Warp and Weft.—As it is impossible to standardize this factor in most woven fabrics it will be necessary by some means to obtain the amount of shrinkage from the sample of cloth submitted for analysis. This can be done very accurately, with some practice and experience, by taking a number of threads and picks, and measuring the length, to the $\frac{1}{32}$ part of an inch when these are stretched to their extreme length on a flat measure.

This part of the analysis is the most important and must be carried out with all the influencing conditions in mind. During weaving the warp and the weft is in a perfectly straight condition, but whilst being made into cloth, and the cloth finished, the yarns have developed some curvature which indicates the amount of contraction of yarn developed. Thus, when the threads and picks taken from a finished sample of cloth are drawn straight and measured, the result will indicate the warp length and reed width to produce that particular size of finished cloth and by proportion the relative warp length and width in loom can be obtained for any required dimensions of finished cloth.

In measuring the drawn out length of yarn taken from any cloth the distance should always be taken on the full side, as shown in Fig. 65. At (A) in this illustration the yarn is shown, containing a certain amount of curvature, taken from a cloth cut 3 in. × 3 in. This same yarn when drawn straight is shown at (B) to measure about $3\frac{15}{32}$ in. When it is pointed out that it is nearly impossible to draw out such threads to their original length, when once they have been woven into a cloth and subjected to the various finishing processes it will be understood that $3\frac{1}{2}$ in. will indicate more accurate loom dimensions than $3\frac{15}{32}$ in. Further it should be noted, that in the case of wool yarns, there are two forms of contraction. The first is due to the warp and weft curving or bending during weaving and a development of the same during dyeing and finishing, and the second is due to the

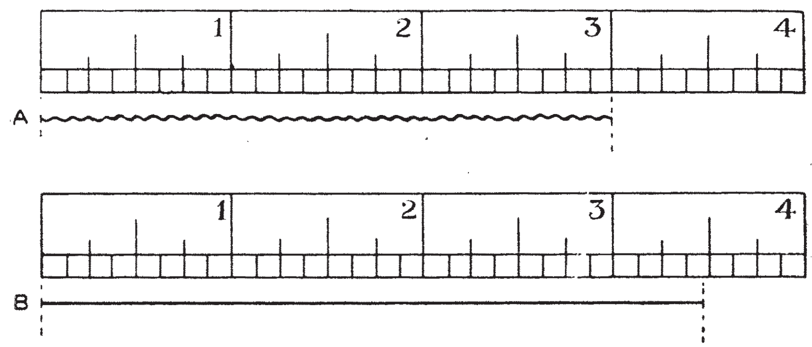

FIG. 65.—Measuring the Contraction of Yarns.

shrinkage and interlocking of the individual wool fibres contained in the yarn. Hence in ascertaining the loom dimensions of cloths which have been severely milled and subjected to excessive shrinkage an allowance for fibre shrinkage must be made

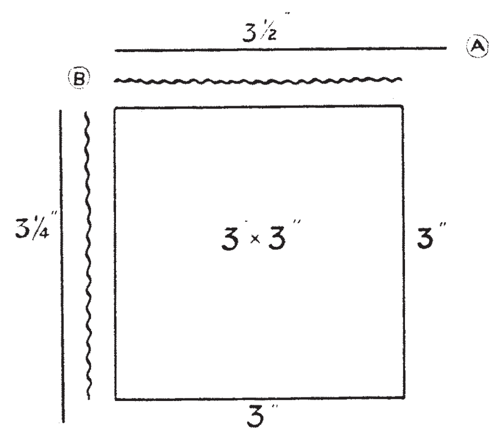

FIG. 66.—Measuring the Contraction of Yarns.

over and above the actual contraction indicated by measuring the thread in a straight condition.

Fig. 66 represents a sample of cloth cut 3×3 in. A pick of weft (A) when drawn straight is found to measure $3\frac{1}{2}$ in. whilst the warp thread (B) measures $3\frac{1}{4}$ in. These figures representing the loom and finished cloth dimensions of a worsted texture. To reproduce this cloth which is 3 in. long and wide a warp will be required $3\frac{1}{4}$ in. long and a loom width of $3\frac{1}{2}$ in.

Example.—It is desirable to reproduce the cloth illustrated in Fig. 66. What length of warp and width in loom will be required in order that the finished cloth will be 60 yds. long and 56 in. wide?

Warp Length.

As 3 in. (length of pattern) : $3\frac{1}{4}$ in. (length of warp) : : 60 yds. (length of cloth) : $x = 65$ yds. of warp.

Width in Loom.

As 3 in. (width of pattern) : $3\frac{1}{2}$ in. (loom width) : : 56 in. (width of cloth) : $x = 65\frac{1}{2}$ in. loom width.

When the analyst has obtained the particulars of the finished cloth and decided the amount of shrinkage of warp and weft, the following loom particulars must be successively decided :—

1. Counts of warp and weft.
2. Threads and picks per inch.
3. Width in loom.
4. Selection of reed.
5. Length of warp.

1. Counts of Warp and Weft.—The counts of yarn in any given cloth, as already shown, may readily be obtained by weighing as long a length as may conveniently be obtained, i.e. at least to the tenth part of a grain, and preferably to the hundredth part of a grain. From the result, allowances must be made according to loss in weight and shrinkage before the counts of yarn in the loom can be obtained.

Example 1.—A worsted cloth is submitted for analysis, after being cut 3×3 in. the particulars of warp and weft are found to be as follows :—

24 threads of warp (2 yards) weigh = 1·8 grains.
24 ,, weft ,, ,, = 1·5 grains.
3 in. of warp stretches to $3\frac{1}{4}$ in.
3 ,, weft ,, $3\frac{1}{2}$ in.

What are the counts of warp and weft in the loom?

Warp.

As 1·8 : 2 yds. : : 12·5 : $x = 13·9$ count of warp (finished).
Allowance for gain in weight owing to contraction.
3 in. : $3\frac{1}{4}$: : 13·9 : $x = 15$.

Loss in weight during finishing = 6 per cent.
Allowance for loss in weight during finishing.

$$100 : 94 :: 15 : x = 14 \text{ count of warp in loom.}$$

or the whole calculation may be worked out as a compound proportion.

$$\begin{array}{rl} 1{\cdot}8 : 12{\cdot}5 & :: 2 : \\ 3 : 3\frac{1}{4} & :: \quad : x = 14 \text{ count of warp in the loom.} \\ 100 : 94 & :: \quad : \end{array}$$

Weft.

As $1{\cdot}5 : 12{\cdot}5 :: 2 : x = 16{\cdot}7$ count of weft (finished).
Allowance for gain in weight owing to contraction :—

$$3 : 3\frac{1}{2} :: 16{\cdot}7 : x = 19{\cdot}4.$$

Allowance for loss in weight during finishing :—

$$100 : 94 :: 19{\cdot}4 : x = 18{\cdot}2 \text{ count of warp in the loom.}$$

or

$$\begin{array}{rl} 1{\cdot}5 : 12{\cdot}5 & :: \quad : \\ 3 : 3\frac{1}{2} & :: 2 : x = 18{\cdot}2 \text{ count of warp in the loom.} \\ 100 : 94 & :: \quad : \end{array}$$

$$= \frac{12{\cdot}5 \times 3\frac{1}{2} \times 94 \times 2}{1{\cdot}5 \times 3 \times 100} = 18{\cdot}2.$$

After some experience in analysing worsted cloths it will be noted, that in many instances the gain due to the contraction about counterbalances the loss in weight involved during finishing. An instance of this is shown in the warp of the foregoing example. The contraction of the warp is from $3\frac{1}{4}$ in. to 3, and the finished count is 13·9 to 14 in the loom. In the case of the weft—owing to increased contraction—the count finished is 16·7 and 18·2 in the loom. Hence it is only an application of experience which will indicate any simplification of the above calculation.

Example 2.—The particulars of warp and weft from a 3 × 3 in. pattern of sicilian cloth (cotton warp and mohair weft) are as follows :—

3 yds. of warp weigh = ·56 grains.
3 ,, weft ,, = 1·21 grains.
3 in. of warp stretches to $3\frac{1}{8}$ in.
3 ,, weft ,, $3\frac{5}{16}$ in.

What are the counts in the loom ?

Warp.

$$\begin{aligned} \cdot 56 &: 8{\cdot}3 \\ 3 &: 3\tfrac{1}{8} \quad :: 3 : x = 44\text{'s counts cotton.} \\ 100 &: 95 \end{aligned}$$

Weft.

$$\begin{aligned} 1\,21 &: 12{\cdot}5 \\ 3 &: 3\tfrac{5}{16} \quad :: 3 : x = 32 \text{ counts worsted.} \\ 100 &: 94 \end{aligned}$$

Example 3.—Three yards of warp and weft from a woollen cloth each weigh 5 grains. The contraction of both being from $3\frac{1}{2}$ to 3 in. What will be the count in the loom, when the cloth has lost 20 per cent of weight during finishing?

$$\begin{aligned} 5 &: 27{\cdot}34 \\ 3 &: 3\tfrac{1}{2} \quad :: 3 : x = 11{\cdot}3 \text{ Yorkshire skein woollen.} \\ 100 &: 80 \end{aligned}$$

2. **Threads and Picks per Inch.**—The number of threads and picks per inch, vary from being in the loom to becoming a finished cloth, according to the shrinkage of warp and weft. On referring to Fig. 58 (p. 135) it will be observed that there are three distinct conditions of dimensions, consequently a corresponding variation in the number of threads and picks per inch, from loom to finished cloth. This illustration graphically shows the amount of variation as follows :—

Warp	70 yds. . . .	= 91 picks per inch.
	$69\frac{3}{4}$ in. reed width .	= 104 threads per inch.
Grey cloth	$62\frac{1}{2}$ yds. . . .	= 102 picks per inch.
	66 in. grey cloth width	= 111 threads per inch.
Finished cloth	$61\frac{1}{4}$ yds. . . .	= 104 picks per inch.
	56 in. finished width	= 126 threads per inch.

With such variations it is necessary to bear in mind the conditions which prevail when analysing a small pattern of cloth. For example :—

A finished all-wool cloth cut 3×3 in. counts 84 threads and 80 picks per inch. The warp when drawn straight measures $3\frac{1}{4}$ in. and the weft $3\frac{1}{2}$ in. What are the number of threads and picks per inch in the reed and the warp?

As $3\frac{1}{2}$ in. : 3 in. : : 84 : $x = 72$ threads per inch in reed.

As $3\frac{3}{8}$ in. : 3 in. : : 80 : $x = 71$ picks per inch of warp.

To obtain the corresponding threads and picks in the grey cloth the take up in weaving must be taken into account, assuming that the warp threads were arranged 65 in. wide in the reed and resulted in 63 in. wide of grey cloth, then

As 63 in. : 65 in. : : 72 : $x = 74$ threads per inch in grey cloth.

The warp, which is 70 yds. long, has resulted in 65 yds. of grey, in which case the picks per inch in grey cloth would be :—

As 65 : 70 : : 71 : $x = 76$ picks per inch in grey cloth.

Width in Loom.—As the loom width of the cloth being subjected to analysis is revealed by the weft being drawn perfectly straight, by direct proportion the loom width for any given finished width can readily be obtained.

Example.—The weft from a pattern cut 4 in. × 4 in. stretches to $4\frac{5}{8}$ in.

Find the loom or reed width which must be employed to result in 56 in. wide of finished cloth.

As 4 in. : $4\frac{5}{8}$ in. : : 56 in. : $x = 64\frac{3}{4}$ in. in loom.

Experience will prove that the best result and the most convenient method of working will be obtained by considering the threads per inch and the width in conjunction as illustrated in the following example :—

A finished cloth cut 3 in. × 3 in. counts 87 threads per inch. The weft when drawn perfectly straight measures $3\frac{3}{8}$ in. What will be the number of threads per inch in the reed, also the width of the warp in the reed to produce a finished cloth 56 in. wide?

As $3\frac{3}{8}$: 3 : : 87 : $x = 77\frac{1}{3}$ threads per inch. in reed

As 3 : $3\frac{3}{8}$: : 56 : $x = 63$ in. wide in reed.

Modifications of calculated results have often to be made owing to limitations imposed by practical conditions. In this particular case the only reed available might be one with 19 dents per inch, and in this to give anything like $77\frac{1}{3}$ threads per inch the warp threads must be sleyed or reeded four threads in each dent. Thus the conditions are that only $19 \times 4 = 76$ threads per inch can be obtained. As the above-stated loom or reed width is in direct ratio to the calculated threads per inch, an alteration of the number of threads per inch necessitates a corresponding alteration in the width. To ensure consistency the following method is recommended :—