87 (threads per inch) × 56 (finished width) = 4872 ends in warp.
4872 ÷ 76 (threads per inch in loom) = 64 in. loom width.

In making any modifications in the calculated number of threads per inch it should be borne in mind that as previously remarked, in woollens and worsteds, there is a tendency to under measure the shrinkage of the yarns. Realizing this, any alteration should be made by decreasing the threads per inch calculated result.

Selection of Reed.—Having found the ends per inch the question occurs—what reed shall be used and what number of ends per dent will prove most efficient? Experience only can decide this, since, although a coarse reed might be selected which *would weave* the piece, still a much better result will usually be obtained by the use of a fine reed, for, within reason, the finer the reed the better. This is particularly so in the case of cotton warps, but designers are warned against applying the experience gained with cotton warps to wool warps, a large deduction owing to the increased bulk and nature of the threads, and the finish imparted being usually necessary. For example, a botany worsted cloth, woven as follows :—

Warp.
All 2/36's grey.
12's reed 6's.
Weft.
All single 18's grey.
72 picks per inch.

will when finished show no reediness, still less will a woollen.

On the other hand a cotton warp lustre dress fabric made as follows :—

Warp.
2/90's cotton.
12's reed 6's.
Weft.
1/26 mohair.
70 picks per inch.

will prove very unsatisfactory. Whatever is done in the loom or in the subsequent finishing to counteract the reediness, the threads will not take their correct or best position, and altogether an unsightly piece results.

If the warp is now sleyed 36's reed 2's or better still 72's

reed 1's, quite a different cloth results: the reed marks go, the fine warp ground asserts itself, and the piece is, compared with the previous one, beautifully covered.

The Length of Warp.—This is a most important matter and one to which, so far, little attention has been directed. In its simplest form the question may be put as follows :—

Example.—A warp 100 yards long is put into the loom. What length of grey and finished cloth will be obtained?

Length of Grey Cloth.—There are two matters here involved —firstly, what allowance is necessary for twisting-in and felling the piece, a portion of the warp being usually left in the healds, by which the succeeding warp is twisted to? Secondly, what will the warp take up during weaving?

The first matter will be influenced by the loomer or twister-in and the loom-tuner or starter of the loom, and can only be estimated, but an allowance of $1\frac{1}{2}$ yards per warp is considered ample under ordinary circumstances.

The second matter is one of much importance, since it affects not only the calculations which are being considered, but also calculations relating to allowances for backing and figuring warps.

As already demonstrated, the take-up of warp during weaving is dependent upon the structure of the cloth which involves type of material, thickness of yarns, number of threads and picks per inch, and the weave employed. It has been stated that ordinary structures take up about an equal amount of warp and weft, whereas in warp-rib cloths the weft is straight, and in consequence more warp is taken up. In the case of weft-rib structures the warp being almost straight, the yield of cloth will be almost the warp length.

In addition to the above factors, it should be observed, that, during the process of weaving, the dimensions of cloths, identical in make or structure, may vary to some extent, owing to the fact that the tensioning of the warp beam will influence the take up in some slight degree.

The length of grey cloth obtainable from a given length of warp, can only be estimated owing to the innumerable variations which obtain in the making of woven fabrics. To make fairly accurate estimates the application of an extensive knowledge of weaving cloths is essential; or it is possible to some extent to estimate this result by resorting to records of lengths of similarly

constructed cloths. For this purpose the warp and grey cloth lengths of different structures of cloths have been tabulated in Tables XV, XXI, and XXIV.

Length of Finished Cloth.—From the pattern submitted for analysis, the analyst calculates the length of finished cloth obtained from a given warp length.

Example.—The warp of a pattern cut 3 × 3 in. when drawn straight measures $3\frac{3}{8}$ in. What length of finished cloth will be produced from 70 yds. of warp?

As the length $3\frac{3}{8}$ in. is the warp length of the finished cloth which is 3 in. long, the length produced from 70 yds. of warp will be in direct proportion.

As $3\frac{3}{8}$ in. : 3 in. : : 70 yds. : $x = 62\frac{1}{4}$ yds. finished cloth.

Grey and Finished Weights of Cloths Compared.—When the analysis of a pattern has been completed a useful method of checking the result is to compare the total weights of grey and finished cloths. For example :—

A costume cloth has been subjected to analysis with the following result :—

12·75 oz. per yard Finished cloth (56 in. × 36 in.).

Loom Particulars :—

Warp.
2/24's worsted.
46 threads per inch.
2856 threads.
70 yds. warp.
66 yds. finished cloth.

Weft.
2/24's worsted.
40 picks per inch of warp.
62 in. reed width.
56 in. finished width.

Weight of Grey Cloth :—

$$\textit{Warp.}— \frac{2856 \times 70}{12 \times 560} = 29{\cdot}75 \text{ lb.}$$

$$\textit{Weft.}— \frac{40 \times 62 \times 70}{12 \times 560} = 25{\cdot}83 \text{ ,,}$$

Total 55·58 lb.

Weight of Finished Cloth :—

$$\frac{12{\cdot}75 \text{ oz. per yard.} \times 66 \text{ yd.}}{16 \text{ oz.}} = 52{\cdot}59 \text{ lb.}$$

In this case the difference between grey and finished weight is 3 lb. which is equal to about 6 per cent. Previously it has been shown that worsted cloths, on an average, lose this amount during finishing; hence this result indicates to some extent the accuracy of the analysis.

Edges or Lists.—In reproducing any woven fabric it is necessary to give special consideration to the edges or lists. The body of a cloth may be perfect in structure and design but if the edges are not even, level and regular, the cloth may be banned as unsaleable.

The appearance and smartness of the list in all cases gives improved character to the piece. In addition to appearance the warp threads which form a list must be strong enough to bear the special tension which is required during finishing, as should the edge break, it is impossible to develop the best type of finish. For this reason 2-fold and 3-fold yarns are often employed as against single yarns for the body warp. Tight or slack lists will result in the edges curling, which will prove an inconvenience to the finisher.

In structures such as Venetians, Amazons, Cashmeres, lining and sateens, where warp or weft predominate the edges have a tendency to curl, and on this account the lists of such styles are composed of plain weave or a modification. Figured structures also require an edge of ordinary weave, as the floats of warp and weft at the edge of the cloth would result in unevenness.

Hence to obtain a level list it might be laid down as a rule that all weaves away from twills, hopsacs, etc., require an edge of some plain weave.

As to what is a suitable list for any particular type of fabric, depends on: 1st, the set; 2nd, the weave; 3rd, the yarns employed. No general rule can be laid down and it is only after experimenting in the loom that a suitable list can be determined.

The following are a few lists which are employed for different structures of standard cloths :—

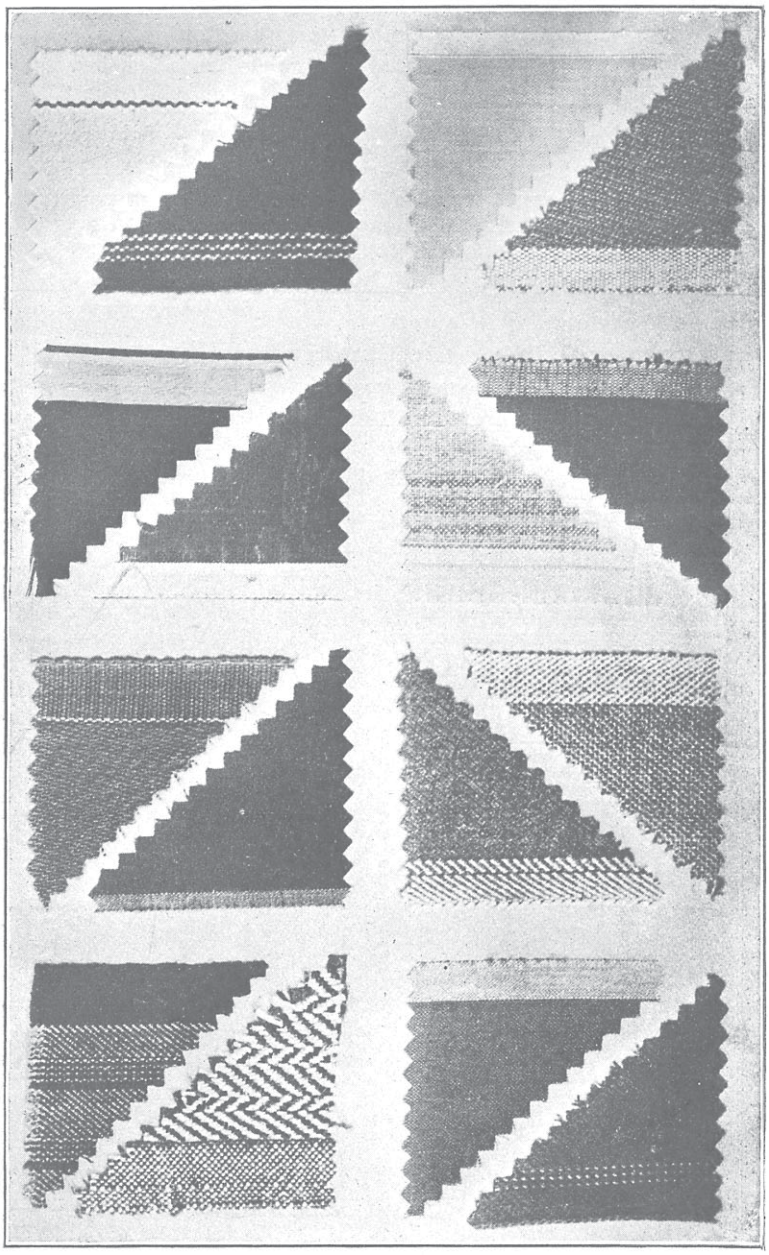

FIG. 67.—Various types of "Edges" or "Lists."

Worsted Twills.—(1) Edges weaving as body of cloth with coloured threads introduced about half an inch from edge.

(2) Edges weaving as body of cloth, but hopsac or reverse weave, with coloured threads introduced.

(3) As 1 or 2 with the warp threads in edges being composed of different colour.

Lustre Sicilians.—Warp arranged 40's reed 1's (plain weave) of 1/50 black cotton, with 24 threads of 2/40 bleached cotton at each edge sleyed 1 in a reed weaving plain.

Cashmeres.—Warp arranged 52 threads per inch of 2/60 black cotton, sleyed 3 in a reed, weaving 2/1 weft twill and a suitable number of 2/30 black cotton threads at each edge, sleyed 2 in a reed weaving plain weave or a modification.

Italian Linings.—Similar to Cashmeres, with the body of warp weaving 5 weft sateen.

Worsted Voile dress cloth.—Body warp of 1/30 voile yarn, arranged 40's reed 1's weaving plain weave and at least half an inch at each edge a number of threads of warp sleyed 2 in a reed weaving plain or the warp threads weaving two as one.

Amazon dress fabric.—Body warp of 1/36's botany weaving 2 end warp sateen, sleyed 24's reed 3's with a suitable number of warp threads, working double, sleyed 2 double threads in a reed weaving a hopsac.

Figured dress fabric.—Warp of 2/60 botany sleyed 32's reed 2's with a suitable number of double warp threads weaving alternately up and down for two picks, sleyed two in a reed.

In Fig. 67 various typical edges or "lists" for fabrics are illustrated.

CHAPTER XI.

EXAMPLES IN THE ANALYSIS OF WOVEN FABRICS.

Example 1.—Worsted Costume Cloth (Fig. 68).

Finished Cloth Particulars :—

1. Weight of pattern cut 3 × 3 in. = 23·4 grains.
2. 3 yds. of warp (worsted, two-fold) = 2·16 ,,
3. ,, weft ,, ,, = 2·3 ,,
4. Threads per inch = 66.
5. Picks ,, ,, = 62.

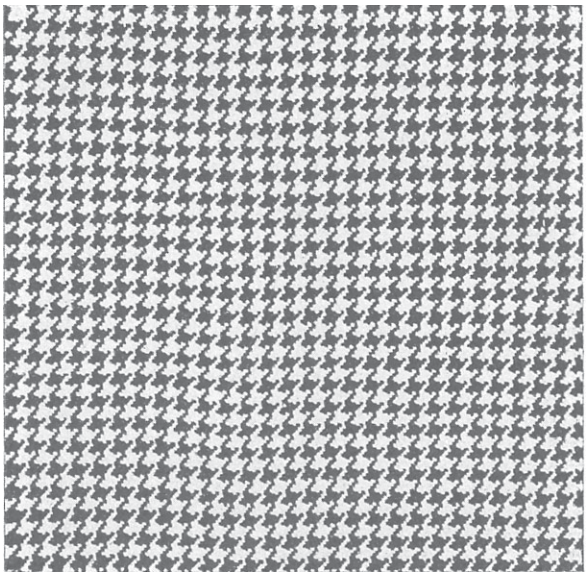

Fig. 68.—Worsted Costume Cloth.

Contraction from Loom to Finished Cloth :—

Warp.—3 in. measures $3\frac{1}{4}$ in.
Weft.—3 in. ,, $3\frac{1}{2}$ in.

The cloth to be reproduced from 70 yds. of warp per cut and the width of finished cloth to be 56 in.

Ounces per Yard (finished cloth).

$$\text{As } 3 \times 3 \text{ in.} : 56 \times 36 \text{ in.} : : 23{\cdot}4 \text{ grains} : \frac{x \times 16}{7000} =$$

$$\frac{23{\cdot}4 \times 56 \times 36 \times 16}{3 \times 3 \times 7000} = 11{\cdot}5 \text{ oz. per yard } (56 \times 36 \text{ in.}).$$

Loom Particulars :—

1. *Count of Warp :—*

$$\begin{array}{r} 2{\cdot}16 : 12{\cdot}5 : : \quad : \\ 3 : \quad 3\tfrac{1}{4} : : 3 \quad : x = \\ 100 : \quad 94 : : \quad : \end{array}$$

$$\frac{12{\cdot}5 \times 3{\cdot}25 \times 94 \times 3}{2{\cdot}16 \times 3 \times 100} = 17{\cdot}7 = 2/36 \text{ worsted.}$$

2. *Count of Weft :—*

$$\begin{array}{r} 2{\cdot}3 : 12{\cdot}5 : : \quad : \\ 3 : \quad 3\tfrac{1}{2} : : \ 3 \ : x = \\ 100 : \quad 94 : : \quad : \end{array}$$

$$\frac{12{\cdot}5 \times 3{\cdot}5 \times 94 \times 3}{2{\cdot}3 \times 3 \times 100} = 17{\cdot}8 = 2/36 \text{ worsted.}$$

3. *Picks per Inch of Warp :—*

$$\text{As } 3\tfrac{1}{4} : 3 \text{ in.} : : 62 : x = 54 \text{ picks.}$$

4. *Threads per Inch in Reed :—*

$$\text{As } 3\tfrac{1}{2} : 3 \text{ in.} : : 66 : x = 56 \text{ threads.}$$

5. *Threads in Warp :—*

$$56 \times 66 = 3696 \text{ threads.}$$

6. *Width in Reed :—*

$$3696 \div 56 = 66 \text{ in.}$$

7. *Length of Finished Cloth :—*

$$3\tfrac{1}{4} : 3 \text{ in.} : : 70 : x = 64\tfrac{3}{4} \text{ yds.}$$

Quantities of Material.—

1. *Weight of Warp in Grey Cloth :—*

$$\frac{3696 \times 70}{18 \times 560} = 25\tfrac{2}{3} \text{ lb.}$$

2. *Weight of Weft in Grey Cloth :—*

$$\frac{54 \times 66 \times 70}{18 \times 560} = 23\tfrac{3}{8} \text{ lb.}$$

3. *Total Weight of Grey Cloth :—*

lb.
$25\frac{2}{3}$ warp
$23\frac{3}{8}$ weft
49 lb.

4. *Total Weight of Finished Cloth :—*

(11·5 oz. per yard.)

$$\frac{11{\cdot}5 \times 64\frac{3}{4}}{16} = 46\frac{1}{2} \text{ lb.}$$

Example 1.—(Fig. 68).—Style of cloth, worsted costume cloth 11·5 oz. per yard (finished cloth), 56 × 36 in.

Warp	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
	2/36's	Botany worsted 56's quality	14/4's	70 yd.	(66 yd.)	$64\frac{3}{4}$ yd.	49 lb.

Weft	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
	2/36's	Botany worsted 56's quality	54 warp 57 grey cloth	66 in.	(63 in.)	56 in.	$46\frac{1}{2}$ lb.

	Threads in Warp.
Warped.—4 threads black = 1820	= 1820
4 ,, white = 1820 + 56 for edges	= 1876
Total	3696

Weight of Warp = $25\frac{2}{3}$ lb.

Wefted.—4 picks black
4 ,, white.

Weight of Weft.—$23\frac{3}{8}$ lb.

Lists.—28 white botany threads at each edge.
Weave.—Figs. 68*a* and 68*b*.

FIG. 68*a*.

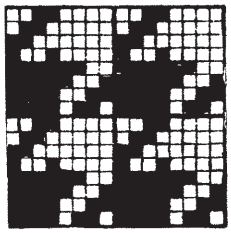

FIG. 68*b*.

Example 2.—Figured Mohair, Lustre Dress Fabric (Fig. 69).

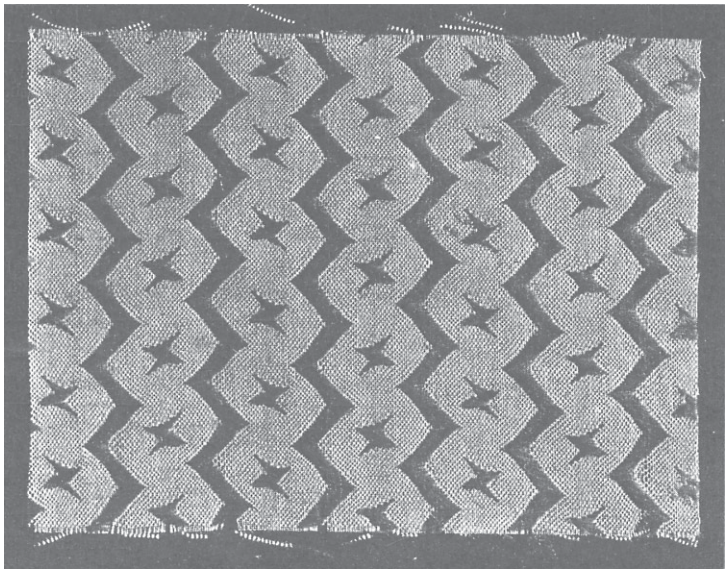

FIG. 69.—Figured Lustre Mohair Fabric.

Finished Cloth Particulars:—

1. Weight of pattern cut 3 × 3 in. = 9·6 grains.
2. 3 yds. of warp (cotton two-fold) = ·4 ,,
3. ,, ,, ,, weft (mohair single) = 1·34 ,,
4. Threads per inch = 71.
5. Picks ,, ,, = 65.

Contraction from Loom to Finished Cloth :—

Warp.—3 in. measures $3\frac{1}{8}$ in.
Weft.—3 in. „ $3\frac{3}{8}$ „

The cloth to be reproduced from 70 yds. of warp per cut and the width of finished cloth to be 44 in.

Ounces per Yard (finished cloth) :—

$$\text{As } 3 \times 3 \text{ in.} : 44 \times 36 \text{ in.} :: 9{\cdot}6 \text{ grains} : \frac{x \times 16}{7000} =$$

$$\frac{44 \times 36 \times 9{\cdot}6 \times 16}{3 \times 3 \times 7000} = 3{\cdot}8 \text{ oz. } (44 \times 36 \text{ in.}).$$

Loom Particulars :—

1. *Count of Warp* :—

$$\begin{aligned} {\cdot}4 &: 8{\cdot}3 :: \quad : \\ 3 &: 3\tfrac{1}{8} :: \ 3 \ : x = \\ 100 &: 94 :: \quad : \end{aligned}$$

$$\frac{8{\cdot}3 \times 25 \times 94 \times 3}{8 \times {\cdot}4 \times 3 \times 100} = 60 \text{ or } 2/120 \text{ cotton.}$$

2. *Count of Weft* :—

$$\begin{aligned} 1{\cdot}34 &: 12{\cdot}5 :: \quad : \\ 3 &: 3\tfrac{3}{8} :: \ 3 \ : x = \\ 100 &: 94 :: \quad : \end{aligned}$$

$$\frac{12{\cdot}5 \times 27 \times 94 \times 3}{8 \times 1{\cdot}34 \times 3 \times 100} = 30\text{'s mohair.}$$

3. *Threads per Inch in Reed* :—

$$\text{As } 3\tfrac{3}{8} : 3 :: 71 : x = 63 \text{ or } 64 \text{ threads}$$
$$= 64\text{'s reed 1's or 32's reed 2's.}$$

4. *Threads in Warp* :—

$$71 \times 44 = 3124 \text{ threads.}$$

5. *Width in Reed* :—

$$3124 \div 64 = 50 \text{ in.}$$

6. *Lengths of Grey and Finished Cloths* :—

$$\text{As } 3\tfrac{1}{8} : 3 :: 70 : x = 67 \text{ yds. (finished cloth).}$$

The following Table indicates that the average grey length of these structures is 61 yds. which during finishing are pulled to an average length of 67 yds. Hence the picks per inch in grey and finished cloth will vary according to lengths.

7. *Picks per Inch of Warp and Grey Cloth* :—

There are 65 picks per inch in the finished cloth, consequently the number per inch of warp and grey cloth will be :—

As 61 yds. (grey cloth) : 67 yds. (finished cloth) : : 65 : x = 71 picks per inch (grey cloth).

As 70 yds. (warp) : 67 yds. (finished cloth) : : 65 : x = 62 picks per inch (warp).

Quantities of Material :—

1. *Weight of Warp in Grey Cloth* :—

$$\frac{3124 \times 70}{60 \times 840} = 4{\cdot}3 \text{ lb.}$$

2. *Weight of Weft in Grey Cloth* :—

$$\frac{62 \times 50 \times 70}{30 \times 560} = 13 \text{ lb.}$$

3. *Total Weight of Grey Cloth* :—

lb.	
4·3	warp
13	weft
17·3 lb.	

4. *Total Weight of Finished Cloth* :—

(3·8 oz. per yard)

$$\frac{3{\cdot}8 \times 67}{16} = 16 \text{ lb.}$$

Example 2.—(Fig. 69).—Style of cloth, figured mohair, 3·8 oz. per yard (finished cloth), 44 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/120's	Cotton	32/2's or 64/1's	70 yd.	(61 yd.)	67 yd.	17·3 lb.
	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	1/30's	Mohair	62 warp 71 grey cloth	50 in.	(49 in.)	44 in.	16 lb.

Threads in Warp.—3124.
Weight of Warp.—4·3 lb.
Weight of Weft.—13 lb.
Lists.—20 double threads at each edge weaving plain.
Weave.—Jacquard.

Example 3.—Extra Warp Striped Cotton (Fig. 70).

Finished Cloth Particulars.—By employing Gaunt's standard weights, the counts of the warp and the weft are found to be :—

1. Various colours of warps = 2/60 cotton.
2. Weft = 2/60 cotton.
3. Ground threads per inch = $74\frac{1}{2}$.
4. Picks per inch = 52.

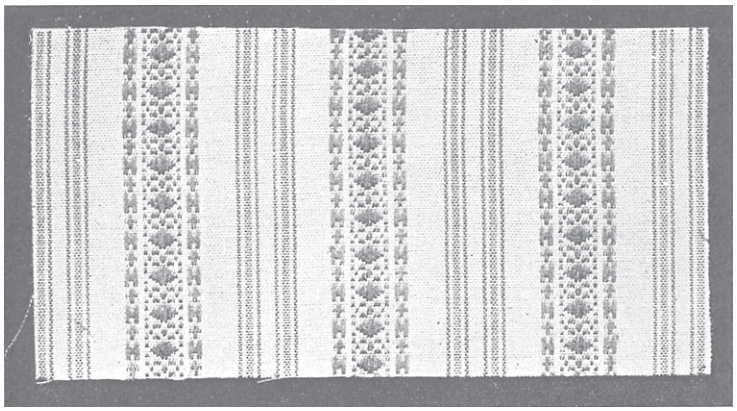

FIG. 70.—Extra Warp Striped Cotton.

Contractions from Loom to Finished Cloth :—

1. Ground warp = 3 in. measures $3\frac{3}{10}$ in.
2. Figure stripe warp = 3 ,, ,, $3\frac{2}{10}$,,
3. Weft = 3 ,, ,, $3\frac{3}{16}$,,

The cloth to be reproduced from 70 yds. of ground warp and the width of the finished cloth to be 44 in.

Loom Particulars :—

1. *Counts of Warp* :—

$$\left.\begin{array}{l} 3 : 3\frac{3}{10} :: 2/60 : \\ 100 : 95 \ :: \quad : \end{array}\right\} x = 2/60 \text{ cotton.}$$

The difference in the contraction of the ground and extra warp has no appreciable influence on the count.

2. *Counts of Weft :—*

$$\begin{matrix} 3 : 3\frac{3}{16} :: 2/60 : \\ 100 : 95 \ :: \quad : \end{matrix} \quad x = 2/60 \text{ cotton.}$$

3. *Threads per Inch in Reed.*—An examination of this cloth has revealed that the extra threads, which are double, are sleyed in the reed, one thread extra to each ground thread. As these styles involved some fairly complex calculations and as such are based on the reed employed, in the first place it must be determined what reed has been employed, also what number of threads have been placed through each.

The ground threads count $74\frac{1}{2}$ to the inch, therefore :—

$$\text{As } 3\tfrac{3}{16} : 3 : : 74\tfrac{1}{2} : x =$$

70 ground threads or 35/2's reed for ground weave.

4. *Threads in Warp, and Warp Dressers Particulars.*—The warp threads are arranged in the cloth as follows :—

20	threads		white	sleyed in 10	dents.
*2	,,		shade A	,, 1	,,
2	,,		white	,, 1	,,
4	,,		shade B	,, 2	,,
2	,,		white	,, 1	,,
2	,,		shade A	,, 1	,,
8	,,		white	,, 4	,,
2	,,		shade A	,, 1	,,
2	,,		white	,, 1	,,
4	,,		shade B	,, 2	,,
2	,,		white	,, 1	,,
⊙2	,,		shade A	,, 1	,,
20	,,		white	,, 10	,,
6	1 ,,	(double)	shade C	,, 3	,,
	1 ,,		white		
4	,,		white	,, 2	,,
20	1 ,,	(double)	shade D	,, 10	,,
	1 ,,		white		
4	,,		white	,, 2	,,
6	1 ,,	(double)	shade C	,, 3	,,
	1 ,,		white		

56 dents per pattern.

The finished width of this cloth is 44 in., therefore as the

finished cloth contains $74\frac{1}{2}$ ground threads per inch or $\frac{74\frac{1}{2}}{2}$ dents per inch the total number of dents to be occupied by warp threads will be :—

$$\frac{74\frac{1}{2}}{2} \times 44 = 1639 \text{ dents.}$$

1639 (dents) ÷ 56 (dents per pattern) =
29 repeats of pattern and 16 dents over.

An important point to decide at this stage is the exact beginning and finishing place in making the warp. In deciding this it must be borne in mind that such warp dresser's instructions be given as will result in there being in the woven fabric an equal amount of ground at both edges of the cloth.

There being 16 dents over a definite number of repeats of pattern, which must be taken into account, allows the following warp dresser's instructions :—

Twenty-nine repeats of pattern, starting at the mark * and finishing at the mark ⊙, such particulars will result in the woven cloth appearing as shown in Fig. 70*a*.

Having decided the warp dresser's particulars it is not a difficult matter to ascertain the number of threads of each colour to make the warp, i.e. :—

Colours of Yarn.	Threads per Pattern.	For 16 Dents over 29 Repeats.	Total number of Threads in Warp.
Shade A	8 × 29 repeats =	232 + 8 =	240
,, B	8 × ,, ,, =	232 + 8 =	240
,, C (double)	12 × ,, ,, =	348 + 0 = (double)	348
,, D (double)	20 × ,, ,, =	580 + 0 = ,,	580
White	96 × ,, ,, =	2784 + 16 =	2800
	Total 144	Total	4208

5. *Width in Reed.*—As there are 1639 dents in reed required to reproduce this structure and it is decided that the reed must contain 35 dents per inch, the width in reed of this warp will be :—

$$1639 \div 35 = 46{\cdot}8 \text{ in. width in reed.}$$

6. *Length of Grey and Finished Cloths.*—It has been noted that 3 in. of ground warp has contracted from $3\frac{3}{10}$ in., con-

sequently if 70 yds. of warp per cut be employed the length of finished cloth will be :—

As $3\frac{3}{10}$ in. : 3 in. : : 70 yds. : $x = 63\frac{2}{3}$ yds. finished cloth.

It has also been noted that 3 in. of figure or extra warp has contracted from $3\frac{2}{10}$ in., which indicates that during weaving this material has been let off less than the ground warp. These weaving conditions necessitate the employment of two warp beams, one for plain ground material and a second for figure material. As the ground warp is 70 yds. long for a definite length

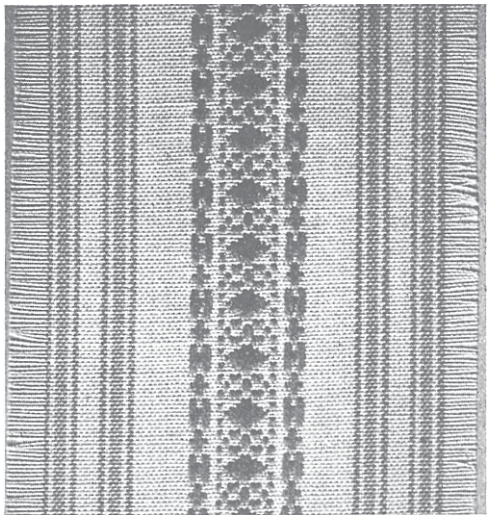

FIG. 70*a*.—Suitable Beginning and Finishing Places for Warp Dresser.

of cloth the question now arises as to the length required of figure warp.

As $3\frac{3}{10}$ in. : $3\frac{2}{10}$ in. : : 70 yd. : $x = 67{\cdot}8$ yds. of figure warp to 70 yds. of ground warp.

In this type of structure the grey length of cloth may be estimated at 63 yds., the finished cloth usually being slightly longer than the grey cloth.

7. *Picks per Inch.*—The picks per inch in the finished cloth are counted to be 52 : the number to the inch of grey cloth and warp will be as follows :—

As 64 yds. : $64\frac{2}{3}$ yds. : : 52 : x = 52 picks per inch of grey cloth.
As 70 yds. : $64\frac{2}{3}$ yds. : : 52 : x = 48 picks per inch of warp.

Quantities of Material.—1. *Weight of Warp :—*

$$\frac{5136 \times 70}{30 \times 840} = 16 \text{ lb.}$$

2. *Weight of Weft :—*

$$\frac{48 \times 46{\cdot}8 \times 70}{30 \times 840} = 9{\cdot}36 \text{ lb.}$$

3. *Total Weight, Grey Cloth.* 25·36 lb.

4. *Finished Cloth Weight.*—The finished cloth weight may be considered 5 per cent less than the grey cloth weight, i.e. $24\frac{1}{4}$ lb. finished cloth.

Example 3 (Fig. 70).—Style of cloth, extra warp striped cotton.

Warp	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
	2/60	Cotton various colours	35/2's	Ground 70 yd. Figure 68 yd.	(63 yd.)	$63\frac{2}{3}$ yd.	25·36 lb.

Weft	Counts.	Material.	Picks per inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
	2/60	Cotton white	48 Warp 52 { grey cloth	46·8 in.	45 in.	44 in.	$24\frac{1}{4}$ lb.

Order of Warp :—

Colour.														Threads per Pattern.		Threads in Warp.
White	20	2	2	8	2	2	20	1	5	1	5	1	=	96	=	2800
A	*2	—	2	2	—	⊙2	—	—	—	—	—	—	=	8	=	240
B	—	4	—	—	4	—	—	—	—	—	—	—	=	8	=	240
C	—	—	—	—	—	—	1	1	—	—	1	1	=	12	=	348 (double)
D	—	—	—	—	—	—	—	—	1	1	—	—	=	20	=	580 (,,)
								5		19		5		144		4208

29 repeats of pattern.
start * and finish ⊙.

Weight of Warp = 16 lb.
Weight of Weft = 9·36 lb.
Lists.—As warp.
Design, Draft and Sleying Plan.—See Fig. 70*b*.
Pegging Plan.—See Fig. 70*c*.

Example 4.—Striped Moirette (Fig. 71)

Finished Cloth Particulars.—By employing Gaunt's standard weights the counts of the warps and the weft are found to be :—

1. Ground warp = 2/44 black mercerized cotton.
2. Stripe ,, = 40/2 white spun silk.
3. Weft ,, = 1/20 polished black cotton.
4. Ground threads per inch = 81.
5. Picks per inch = 68.

Contractions from Loom to Finished Cloth :—

1. Ground warp = 3 in. measures $3\frac{5}{8}$ in.
2. Stripe ,, = 3 ,, ,, $3\frac{1}{8}$,,
3. Weft ,, = 3 ,, ,, $3\frac{1}{16}$,,

The cloth to be reproduced from 70 yds. of ground warp and the width of the finished cloth to be 30 in.

Loom Particulars.—1. *Count of Ground Warp :—*

$$\left.\begin{matrix} 3 : 3\frac{5}{8} : : \\ 100 : 95 : : \end{matrix}\right\} 2/44 : x = 2/50 \text{ cotton.}$$

2. *Count of Stripe Warp :—*

$$\left.\begin{matrix} 3 : 3\frac{1}{8} : : \\ 100 : 95 : : \end{matrix}\right\} 40/2 : x = 40/2 \text{ silk.}$$

3. *Count of Weft :—*

$$\left.\begin{matrix} 3 : 3\frac{1}{16} : : \\ 100 : 95 \ : : \end{matrix}\right\} 1/20 : x = 1/20 \text{ cotton.}$$

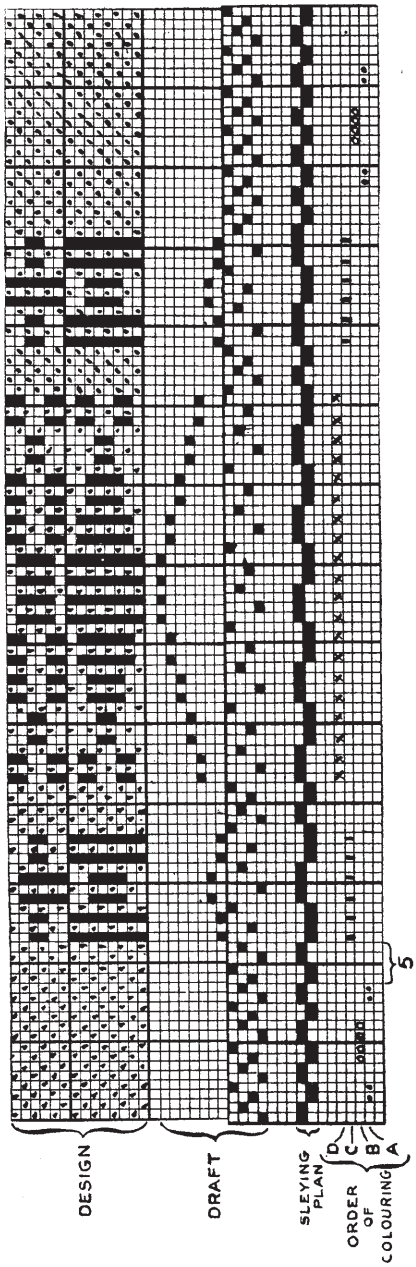

FIG. 70*b*.—Design, draft, sleying plan, and order of warping.

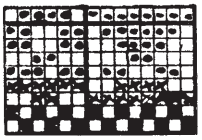

FIG. 70*c*.—Pegging Plan.

4. *Threads per Inch in Reed.*—The white silk threads are weaving two as one and are sleyed one double thread extra to

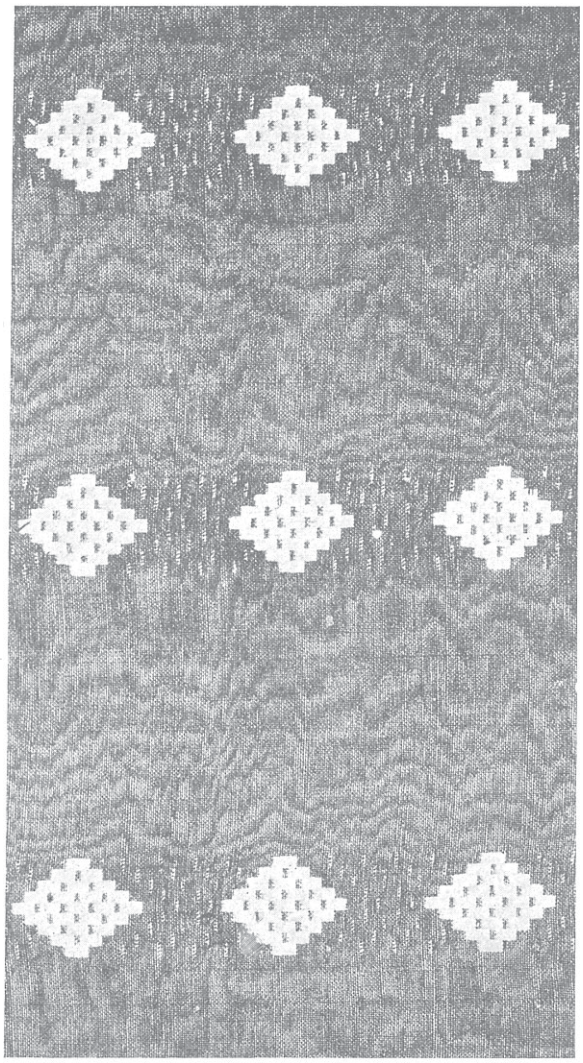

FIG. 71.—Striped Moirette.

each ground thread. The ground threads count 82 per inch, therefore :—

As $3\frac{1}{16}$ in. : 3 in. : : 81 : $x = 80$ ground threads or 40/2's reed for ground weave.

5. *Threads in Warp.*—The warp threads are arranged in the cloth as follows:—

$$54 \left\{ \begin{array}{l} 1 \text{ double thread white silk} \\ 1 \text{ thread mercerized black cotton} \end{array} \right\} \text{in 27 dents.}$$

158 ,, ,, ,, ,, ,, 79 ,,

Dents per pattern 106

The finished width of the cloth is 30 in., therefore as it contains 81 threads or $40\frac{1}{2}$ dents per inch, the total number of dents to be occupied by warp threads will be: $40\frac{1}{2} \times 30 = 1215$ dents.

1215 (dents) ÷ 106 (dents per pattern) = 11 repeats of pattern and 49 dents over.

There being 49 dents over a definite number of repeats of pattern, which must be taken into account, will cause the warp dresser's instructions to be: 11 repeats of pattern, starting and finishing with 128 threads of black mercerized cotton.

The number of threads required to make the warp will be:—

	Threads per Pattern.		For 49 Dents over.	Total Number of Threads.
Silk	54 × 11 repeats	=	594 + 0 = (double)	594
Cotton	212 × ,, ,,	=	2332 + 98 =	2430
Total	266			Total 3024

6. *Width in Reed.*—As there are 1215 dents in the reed required to reproduce this cloth, and it is decided that the reed must contain 40 dents per inch, the space occupied by the warp will be:—

$$1215 \div 40 = 30\tfrac{1}{2} \text{ in. width in reed.}$$

7. *Length of Grey and Finished Cloths.*—It has been ascertained that 3 in. of ground warp has contracted from $3\frac{5}{8}$ in., therefore if 70 yds. of warp per cut be employed, the length of the finished cloth will be:—

$$\text{As } 3\tfrac{5}{8} \text{ in.} : 3 \text{ in.} :: 70 \text{ yds.} : x = 58 \text{ yds. finished cloth.}$$

The extra silk warp has contracted from $3\frac{1}{8}$ in. to 3 in., the length of silk warp will be much less than the ground warp.

As $3\frac{5}{8}$ in. : $3\frac{1}{8}$ in. :: 70 yds. : $x = 60\frac{1}{2}$ yds. of silk warp to 70 yds. of cotton warp.

During the finishing of these goods the length is pressed out

to the extent of about half a yard in sixty, consequently the grey length of cloth can be estimated at $57\frac{1}{2}$ yds.

8. *Picks per Inch.*—The picks in the finished cloth are counted to be 68 per inch, the number to the inch of grey cloth and warp will be :—

As $57\frac{1}{2} : 58 :: 68 : x = 68$ picks per inch in grey cloth.

As $70 : 58 :: 68 : x = 56$ picks per inch of warp.

Quantities of Material.—1. *Weight of Warps* :—

$$\text{Silk } \frac{594 \times 2 \times 60}{40 \times 840} = 2{\cdot}1 \text{ lb.}$$

$$\text{Cotton } \frac{2430 \times 70}{25 \times 840} = 8{\cdot}07 \text{ ,,}$$

2. *Weight of Weft* $\dfrac{56 \times 30{\cdot}25 \times 70}{20 \times 840} = 7$,,

3. *Total Weight, Grey Cloth.* 17·17 lb.

4. *Finished Cloth Weight.*—The finished cloth weight can be considered 5 per cent less than grey cloth weight, i.e. $16\frac{1}{4}$ lb. finished cloth.

Example 4.—(Fig. 71).—Style of cloth, striped moirette.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/50's	Black mercerized cotton.	40/2's	70 yd.	$57\frac{1}{2}$ yd.	58 yd.	17·17 lb.
	40/2	White spun silk		60 yd.			

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	1/20	Black polished cotton	56 warp 68 { grey cloth	$30\frac{1}{2}$ in.	30 in.	30 in.	$16\frac{1}{4}$ lb.

Order of Warp :—

		Thread.
54	1 double thread, silk = (double) 1 thread black cotton =	594
*158	,, ,, ,,	2430
11 repeats of pattern		Total 3024

* Start and finish 128 threads black cotton on two warp beams.

Weight of Warps :—

Silk	= 2·1 lb.
Black cotton	= 8·07 ,,
	10·17 lb.

Weight of Weft.—7 lb.

Lists.—As warp.

Draft and Sleying Plan.—According to warping plan : ground threads on 4 shafts (hopshaft draft) sleyed 2 in a dent and silk threads on 5 shafts (according to pattern) and sleyed extra, Fig. 71*a*.

Pegging Plan.—Fig 71*b*.

Example 5.—Cotton and Artificial Silk Dress Fabric (Fig. 72).

Finished Cloth Particulars.—By employing Gaunt's standard weights the count of the warp and wefts are found to be :—

1. Warp = 2/80's black cotton.
2. Cotton weft = 2/80's black cotton.
3. Artificial silk weft = 1/30's (cotton count).
4. Threads per inch = 51.
5. Picks per inch = 47.

Contraction from Loom to Finished Cloth :—

1. Warp = 3 in. measures $3\frac{1}{8}$ in.
2. Weft = 3 in. measures $3\frac{1}{4}$ in.

The cloth to be reproduced from 70 yds. of warp and the width of finished cloth to be 44 in.

Loom Particulars.—1. *Counts of Warp and Weft.*—The contraction of yarns are so slight also the loss in weight during the finishing of this type of fabric that the finished count of warp and wefts may be taken to be the same in the loom.

Warp = 2/80's cotton.

Wefts = 2/80 cotton and 1/30 (cotton counts) artificial silk.

2. *Threads per Inch in Reed :—*

As $3\frac{1}{4}$ in. : 3 in. : : 51 : x = 47 threads or 47 reed 1's.

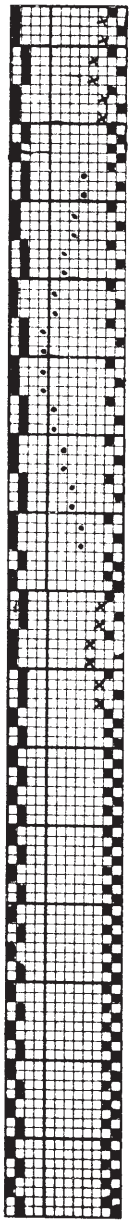

FIG. 71*a*.

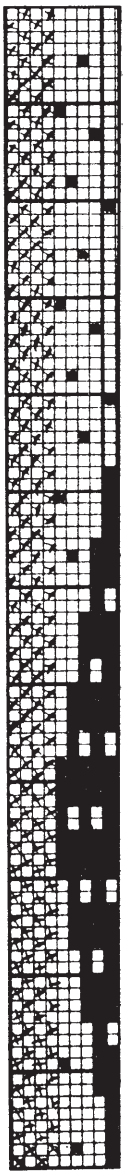

FIG. 71*b*.—Pegging Plan.

3. *Threads in Warp* :—

$$51 \times 44 = 2244 \text{ threads.}$$

4. *Width in Reed* :—

$$2244 \div 47 = 48 \text{ in.}$$

5. *Lengths of Grey and Finished Cloths* :—

As $3\frac{1}{8}$ in. : 3 in. : : 70 yds. : $x = 67$ yds. (finished cloth).

Taking into consideration the weave, difference in material of warp and weft, and the present contraction shown on warp

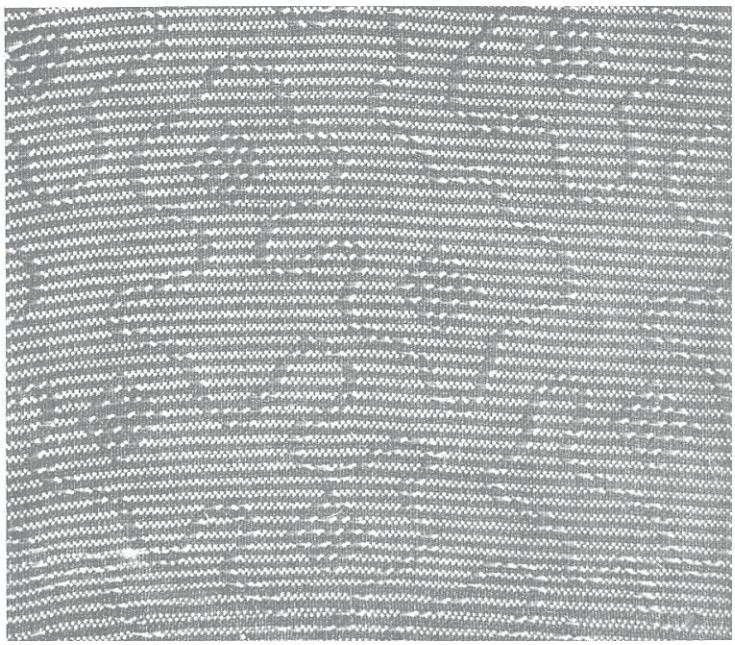

FIG. 72.—Figured Cotton and Artificial Silk Dress Cloth.

and weft, it is evident that this fabric, during the finishing processes, has been drawn out in length.

A reasonable estimate of grey cloth length is 65 yds.

6. *Picks per Inch of Warp and Grey Cloth.*—Picks per inch in finished cloth 67 yds. long = 47. What are the number of picks where the cloth is 65 yds. (grey cloth) and 70 yds. (warp length)?

$$70 : 67 : : 47 : x = 45 \text{ picks per inch of warp.}$$

$$65 : 67 : : 47 : x = 48 \text{ picks per inch of grey cloth.}$$

Quantities of Material.—1. *Weight of Warp in Grey Cloth.*—

$$\frac{2244 \times 70}{40 \times 840} = 4{\cdot}67 \text{ lb.}$$

2. *Weight of Weft in Grey Cloth* :—

$$\frac{45 \times 48 \times 70 \times 2}{40 \times 840 \times 4} = 2\tfrac{1}{4} \text{ lb. cotton.}$$

$$\frac{45 \times 48 \times 70 \times 2}{30 \times 840 \times 4} = 3 \text{ lb. art. silk.}$$

3. *Total Weight of Grey Cloth* :—

4·67 lb. warp.
2·25 ,, cotton weft.
3 ,, art. silk weft.
9·92 lb.

4. *Total Weight of Finished Cloth* :—

($2\frac{1}{4}$ oz. per yard.)
$2\frac{1}{4} \times 67 = 9{\cdot}42$ lb.

Example 5.—(Fig. 72). Style of cloth, cotton and artificial silk, $2\frac{1}{4}$ oz. per yard (finished cloth), 44 in. × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/80	Black cotton	47/1's	70 yd.	(65 yd.)	67 yd.	9·92 lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	2/80 1/30 cotton	Black cotton. Art. silk	45 warp 48 { grey cloth	48 in.	(47 in.)	44 in.	9·42 lb.

Threads in Warp.—2244.
Picking.—2 picks black cotton.
2 ,, art. silk.

Weight of Warp.—4·67 lb.

Weight of Weft :—

Black cotton = $2\frac{1}{4}$ lb.
Art. silk = 3 ,,

Lists.—20 threads 2/40 white cotton at each edge weaving plain.

Weave.—Jacquard.

Example 6.—Corduroy Woollen (Fig. 73).

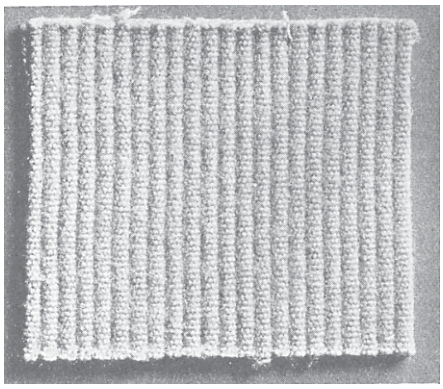

Fig. 73.—Corduroy Woollen.

Finished Cloth Particulars.—By employing Gaunt's standard weights, the ounces per yard, counts of warps and weft, are found to be :—

1. 32·8 oz. per yard (56 in. × 36 in.).
2. Cotton warp = 2/28. Woollen warp = 23 skeins.
3. Woollen weft = 16 skeins.
4. Threads per inch = 92.
5. Picks per inch = 88.

Contractions from Loom to Finished Cloth :—

1. Cotton warp = 3 in. measures $3\frac{3}{4}$ in.
2. Woollen warp = 3 in. ,, $3\frac{3}{4}$,,
3. Woollen weft = 3 in. ,, $4\frac{1}{4}$,,

The cloth to be reproduced from 70 yds. of warp and the width of the finished cloth to be 56 in.

Loom Particulars.—1. *Count of Cotton Warp :—*

$$\left.\begin{matrix} 3 : 3\frac{3}{4} : : \\ 100 : 95 : : \end{matrix}\right\} 2/28 : x = 2/34 \text{ cotton.}$$

2. *Count of Woollen Warp.*—15 per cent loss in weight.

$$\left.\begin{matrix}3 : 3\frac{3}{4} : : \\ 100 : 85 : :\end{matrix}\right\} 23 : x = 24 \text{ skeins woollen.}$$

3. *Count of Woollen Weft :—*

$$\left.\begin{matrix}3 : 4\frac{1}{4} : : \\ 100 : 85 : :\end{matrix}\right\} 16 \text{ skeins} : x = 20 \text{ skeins woollen.}$$

4. *Threads per Inch in Reed :—*

$4\frac{1}{4}$ in. : 3 in. : : 92 : $x = 65$ threads.

5. *Threads in Warp :—*

$92 \times 56 = 5160$ threads.

Arranged :—2 threads cotton = 1032 threads
8 ,, woollen = 4128 ,,

516 repeats 5160 threads

6. *Width in Reed :—*

Threads in warp $5160 \div 65$ threads per inch = $79\frac{1}{2}$ in.

7. *Length of Grey and Finished Cloths :—*

As $3\frac{3}{4}$ in. : 3 in. : : 70 yd. : $x = 56$ yd. finished cloth.

The length of grey cloth may be estimated at 58 yd.

8. *Picks per Inch.*—There are 88 picks per inch in the finished cloth. What will be the number per inch of warp and grey cloth?

70 yd. warp = picks per inch.
58 ,, grey cloth = ,, ,,
56 ,, finished cloth = 88 ,, ,,

As 70 : 56 : : 88 : $x = 70$ picks per inch of warp.

As 58 : 56 : : 88 : $x = 85$ picks per inch of grey cloth.

Quantities of Material.—1. *Weight of Warps :—*

$$\text{Cotton } \frac{1032 \times 70}{17 \times 840} = 5 \text{ lb.}$$

$$\text{Woollen } \frac{4128 \times 70}{24 \times 256} = 47 \text{ ,,}$$

2. *Weft :—*

$$\frac{70 \times 70 \times 79{\cdot}5}{20 \times 256} = 76 \text{ ,,}$$

3. *Total Weight (Grey Cloth).* 128 lb.

4. *Finished Cloth Weight :—*

32·8 oz. per yard × 56 yd. = 108 lb.

Example 6. (Fig. 73).—Style of cloth, corduroy woollen, 32·8 oz. per yard (finished cloth), 56 in. × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/34's 24 skeins	Cotton Woollen	65 threads per inch	70 yd.	(58 yd.)	56 yd.	128 lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	20 skeins	Woollen	70 warp 85 {grey cloth	79½ in.	68 in.	56 in.	108 lb.

Order of Warping :—

2 threads cotton = 1032 threads
8 ,, woollen = 4128 ,,

516 repeats on one warp beam 5160 threads

Weight of Warp :—

Cotton = 5 lb.
Woollen = 47 ,,

52 lb.

Weight of Weft = 76 lb.

Lists.—As warp.

Weave.—(Fig. 73*a*.) The cotton threads are indicated in crosses.

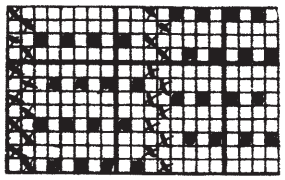

Fig. 73*a*.

Example 7.—Double Cloth Woollen (Fig. 74*a*, face cloth ; Fig. 47*b*, back cloth).

Finished Cloth Particulars :—

1. Weight per yard = 32 oz. (56 × 36 in.).
2. Woollen warp = 10½ skeins (woollen).

3. Bending cotton warp = 2/60 (cotton).
4. Woollen weft = $9\frac{1}{2}$ skeins (woollen).
5. Threads per inch of woollen = 47.
6. Picks per inch = 40.

Contraction from Loom to Finished Cloth :—

1. Cotton and woollen warp = 3 in. measures $3\frac{5}{16}$ in.
2. Woollen weft = 3 in. measures $3\frac{1}{2}$ in.

The cloth to be reproduced from 70 yds. of warp, and the width of the finished cloth to be 56 in.

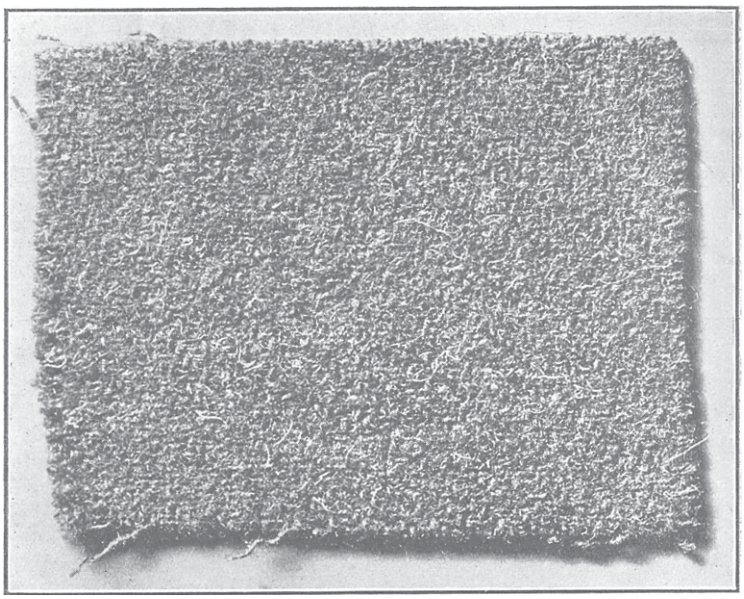

FIG. 74*a*.—Woollen Double Cloth (face).

Loom Particulars.—1. *Count of Warp* (woollen) (25 per cent loss in weight) :—

$$\left.\begin{matrix} 3 : 3\frac{5}{16} : : \\ 100 : 75 \ : : \end{matrix}\right\} 10\tfrac{1}{2} \text{ skeins} : x = 8 \text{ skeins.}$$

2. *Count of Binding Warp* (cotton) :—

As finished counts 2/60 cotton.

3. *Count of Weft.*—(25 per cent loss in weight) :—

$$\left.\begin{matrix} 3 : 3\frac{1}{2} : : \\ 100 : 75 : : \end{matrix}\right\} 9\tfrac{1}{2} \text{ skeins} : x = 8 \text{ skeins (woollen).}$$

4. *Threads in Warp* :—

$47 \times 56 = 2640$ woollen threads.

The warp is arranged :—

1 cotton thread for binding (extra).

4 woollen threads.

$2640 \div 4 = 660$ cotton threads (extra).

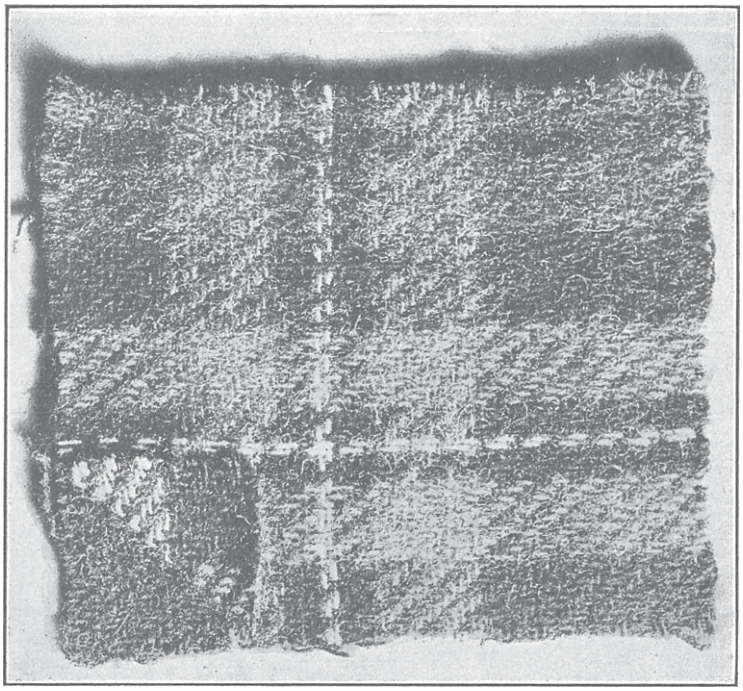

FIG. 74*b*.—Woollen Double Cloth (back).

5. *Threads per Inch in Reed* :—

$3\frac{1}{2}$ in. : 3 in. : : 47 : $x = 40$ woollen threads per inch.

6. *Width in Reed* :—

$2640 \div 40 = 66$ in.

7. *Length of Grey and Finished Cloths* :—

$3\frac{5}{16}$: 3 : : 70 : $x = 63\frac{1}{2}$ yds. (finished cloth).

The grey cloth length may be estimated at 65 yds.

8. *Picks per Inch.*—There are 40 picks per inch in the finished cloth. The picks per inch of warp will be :—

As $70 : 63\frac{1}{2} :: 40 : x = 36$ picks per inch of warp.

The picks per inch in grey cloth :—

As $65 : 63\frac{1}{2} :: 40 : x = 39$ picks per inch in grey cloth.

Quantities of Material.—1. *Weight of Warp* (woollen) :—

$$\frac{2640 \times 70}{8 \times 256} = 90 \text{ lb.}$$

2. *Weight of Extra Warp* (cotton) :—

$$\frac{660 \times 70}{30 \times 840} = 1\frac{5}{6} \text{ lb.}$$

3. *Weight of Weft* :—

$$\frac{36 \times 66 \times 70}{8 \times 256} = 81 \text{ lb.}$$

4. *Weight of Grey Cloth* $= 172\frac{5}{6}$ lb.

5. *Weight of Finished Cloth* :—

32 oz. (56 in. × 36 in.) × $63\frac{1}{2}$ yds. = 128 lb.

Example 7 (Fig. 74).—Style of cloth, double cloth woollen, 32 oz. per yard (finished cloth), 56 in. × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	8 skeins 2/60	Woollen coloured cotton	10/4's	70 yd.	(65 yd.)	$63\frac{1}{2}$ yd.	$172\frac{5}{6}$ lb.
	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	8 skeins	Woollen coloured	36 warp 39 { grey cloth	66 in.	(62 in.)	56 in.	128 lb.

Order of Warping :—

2 { 1 thread woollen face cloth = 1320 threads on 1 beam.
  { 1 „ „ back „ = 1320 „ „ „
  1 „ cotton for binding = 660 „ „ „

660 repeats.

Weight of Warp:—Woollen = 90 lb.
Cotton = $1\frac{5}{6}$ lb.
Weight of Weft = 81 lb.
Lists.—As warp.
Weave and Draft.—Fig. 74*c*.

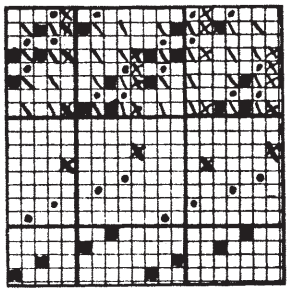

FIG. 74*c*.—Design and Draft.

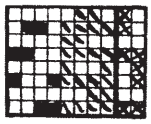

FIG. 74*d*.—Pegging Plan.

Pegging Plan.—Fig. 74*d*.

Example 8.—Weft Cut Pile Corduroy Woollen (Fig. 75).

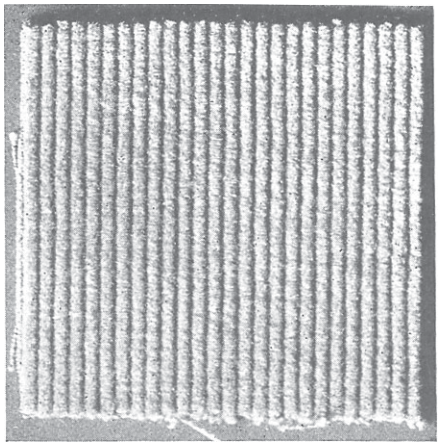

FIG. 75.—Weft Cut Pile Corduroy Woollen.

Finished Cloth Particulars:—
1. Weight per yard = 16·4 oz. (13in. × 36 in.).
2. Warp = 2/16 cotton.
3. Weft = 32 skeins woollen.

4. Threads per inch = 66.

5. Picks per inch = 210.

Contraction from Loom to Finished Cloth :—

1. Warp = 3 in. measures $3\frac{1}{4}$ in.

2. Weft = 3 in. ,, $3\frac{13}{16}$ in.

The cloth to be reproduced from 70 yds. of warp, and the width of the finished cloth to be 30 in.

Loom Particulars.—1. *Count of Warp* :—

$$\left.\begin{matrix} 3 : 3\frac{1}{4} : : \\ 100 : 95 : : \end{matrix}\right\} 2/16 : x = 2/16 \text{ cotton.}$$

2. *Count of Weft* (15 per cent loss in weight) :—

$$\left.\begin{matrix} 3 : 3\frac{13}{16} : : \\ 100 : 85 : : \end{matrix}\right\} 32 \text{ skeins} : x = 34 \text{ skeins woollen.}$$

3. *Threads per Inch in Reed* :—

$$3\tfrac{13}{16} \text{ in.} : 3 \text{ in.} : : 66 : x = 52 \text{ threads.}$$

4. *Threads in Warp* :—

$$66 \times 30 = 1980 \text{ threads.}$$

5. *Width in Reed* :—

$$1980 \text{ threads} \div 52 = 38 \text{ in.}$$

6. *Length of Grey and Finished Cloths* :—

$$3\tfrac{1}{4} : 3 : : 70 \text{ yds.} : x = 64\tfrac{1}{2} \text{ yds. (finished cloth).}$$

In this type of structure the grey cloth length may be estimated as finished cloth length say 65 yds.

7. *Picks per Inch.*—There are 210 picks per inch in the finished cloth. What will be the number per inch of warp and grey cloth ?

70 yds. warp = per inch.
65 ,, grey cloth = per inch.
$64\frac{1}{2}$,, finished cloth = 210 per inch.

As $70 : 64\frac{1}{2} : : 210 : x = 194$ per inch of warp.

As $65 : 64\frac{1}{2} : : 210 : x = 208$ per inch of grey cloth.

Quantities of Material :—

1. *Weight of Warp* :—

$$\frac{1980 \times 70}{8 \times 840} = 20\tfrac{5}{8} \text{ lb.}$$

2. *Weight of Weft* :—

$$\frac{194 \times 38 \times 70}{34 \times 256} = 59\tfrac{1}{4} \text{ ,,}$$

3. *Total Weight of Grey Cloth.* $79\frac{7}{8}$ lb.

4. *Finished Cloth Weight* :—

16·4 oz. (30 in. × 36 in.) × 64½ yds. = 66 lb.

Example 8 (Fig. 75).—Style of cloth, weft cut pile, corduroy woollen, 16·4 oz. per yard (finished cloth) 30 in. × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/16's	Cotton	52 threads per inch	70 yd.	(65 yd.)	64½ yd.	79⅞ lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	34 skeins	Woollen	194 Warp 208 {grey cloth}	38 in.	(32 in.)	30 in.	66 lb.

Threads in Warp.—1890 threads.
Weight of Warp.—20⅝ lb.
Weight of Weft.—59¼ lb.
Lists.—As warp.
Weave.—Fig. 75*a*.

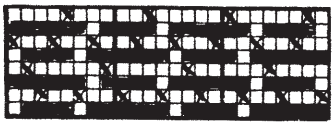

Fig. 75*a*.—Design.

Example 9.—Colour and Weave Worsted Costume Cloth (Fig. 76).

Finished Cloth Particulars :—

1. Weight per yard = 8·04 oz. (56 in. × 36 in.).
2. Warp = 2/50 worsted.
3. Weft = 2/49 ,,
4. Threads per inch = 62.
5. Picks per inch = 61.

Contraction from Loom to Finished Cloth :—

Warp.—3 in. measures $3\frac{1}{4}$ in.

Weft.—3 in. ,, $3\frac{5}{16}$ in.

The cloth to be reproduced from 70 yds. of warp per cut, and the width of the finished cloth to be 56 in.

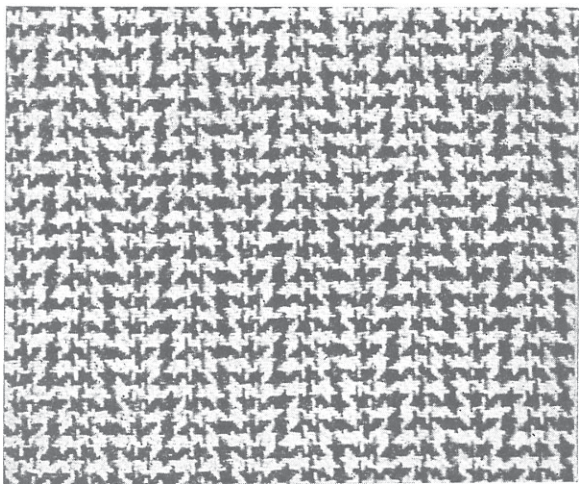

FIG. 76.—Colour and Weave Worsted Cloth.

Loom Particulars.—1. *Count of Warp* :—

$$\left.\begin{matrix} 3 : 3\frac{1}{4} : : \\ 100 : 95 : : \end{matrix}\right\} 2/50 : x = 2/50 \text{ worsted.}$$

2. *Count of Weft* :—

$$\left.\begin{matrix} 3 : 3\frac{5}{16} : : \\ 100 : 94 : : \end{matrix}\right\} 2/49 : x = 2/50 \text{ worsted.}$$

3. *Threads per Inch in Reed* :—

$$3\tfrac{5}{16} \text{ in.} : 3 \text{ in.} : : 62 : x = 56 \text{ threads.}$$

4. *Threads in Warp* :—

$$62 \times 56 = 3472 + 2 = 3474 \text{ threads.}$$

5. *Width in Reed* :—

$$3474 \div 56 = 62 \text{ in.}$$

6. *Length of Grey and Finished Cloths* :—

$3\frac{1}{4}$ in. : 3 in. : : 70 yds. : $x = 64\frac{1}{2}$ yds. (finished cloth).

In this structure it may be estimated that the grey length of cloth is $65\frac{1}{2}$ yds.

7. *Picks per Inch :—*

70 yds. warp = picks per inch.
$65\frac{1}{2}$,, grey cloth = picks per inch.
$65\frac{1}{2}$,, finished cloth = 61 picks per inch.
$70 : 64\frac{1}{2} :: 61 : x = 56$ picks per inch of warp.
$65\frac{1}{2} : 64\frac{1}{2} :: 61 : x = 60$,, ,, ,, of grey cloth.

Quantities of Material :—

1. *Warp :—*

$$\frac{3474 \times 70}{25 \times 560} = 17{\cdot}25 \text{ lb.}$$

2. *Weft :—*

$$\frac{56 \times 62 \times 70}{25 \times 560} = 17{\cdot}25 \text{ ,,}$$

3. *Total Weight of Grey Cloth.* 34·5 lb.
4. *Finished Cloth Weight :—*

8·04 oz. × $64\frac{1}{2}$ yds. = 32·4 lb.

Example 9 (Fig. 76).—Style of cloth, worsted costume cloth 8·04 oz. per yard (finished cloth) 56 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
Warp				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
	2/50's	Botany worsted. 56's quality	14/4's	70 yd.	($65\frac{1}{2}$ yd.)	$64\frac{1}{2}$ yd.	$34\frac{1}{2}$ lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
Weft				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
	2/50's	Botany worsted. 56's quality	56 Warp 60 grey cloth	62 in.	(60 in.)	56 in.	32·4 lb.

Order of Warping :—

Black	1	2	1	4	= 1544 black threads.
White	1	1	4	4	= 1930 white ,,
	193 repeats				3474

Order of Picking :—

4 picks black.
4 ,, white.

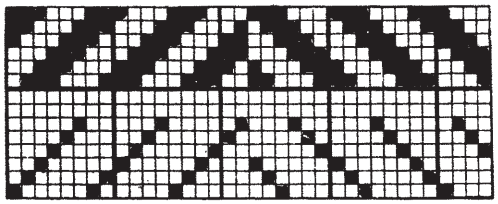

FIG. 76*a*.—Design and Draft.

FIG. 76*b*.—Pegging Plan.

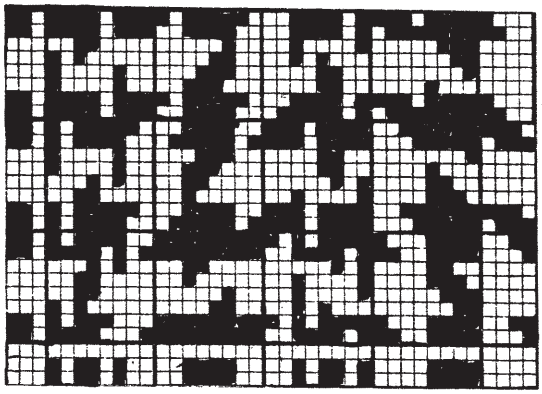

FIG. 76*c*.—Colour and Weave Effect.

Weight of Warp = 17·25 lb.
Weight of Weft = 17·25 lb.
Lists.—As warp.
Weave and Draft.—Fig. 76*a*.
Pegging Plan.—Fig. 76*b*.
Colour and Weave Effect.—Fig. 76*c*.

CHAPTER XII.

QUICK METHODS OF ANALYSIS, STANDARD WEIGHTS AND GAUGES.

PREVIOUS chapters have indicated that, to obtain the weight per yard, and counts of warp and weft, a certain amount of calculation is involved. This to some extent may be obviated by employing standard weights.

Standard Weights.—By means of these weights—without resort to calculation—the following results may be obtained :—

(*a*) The weight per yard in ounces (54 × 36 in.) and the corresponding grammes per square metre.

(*b*) The count in woollen (Y. Sk.) of warp or weft threads.

" " " worsted " " " " "

" " " cotton or spun silk " " " " "

To obtain these results the pattern must be cut, either of two sizes. No. 1 cutter gives a pattern 3 × 3 in. or 9 sq. in. No. 2 cutter gives a cross-shaped pattern (Fig. 63) the area of which is 2 sq. in.

Ounces per Yard (54 *in. wide*) *and Grammes per Square Metre.*—As the patterns may be cut into two sizes, there are, in consequence, two sets of weights to obtain this result. However, in both cases the method is simple and the same. In each case there are a number of aluminium weights, which range, in the ratio of from $\frac{1}{8}$th of an oz. to 20 oz. and stamped on each is the equivalent in grammes per square metre.

The method of procedure is to place the pattern cut in one pan of the scales, and the weights required to balance the pattern at once indicate the result.

To Obtain the Count of Yarn.—There are three aluminium weights marked, woollen, worsted, and cotton respectively (Fig. 77), and the number of threads 3 in. long which balance either of these weights, indicates the count of yarn in that particular denomination.

Example 1.—24 threads from a worsted pattern cut 3 × 3 in. balance the weight marked worsted, the counts of the yarn will be 24's or 24 × 560 = 1 lb. of yarn.

Example 2.—20 threads from a woollen cloth, each 3 in. long, balance the woollen weight: thus the counts will be 20 Yorkshire skeins woollen or $20 \times 256 = 1$ lb. of yarn.

Example 3.—40 threads 3 in. long are equal to the cotton weight. The hanks per lb. of counts will be 40's or $40 \times 840 =$ yards per lb.

When No. 2 cutter is employed it will be found that the threads of warp and weft across the centre are $1\frac{1}{2}$ in. in length. Hence 40 threads $1\frac{1}{2}$ in. long will be equal to 20 threads 3 in. long.

Note that:—

(1) Patterns tested in a grey condition. Grey weight and counts are given.

(2) Patterns tested in a finished condition. Finished weight and counts are given.

Basis of Calculation for Standard Weights.—*Weight per Yard.*—In 1 yd. of cloth there are 36×54 in. $= 1944$ sq. in.; therefore the pattern cut 3×3 in. or 9 sq. in. will be $\frac{9}{1944} = \frac{1}{216}$ part of the weight per yard; and where No. 2 cutter is employed, giving 2 sq. in. of cloth, the pattern cut will be $\frac{2}{1944} = \frac{1}{972}$ part of the weight per yard. Thus as there are 7000 grains per lb. the weight in grains of the standard weights will be as follows:—

No. 1 cutter (3×3 in. or 9 sq. in.).

$\frac{1}{216}$ part of 20 oz. = 40·5 grains or 20 oz. aluminium weight.

" " " 10 " = 20·25 " " 10 " " "
" " " 5 " = 10·125 " " 5 " " "
" " " 4 " = 8·1 " " 4 " " "
" " " 2 " = 4·05 " " 2 " " "
" " " 1 " = 2·025 " " 1 " " "
" " " $\frac{1}{2}$ " = 1·017 " " $\frac{1}{2}$ " " "
" " " $\frac{1}{4}$ " = ·508 " " $\frac{1}{4}$ " " "
" " " $\frac{1}{8}$ " = ·259 " " $\frac{1}{8}$ " " "

No. 2 cutter (2 sq. in.).

$\frac{1}{972}$ part of 20 oz. = 9 grains or 20 oz. aluminium weight.

" " " 10 " = 4·5 " " 10 " " "
" " " 5 " = 2·25 " " 5 " " "
" " " 4 " = 1·8 " " 4 " " "
" " " 2 " = ·9 " " 2 " " "
" " " 1 " = ·45 " " 1 " " "
" " " $\frac{1}{2}$ " = ·227 " " $\frac{1}{2}$ " " "
" " " $\frac{1}{4}$ " = ·113 " " $\frac{1}{4}$ " " "
" " " $\frac{1}{8}$ " = ·056 " " $\frac{1}{8}$ " " "

Standard weights may be made to give the ounces per yard for any dimension of cloth. In most instances, as for example in the worsted coating trade, a set of weights, based on the cloth

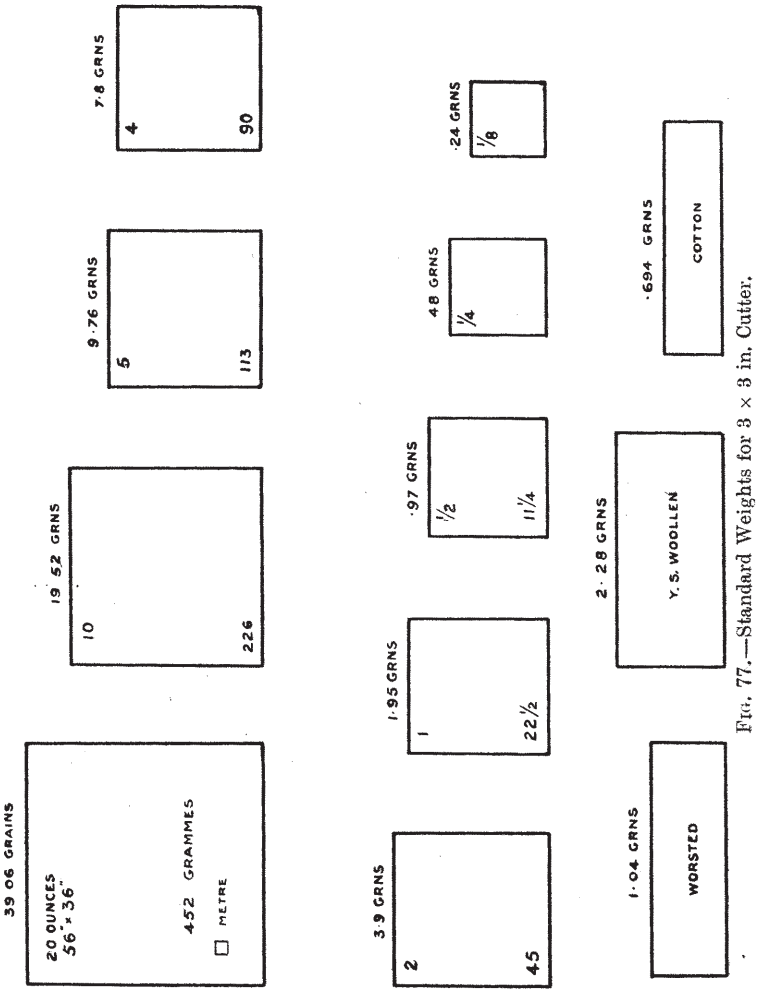

FIG. 77.—Standard Weights for 3 × 3 in. Cutter.

being 56 in. wide and 36 in. to the yard, would be most useful. The weight in grains of the standard weights would be for a pattern cut 3 × 3 in. as stated in Fig. 77.

Counts of Yarn :—

(*a*) 560 yds. of 1's count worsted weighs 1 lb. (7000 grains).

$\therefore$ 3 in. ,, ,, ,, ,, $\frac{7000 \times 3}{560 \times 36} =$

1·04 grains, weight of worsted weight.

(*b*) 256 yds. of 1's count woollen weighs 1 lb. (7000 grains).

$\therefore$ 3 in. ,, ,, ,, ,, $\frac{7000 \times 3}{256 \times 36} =$

2·28 grains, weight of woollen weight.

(*c*) 840 yds. of 1's count cotton and spun silk weighs 1 lb. (7000 grains).

$\therefore$ 3 in. of 1's count cotton and spun silk weighs $\frac{7000 \times 3}{840 \times 36} =$

·694 grains, weight of cotton and spun silk weight.

Yarn Gauge.—To ascertain the count of yarn from any fabric without resort to calculation.

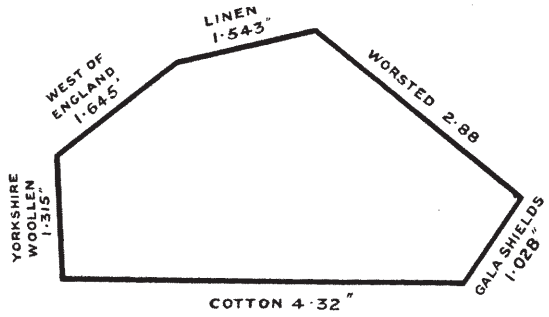

FIG. 78.—Yarn Gauge.

Fig. 78 illustrates a gauge made of aluminium by which the count of yarn may quickly be obtained in any of the denominations stated.

The instructions are to place the required side of the gauge to the pattern and cut the fabric exactly the same length and width. Then place as many threads of warp or picks of weft in a pan of a balance as will weigh one grain. The count of yarn in the finished cloth is equal to the number of threads which weigh one grain.

Example.—If 20 threads taken from a worsted cloth, each as long as the worsted side of the gauge, weigh one grain, the result is 20's worsted count.

In the case of a cotton fabric, if 40 threads each as long as the

cotton side of the gauge weigh one grain, the result is 40's cotton count.

The method is the same in all other systems of counting.

Basis of Calculation for Yarn Gauge.—The gauge is based on the length in inches of 1's count in the various denominations.

Worsted Counts.—In 1's worsted there is one hank of 560 yds. weighing 1 lb. (7000 grains) : therefore the length of 1's yarn which weighs one grain will be :—

$$\frac{560 \times 36}{7000} = 2{\cdot}88 \text{ in. for worsted count.}$$

As in 20's worsted there are 20 hanks per lb., there will be 20 threads 2·88 in. long to weigh one grain.

Cotton Counts, 840 yds. per hank :—

$$\frac{840 \times 36}{7000} = 4{\cdot}32 \text{ in. for cotton count.}$$

Yorkshire Skeins Woollen, 256 yds. per hank :—

$$\frac{256 \times 36}{7000} = 1{\cdot}315 \text{ in. for Yorkshire skeins woollen count.}$$

Galashiels Count, 200 yds. per hank :—

$$\frac{200 \times 36}{7000} = 1{\cdot}028 \text{ in. for Galashiels count.}$$

West of England Count, 320 yds. per hank :—

$$\frac{320 \times 36}{7000} = 1{\cdot}645 \text{ in. for West of England count.}$$

Linen Count, 300 yds. per hank :—

$$\frac{300 \times 36}{7000} = 1{\cdot}543 \text{ in. for linen count.}$$

Analysis by Comparison.—The method of analysing a fabric by comparison is one of the quickest and most reliable employed for obtaining the loom particulars of an unknown cloth. On account of these advantages it is the one chiefly in use in the industry. The principle underlying the method is that of comparing the constituents of an unknown cloth with those of a known cloth.

Conditions.—It is already realized that all woven fabrics vary from being in the loom to becoming finished cloths according to : (1) the quality of the raw material, (2) structure of yarn, (3) build of cloth, and (4) type of finish and degree of treatment during finishing. Therefore when a known cloth is being chosen for this purpose, the utmost care must be taken, *because if any of the above*

four factors, in the known and unknown cloths, are distinctly different, the variation from loom to finished cloth will have varied according, and the comparison will not be a fair one and in consequence the results will be incorrect.

The application of this method will have some limitation as the analyst is not likely to possess a sample and loom particulars of every type of woven fabric which may be submitted to him for analysis.

Example 1.—To a maker of worsted dress cloths an unknown cloth is submitted for reproduction. Having ascertained the quality, structure, weave, etc., of the structure submitted, the maker selects a cloth of his own make which he considers nearest in the details mentioned. The maker's known cloth is of the following particulars :—

" Known " Cloth :—

Example 1.—Style of cloth, worsted dress, 9·9 oz. per yard (finished cloth), 56 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/48's	Grey botany	15/4's	70 yd.	65 yd.	63 yd.	41·8 lb.
	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	1/24	Grey botany	60 warp 64 { grey cloth	67 in.	64 in.	56 in.	39 lb.

Comparison of " Known " and " Unknown " Cloths :—

1. *Weight per Yard* (finished cloth).—Cut both patterns 3 × 3 in. and test for weight per yard (for convenience employing Gaunt's standard weights).

" Known " cloth = 9·9 oz. (56 × 36 in.).
" Unknown " ,, = 7·74 ,, ,, ,,

2. *Counts of Warp in Loom.*—Take a suitable number of warp threads, 3 in. long, from "known" cloth of 2/48's (say 48 threads) and place them in one pan of a pair of scales: in the other pan place as many threads, the same length, from "unknown" cloth as will balance the threads from known cloth.

In this case it is found that 60 threads from "unknown" cloth, balance and are equal in weight to 48 threads of 2/48 ∴ if 48 threads (known) are equal to 2/48 in the loom, 60 threads (unknown) will be:—

$$48 : 60 :: 2/48 : x = 2/60$$ warp counts of unknown cloth.

3. *Counts of Weft in Loom* (as in the case of warp).—From 'known" cloth 24 picks of 1/24's are found to balance 30 picks from "unknown".

∴ if 24 picks are equal to 1/24's counts in the loom 30 picks will be:—

As $24 : 30 :: 1/24 : x = 1/30$ weft counts of unknown cloth.

4. *Threads per Inch in Loom.*—On examination it is found that in both "known" and "unknown" cloths, there are 72 threads per inch.

∴ if 72 threads (finished) are obtained from 60 in th loom (known cloth), then in the "unknown" cloth 72 threads (finished) will be obtained from 60 threads per inch in the loom, or

As $72 : 72 :: 60 : x = 60$ threads per inch in loom of "unknown".

5. *Picks per Inch in Loom.*—On the two cloths being compared for picks per inch, it is found that the "known" cloth contains 68 to 64 in the "unknown" cloth.

∴ If 67 gives 60 in the loom, what in the loom will the "unknown" cloth be, which counts 64 picks?

As $68 : 64 :: 60 : x =$

57 picks per inch in loom of "unknown" cloth.

6. *Widths and Lengths of "Unknown" Cloth.*—As the two cloths are alike in all which affects the contraction or shrinkage and the above results of the unknown cloth, being obtained by comparison with a cloth of a certain variation from loom to finished dimensions, it is obvious that the various widths and length of the two cloths must be identical, if the particulars obtained are to be correct.

Particulars of "Unknown" Cloth :—

Example 1.—Style of cloth, worsted dress, 7·74 oz. per yard (finished cloth), 56 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/60	Grey botany	15/4's	70 yd.	65 yd.	61 yd.	32·65 lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	1/30	Grey botany	57 warp 61 grey cloth	67 in.	64 in.	56 in.	30·5 lb.

Total Grey and Finished Weights of "Known" and "Unknown" Cloths :—

1. "*Known*" (*Grey Cloth*) :—

$$\text{Warp } \frac{4020 \times 70}{24 \times 560} = 20{\cdot}9 \text{ lb.}$$

$$\text{Weft } \frac{60 \times 67 \times 70}{24 \times 560} = 20{\cdot}9 \text{ ,,}$$

$$41{\cdot}8 \text{ lb.}$$

2. "*Known*" (*Finished Cloth*) :—

9·9 oz. (56 × 36 in.) × 63 yds. = 39 lb.

3. "*Unknown*" (*Grey Cloth*) :—

$$\textit{Warp } \frac{4020 \times 70}{30 \times 560} = 16{\cdot}75 \text{ lb.}$$

$$\textit{Weft } \frac{57 \times 70 \times 67}{30 \times 560} = 15{\cdot}9 \text{ ,,}$$

$$32{\cdot}65 \text{ lb.}$$

4. "*Unknown*" (*Finished Cloth*) :—

7·74 oz. (56 × 36 in.) × 63 yds. = 30·5 lb.

Example 2.—To a maker of worsted coatings a small piece of cloth, Fig. 80, is submitted for reproduction. Having ascertained the quality, structure, weave, etc., of the pattern submitted, the maker selects a cloth of his own make, Fig. 79, which he considers nearest in the above details. The maker's known cloth is of the following particulars :—

"Known" Cloth :—

Example 2 (Fig. 79).—Style of cloth, worsted coating, 11 oz. per yard (finished cloth), 56 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/36's	Botany, various colours	14/4's	70 yd.	66 yd.	64 yd.	46¼ lb.
	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	2/36's	Botany, solid colour.	53 warp 56 {grey cloth	61 in.	59 in.	56 in.	44 lb.

Comparison of "Known" and "Unknown" Cloths :—

1. *Weight per Yard* (finished cloth).—Both cloths are cut 3 × 3 in. and when tested for weight per yard are found to be as follows :—

"Known" cloth = 11 oz. (56 × 36 in.).
"Unknown" cloth = 8·8 oz. „ „

2. *Count of Warp.*—18 warp threads 3 in. long from "known" cloth (2/36's) are equal in weight to 20 warp threads 3 in. long from "unknown" cloth, therefore :—

As 18 : 20 : : 2/36 : x = 2/40 *count of Warp in "Unknown" cloth.*

3. *Count of Weft.*—18 picks of weft (2/36's) 3 in. long from

" known " cloth are equal in weight to 25 picks, each 3 in. long from " unknown " cloth, therefore :—

As 18 : 25 : : 2/36's : x = 2/50's "*count of weft*" in "*unknown*" *cloth.*

4. *Threads per Inch in Loom.*—On examination it is found

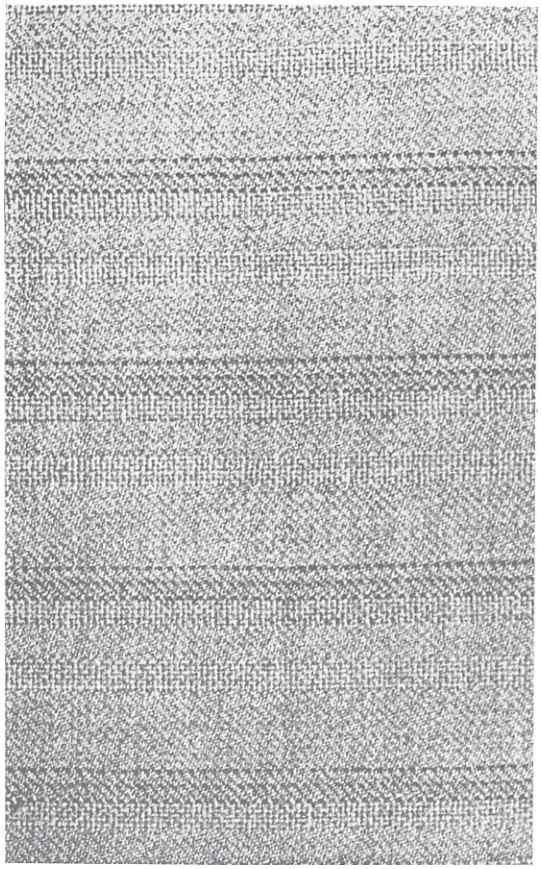

Fig. 79.—" Known " Cloth.

that in both structures there are 60 threads per inch. In the " known " cloth the 60 threads per inch are obtained from 56 in the loom, thus the threads per inch in " unknown " cloth will be :—

As 60 : 60 : : 56 : x = 56 threads per inch in " unknown " cloth.

5. *Picks per Inch in Loom.*—On the two cloths being compared for picks per inch, it is found that there are 60 in both cases. In

the "known" cloth 60 picks finished are obtained from 56 in the loom, therefore the picks per inch in "unknown" cloth will be :—

As 60 : 60 : : 56 : $x = 56$ picks per inch in "unknown" cloth.

Total Grey and Finished Weights of "Known" and "Unknown" Cloths :—

1. "*Known*" (*Grey Cloth*) :—

$$\text{Warp } \frac{3420 \times 70}{18 \times 560} = 23\tfrac{3}{4} \text{ lb.}$$

$$\text{Weft } \frac{56 \times 61 \times 66}{18 \times 560} = 22\tfrac{1}{4} \text{ ,,}$$

$$46 \text{ lb.}$$

2. "*Known*" (*Finished Cloth*) :—

11 oz. (56 × 36 in.) × 64 yds. = 44 lb.

3. "*Unknown*" (*Grey Cloth*) :—

$$\text{Warp } \frac{3420 \times 70}{20 \times 560} = 21\tfrac{1}{2} \text{ lb.}$$

$$\text{Weft } \frac{56 \times 61 \times 66}{25 \times 560} = 16 \text{ ,,}$$

$$37\tfrac{1}{2} \text{ lb.}$$

4. "*Unknown*" (*Finished Cloth*) :—

8·8 oz. (56 × 36 in.) × 64 yds. = 35·2 lb.

Particulars of "Unknown" Cloth :—

Example 2 (Fig. 80).—Style of cloth, worsted coating, 8·8 oz. per yard (finished cloth), 56 × 36 in.

Warp	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
	2 40's	Botany, various colours	14/4's	70 yd.	66 yd.	64 yd.	37½ lb.

Weft	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
	2/50's	Botany, solid colour	53 warp 56 { grey cloth	61 in.	59 in.	56 in.	35·2 lb.

Analysis of Standard Cloths without Resort to Calculations.—In the analysis of some standard cloths, the loom particulars may be obtained from the finished cloth without resort to calculations.

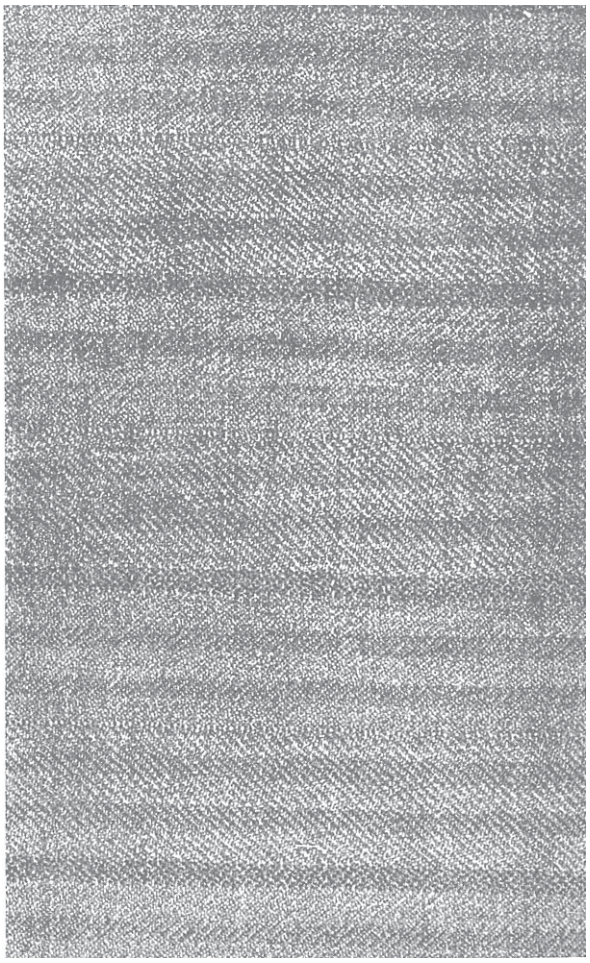

FIG. 80.—"Unknown" Cloth.

The maker of certain classes of goods composed of identical constituents and subjected to similar finishing treatments, recognizes that the variation of cloth dimensions from being in the loom to being finished is identical. A certain standard cloth

may be produced in many qualities, but in each quality the factors which control the shrinkage from loom to finished cloth dimensions are approximately alike. Consequently, by the application of experience or reference to tabulated particulars, the maker of a standard type of cloth may readily ascertain the particulars for reproducing an unknown cloth which is somewhat similar in its constituents.

A typical example is provided in the well-known union lustre dress fabric. In all cases this type of structure is composed of cotton warp, mohair, or lustre weft. The ground weave is usually of a plain ground character and in all instances these structures are submitted to a "bright" finish. Such a cloth (Fig. 81) is submitted to a maker of these goods for reproduction.

Method of Analysis.—1. *Count of Warp and Weft.*—These goods being produced from standard counts and qualities of warp and weft, and the maker being familiar with these, from examination is able to accurately estimate the count of warp and weft as follows :—

Warp = 2/100's cotton.
Weft = 1/26's mohair.

2. *Loom and Finished Cloth Dimensions.*—Table XXI (p. 146) indicates the loom, grey and finished cloth dimensions of twenty makes similar to this under consideration. These results indicate little variation and the averages are stated to be :—

50 in. loom width.	70 yds. warp.
49 ,, grey cloth width.	$60\frac{1}{4}$,, grey cloth.
44 ,, finished cloth width.	$67\frac{1}{2}$,, finished cloth.

There is a contraction in width from loom to finished cloth width of 12 per cent. The elongation from grey cloth to finished cloth length is also 12 per cent.

(*a*) *Width in Loom.*—If the finished cloth width is 44 in. the width in loom will be :—

As 88 : 100 : : 44 : x = 50 in. wide.

(*b*) *Length of Finished Cloth.*—When 70 yds. of warp per cut is employed, the grey length of cloth will be about $60\frac{1}{4}$ yds., consequently the finished length :—

As 100 : 112 : : $60\frac{1}{4}$ yds. : $x = 67\frac{1}{4}$ yds.

3. *Threads per Inch in Reed.*—The contraction from loom to finished cloth width is 12 per cent, consequently, as the threads

per inch in the finished cloth count 73, the same in the reed will be :—

As 100 : 88 : : 73 : $x = 64$ threads.

Fig. 81.—Figured Lustre.

or, as 50 in. in loom results in 44 in. wide of finished cloth, the threads per inch in reed will be :—

As 50 in. : 44 in. : : 73 in. : $x = 64$ threads.

4. *Picks per Inch of Warp and Grey Cloth.*—The finished cloth

counts 68 picks per inch, the picks per inch in grey cloth will be :—

As 100 : 112 : : 68 : $x = 76$ picks per inch grey cloth,

or these results may be obtained by taking into consideration the various lengths :—

70 yds. warp = 67 picks per inch.
$60\frac{1}{4}$,, grey cloth = 76 picks per inch.
$67\frac{1}{2}$,, finished cloth = 68 picks per inch.

(*a*) *Picks per Inch in Grey Cloth* :—

$60\frac{1}{4} : 67\frac{1}{2} : : 68 : x = 76$ picks per inch.

(*b*) *Picks per Inch of Warp* :—

As $70 : 67\frac{1}{2} : : 68 : x = 67$ picks per inch.

Weights of Grey and Finished Cloths :—

Grey Cloth :—

$$\text{Warp } \frac{3200 \times 70}{50 \times 840} = 5\frac{1}{3} \text{ lb.}$$

$$\text{Weft } \frac{67 \times 50 \times 70}{26 \times 560} = 16 \text{ ,,}$$

$21\frac{1}{3}$ lb.

Finished Cloth.—By standard weights the weight per yard is ascertained to be $4\frac{3}{4}$ oz. 44 × 36 in. $4\frac{3}{4}$ oz. × $67\frac{1}{2}$ yds. = 20 lb.

Example 1 (Fig. 81).—Style of cloth, mohair lustre, $4\frac{3}{4}$ oz. per yard (finished cloth), 44 × 36 in.

	Counts.	Material.	Reed.	Lengths.			Total Weight.
				Warp.	Grey Cloth.	Finished Cloth.	Grey Cloth.
Warp	2/100	Cotton	32/2's	70 yd.	$60\frac{1}{4}$ yd.	$67\frac{1}{2}$ yd.	$21\frac{1}{3}$ lb.

	Counts.	Material.	Picks per Inch.	Widths.			Total Weight.
				Loom.	Grey Cloth.	Finished Cloth.	Finished Cloth.
Weft	1/26	Mohair	67 warp 76 grey cloth	50 in.	49 in.	44 in.	20 lb.

CHAPTER XIII.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF FIBRES IN WOVEN FABRICS.

Method of Determining the Nature and Quality of Fibres.—The chief object of most cloth analysis is to determine the loom particulars for reproducing the sample of cloth submitted. In addition it is necessary to define the nature and quality of the fibre or fibres which constitute the threads of the fabric. There are four methods by which the nature and quality of fibres may be determined:—

1. Ordinary Observations.
2. Burning Tests.
3. Microscopic Examination.
4. Chemical Reaction.

General Observations.—From observations and the application of some experience and by the exercise of a reasonable amount of care and judgment, very reliable tests may be made in ascertaining the particular quality and type of fibre employed to produce woven fabrics. The method is to take from the cloth, threads of warp and weft, and unravel or untwist a number of each between the fingers and thumbs, in order that an examination of the fibres might be made. With the naked eye or assisted by means of a magnifying glass a bunch of fibres are examined—possibly by being drawn upon a black velvet board—and recognized to be one or another of the various textile fibres.

One experienced in wool yarns and cloths can readily estimate what particular quality of wool has been employed by noting the length, waviness, and fineness of the fibres, bearing in mind the same features of known qualities of wool.

Burning Tests.—A very simple method of discriminating between fibres of vegetable and animal origin is by the manner in which they burn.

Vegetable Fibres.—Cotton, linen, ramie, etc., ignite and

burn readily, with a bright smokeless and odourless flame, and will leave only a small amount of ash.

Animal Fibres.—Wool, hair, and silk are more difficult to ignite than vegetable fibres. From ignited wool the flame is more or less lifeless, and burns slowly, with the emission of a disagreeable odour, the residue forming itself into a black bead-like form or knob.

This result applies to silks which are practically free from adulteration or weighting material. For example, when a heavily weighted silk is ignited, instead of forming itself into small black beads or knobs, it burns, leaving a distinct ash which retains somewhat the shape of the original material.

It is evident, however, that the burning test can only be employed for material in bulk, and is of little value in determining the fibre constituents of a blend.

Microscopic Examination. — Testing materials by microscopic examination is a most valuable and reliable method, especially when the mechanical structure of the fibre has not been altered, during the processes of manufacture, as is usually the case in woven fabrics.

When fibres are placed under the microscope and examined, especially with transmitted light, and with powers varying from 20 up to 200 diameters, their appearance and distinctions will be clearly visible and may be compared with the well-known structures of :—

(*a*) *Wool.*—This fibre is easily distinguished, being practically always of a more or less cylindrical form. It is covered with rings or scales, with fine, smooth, or imbricated edges, which point from root to tip of the fibre. These scales differ much in form, regularity, and in size. There are also indications of a curl or curvature in the fibre. These peculiarities are always distinctive and enable wool to be at once differentiated from silk and other fibres.

(*b*) *Hair* differs in appearance from wool inasmuch as though it is usually covered with similar scales on the surface of the fibre, these scales are always more closely adherent to the shaft of the fibre and the edges are not turned outwards. Mohair, alpaca, vicuna, llama, cashmere, and other hairs all closely resemble each other in this respect.

(*c*) *Silk.*—The cultivated silk fibre derived from mulberry

silkworm has the appearance of a double stand of a clear, semi-transparent, lustrous, continuous fibre. Wild silks always exhibit a fibre which is much flatter and irregular, and is usually more striated on the surface in the direction of length. It is also larger in diameter than cultivated silks.

(*d*) *Artificial Silks.*—Viscose, imitation horse hair, etc. The artificial silk fibre under the microscope is very similar to silk. Chemically silk and artificial silk are very different, which is better disclosed by a burning or chemical test than by microscopic means.

(*e*) *Cotton: Ordinary,* microscopically presents the appearance of twisted collapsed ribbons, with more or less thickened edges, and exhibiting a wrinkled surface. The cross section reveals a central cavity with cloudy deposits.

Mercerized Cotton.—Mercerized cotton appears like silk to the naked eye, yet microscopic examination of the fibres determines the matter in case of doubt. When the yarn or cloth has been fully mercerized, the cotton fibre is fuller and almost void of the surface markings or twists which characterize ordinary cotton.

(*f*) *Flax, Hemp, and Jute.*—These fibres have a general similar appearance, consisting of a series of cells united together longitudinally and in the case of flax and hemp usually thickened at the point of juncture with a node or ring, which adds strength and rigidity to the fibre. In the case of jute, the nodes are generally absent, although the point of juncture of the multiple cells is very apparent.

Chemical Reactions.—By microscopic examination the nature of the material or materials can be ascertained, but not the quantity and proportions in which two materials might be present. Chemical reaction not only indicates the type of material but may also be employed to ascertain the proportion in which the materials are present.

From time to time many chemical tests have been given to the public for the purpose of discriminating between the various textile fibres, especially those of vegetable origin. As all vegetable fibres are of practically the same chemical composition—cellulose—it is very difficult to obtain, by means of a chemical agent, a distinguishing colour or feature in one fibre which the same agent does not impart in some degree to the other. Therefore before any reliable results can be obtained the application of some knowledge and experience of chemistry is essential.

Practically all the fibres employed in the manufacture of woven fabrics are of vegetable or animal origin, hence it will not be difficult to realize that the chemical reagents used as solvents for the fibres can be divided into two distinct classes :—

(*a*) Those employed as solvents for vegetable fibres.

(*b*) Those employed as solvents for animal fibres.

Chemical Reaction on Textile Fibres.—Table XXVI indicates the characteristic chemical reactions on the principal fibres, and by suitably employing these tests the various fibres may be easily distinguished from each other.

The reagents employed for the tests may be prepared as follows :—

1. *Madder Tincture.*—Extract 1 grm. of ground madder with 50 c.c. of alcohol and filter from undissolved matter.

2. *Fuchsine Solution.*—Dissolved 1 grm. of fuchsine (magenta) in 100 c.c. of water, then add caustic soda solution drop by drop until the fuchsine solution is decolorized : filter and preserve in a well-stoppered bottle. In applying the test with this reagent the mixed fibres are treated with the hot solution, then well rinsed, when the animal fibres will be dyed red and the vegetable fibres remain colourless.

3. *Zinc Chloride Solution.*—Dissolve 1000 grm. of zinc chloride in 850 c.c. of water, and add 40 grm. of zinc oxide, heating until complete solution is effected.

4. *Sodium Plumbate* (solution of lead in caustic soda).—Dissolve 5 grm. of caustic soda in 100 c.c. of water and add 5 grm. of litharge (PbO) and boil until dissolved.

5. *Caustic Soda.*—Dissolve 10 grm. of caustic alkali in 100 c.c. of water and filter.

6 and 7. *Sulphuric and Nitric Acid.*—The commercial concentrated acids are employed.

8. *Iodine Solution.*—Dissolve 3 grm. of potassium iodide to 60 c.c. of water and add 1 grm. of iodine. Dilute this solution before using with 10 parts of water. When the reaction is employed in connection with sulphuric acid, the latter consists of 3 parts of concentrated sulphuric acid, 1 part water and 3 parts of glycerine. The glycerine has the effect of preventing injury to the fibre.

Note.—In Nos. 1, 2, 3, 4 and 5 the material is firstly gently warmed and finally boiled for a short time. Nos. 6 and 7 must be used cold.

TABLE XXVI.

CHEMICAL REACTION ON TEXTILE FIBRES.

	Wool.	Silk	Cotton.	Linen.
Madder tincture	*Nil*	*Nil*	Colours yellow	Colours orange
Fuchsine solution magenta	Colours red	Colours red	*Nil*	*Nil*
Zinc chloride solution	Partially dissolves	Dissolves	Undissolved	Undissolved
Sodium plumbate	Black precipitate	No precipitate	*Nil*	*Nil*
Caustic soda	Dissolves slowly	Dissolves gradually	Colours faintly	Colours faintly
Sulphuric acid	Dissolves when heated	Dissolves quickly when heated	Quickly dissolves	Quickly dissolves
Nitric acid	Colours yellow dissolves slowly	Colours yellow and rapidly dissolves	*Nil*	Dissolves
Iodine solution	—	—	Colours yellow	Colours yellow

The fibres are moistened first with the iodine solution and then with the sulphuric acid solution.

Distinguishing Test for Flax and Jute.—Moisten the two samples with an acidulated alcoholic solution of phloroglucine. Jute will stain an intense reddish-brown and flax will remain practically unchanged (a slight yellowing may be noticed).

Note.—The stain is not permanent—therefore a lighter colour will result in the course of time.

Loading Worsteds and Woollens.—It frequently happens that the cloth finisher is instructed to deliver a cloth after finishing the same weight as prior to finishing. As previously pointed out, fabrics composed of wool fibre lose a certain amount of weight during the finishing processes. It is obvious that this loss in weight can only be made up by adulteration or artificial means. A suitable example is provided in following botany worsted twill cloth submitted to a " clear " finish :—

Average of 20 *pieces* :—

$58\frac{3}{7}$ lb. Weight of grey cloth.

$59\frac{5}{7}$,, ,, Finished cloth.

The finished fabric shows an increase in weight of over one pound. This difference, however, does not signify the actual amount of loading. As " clear " finished worsted goods lose about 6 per

cent in weight, the finished weight of these goods—if unadultered —should be: $58\frac{3}{7}$ lb. – 6 per cent = 55 lb. Hence the amount of loading is from 55 lb. to $59\frac{5}{7}$ lb., which is equal to about a 10 per cent adulteration.

Wool fabrics by reason of their great hygroscopic properties are usually weighted by being impregnated with hygroscopic substances such as magnesium chloride. Other agents employed for filling worsted and woollen goods are: Zinc chloride, magnesium chloride, magnesium sulphate, glue, gelatin, dextrin, starch, and water glass (alkali silicate).

Zinc chloride is a most useful loading agent on account of it possessing great hygroscopic properties. When a wool fabric has passed through solutions containing this agent the chloride is absorbed and permanently retained in form of liquid or moisture, and a slippery handle imparted.

Distinguishing Tests for Loaded Wool Cloths.—(*a*) A rough test for a weighted cloth is to wet the fabric with a sponge on one side. If a deliquescent material has been employed to retain moisture, the water will sink in at once: whereas with unadulterated cloth the moisture will remain on the surface in the form of beads and will take a considerable time to penetrate the interior.

Although this test may be used as a guide, a more reliable one may be carried out on the following lines :—

(*b*) A suitable size of the suspected material should be boiled for half an hour in water made slightly acid with hydrochloric acid, which will extract the filling. The water should now be squeezed off, decanted and placed on one side. After a second extraction in fresh water, the two liquors should be carefully evaporated down to perfect dryness, when whatever substance has been employed, will be left behind as a solid residue.

If possible distilled water should be employed for extracting.

Tests for the Weighting and Dressing of Cotton, etc., Goods.—Weighting and dressing of cotton goods is often carried out with addition of starches, soaps, softening, and antiseptic agents.

One of the most common filling agents is magnesium chloride, and during finishing this compound is converted into a basic salt which is no longer soluble in water.

I. A weighed quantity of cloth is extracted in a Soxhlet apparatus with ether—this removes fats, waxes, and zinc chloride. The ether extract is transferred to a separating funnel, and washed twice with dilute hydrochloric acid to remove the zinc chloride.

The ethereal solution is transferred to a small weighed flask, the ether distilled off, and the residue dried at 105° C. for about two hours. The gain in weight of the flask represents fat or wax.

II. The zinc chloride is obtained by ashing about 5 grams of the cloth in a small weighed crucible; the ash is washed well with distilled water, and the zinc oxide collected on a filter paper; the filter paper and contents are transferred to a weighed crucible, ashed, and the gain in weight multiplied by 1·7 to obtain the weight of zinc chloride.

III. Magnesium chloride is estimated similarly to zinc chloride; after ashing, the ash is treated, when cold, with two or three drops of nitric acid, the crucible covered with a lid and heated in a fume chamber to expel acid fumes. The residue is then filtered and treated as in II. The weight of the ash multiplied by 2·37 gives the weight of magnesium chloride.

IV. A weighed quantity of the sample after extraction with ether in a Soxhlet is steeped for a few minutes in cold 1 per cent caustic soda, well washed, boiled with 2 per cent hydrochloric acid until no further change takes place; wash well with distilled water, dry, and weigh. Loss = size, organic and inorganic weighting. If the weight of the cotton is required in the conditioned state, 8 per cent of its weight must be added.

Cotton and wool in union in presence of magnesium chloride requires treating with boiling 2 per cent hydrochloric acid to remove the magnesium salt. A weighed quantity, about 5 grams, is boiled with alcohol to remove soap; the cloth is then boiled twice with 200 c.c. of 2 per cent hydrochloric acid, and after each treatment well washed with distilled water, boiled with alcohol; it is then dried at 105° C. and weighed. Loss in weight = moisture + filling.

The piece is now boiled with 10 per cent caustic soda, well diluted with water and filtered; the cotton which remains on the filter is well washed with water, then with a little dilute acetic acid, dried at 100° C. and weighed.

For cotton in the conditioned state add 10 per cent; about 2 per cent of the cotton is lost during boiling with caustic soda.

The weight of the dried cotton subtracted from the weight of the dried cotton plus wool gives dry wool; to this add 15 per cent for conditioned wool.

Cotton and silk unions. On account of high weighting in silk the percentage is best obtained by separating the separate fibres

of cotton and silk from a weighed quantity of the material. The fibres are weighed, and in the case of the silk, the real weight of silk is found by burning the silk in a weighed crucible and subtracting the weight of the ash from it. In the case of tin and iron fixed on silk as tannate, the weight of tin tannate is found by multiplying the weight of the ash by 3·33, and in the case of iron as tannate by 7·2.

If the union cannot be separated into separate fibres, the silk is dissolved from the union, after removing as much filling as possible by alternate boiling with 1 per cent caustic soda and 2 per cent hydrochloric acid, by steeping in a cold ammoniacal nickel solution for two to three minutes, washing with water, boiling with 2 per cent hydrochloric acid, washing with water, drying and weighing.

The ammoniacal nickel solution is prepared from 25 grams of nickel sulphate dissolved in 100 c.c. of water; to this solution caustic soda is added, in small quantities at a time, until a drop of the solution gives a pink colour with phenol phthalein. The solution is diluted to 125 c.c. and mixed with an equal bulk of concentrated ammonia.

Loading and Filling in Silk Fabrics.—The practice of adding to the weight of silk goods in the dyeing and finishing operations has become so common, that it is necessary, in silk cloth analysis, to ascertain the amount of fibre present and the amount and character of the loading material.

Determination of Adulteration and Filling. Physical Examination.—Whether a fabric loaded or filled on one side or impregnated will be detectable at once. Goods containing such loading agents as starch will be recognized, as such fabrics, if rubbed between the fingers, will lose their stiffness. By the aid of a magnifying glass it can be ascertained whether the covering of filling is merely superficial or penetrates the cloth.

Determination of Moisture.—1. Weigh a suitable size of cloth in grains.

2. (*a*) Place the sample for about half an hour in drying oven.

(*b*) Place the sample in a desiccator to cool down.

(*c*) Weigh the sample in grains.

The difference between the first and final weighings indicates the amount of moisture. When the difference is more than the standard regain of moisture, a degree of loading may be suspected, since loading agents possess great hygroscopic properties.

Determination of Extraneous Substances.—Test 1.—1 and 2 as in determination for moisture. 3. Expel the extraneous substances and ascertain the absolute dry weight of the pattern by :—

(*a*) Treating the sample at boiling heat with malt extract.

(*b*) Rinse thoroughly in several changes of water.

(*c*) Dry in oven and cool in desiccator.

(*d*) Weigh in grains.

The difference between the weights of 2 and 3 indicate the amount of extraneous matter. As a few insolubles may remain, the sample is boiled for a short time in dilute acid and reweighed after drying.

Test 2.—As in Test 1 employing a 5 per cent solution of ammonia in place of malt extract and boiling for half an hour.

Ether Test for Insolubles.—The material to be tested is washed three times in ether (enough ether to saturate the material). Pour the ether containing the insolubles in a separate flask. Although washing three times in ether is the regular thing, more or less washes may be employed according to the amount of insolubles. The flask containing the ether plus the insolubles is then shaken up with an equal quantity of water. The water being allowed to settle brings down with it the insolubles. This process should be repeated until the ether is clear, and when completed the water and insolubles are placed into a paper filter (which has previously been weighed) and allowed to drain, leaving the insolubles on the paper. The additional weight on the paper is employed to obtain the percentage of insolubles.

Net Fatty Matters by the Ether Process.—With a syphon arrangement ether is allowed to soak the material to be tested for one and a half hours. At the end of this time the flask containing the ether and net fatty matters is distilled and the residue is the fatty matter contained in the material. As a precaution the flask is placed in a hot oven to evaporate any ether remaining. The net fatty matter is calculated on the additional weight of the flask.

To Ascertain the Amount of Cotton and Wool in Mixed or Union Cloths :—

Method 1.—When the whole or part of the warp is composed of cotton threads and the weft of wool or vice versa.

(1) Weigh a suitable size of pattern in grains.

(2) Ether wash.

(3) Extract all impurities such as dirt, grease, and free dye-ware, by boiling.

(4) Ascertain the absolute dry weight of the sample by :—

(*a*) Placing the sample for half an hour in a drying oven.

(*b*) Place the sample in a desiccator to cool down.

(*c*) Weigh the sample in grains.

(5) Separate the cotton threads from the wool and weigh each material separately.

Example.—A sample is composed of cotton warp and wool weft.

Grains.

Weight of sample before extracting impurities and drying = 12·6
,, ,, after ,, ,, ,, ,, = 10·8
Amount of moisture and impurities = 1·8

∴ 12·6 : 1·8 : : 100 : 14·3 per cent of moisture and impurities.

Weight of cotton warp threads (dry) = 4·0 grains.
,, wool weft ,, ,, = 6·8 ,,
10·8 grains.

∴ 10·8 : 4 : : 100 : 37 per cent of cotton.

∴ 10·8 : 6·8 : : 100 : 63 per cent of wool.

To Ascertain the Amount of Silk and Cotton in Mixed or Union Cloths. Separation of Cotton from Silk :—

Method.—(1), (2), (3) as in Method 2 (separating cotton from wool).

(4) Dissolve the silk and ascertain the absolute dry weight of the residue by :—

(*a*) Boiling the sample in a solution containing 10 per cent of caustic soda until the silk dissolves.

(*b*) Rinse thoroughly in several changes of cold water.

(*c*) Neutralize the caustic soda and wash thoroughly in hot water.

(*d*) Dry in oven and cool in desiccator.

(*e*) Weigh in grains.

(5) In calculating the percentage, add 2 per cent to the weight of cotton on account of loss which occurs in the soda bath.

Example.—A sample of cloth is composed of a warp, part of which is cotton and silk twist the remainder of the cloth being cotton.

Grains.

Weight of sample before extracting impurities and drying = 10·6
" " after " " " " = 9·2
Amount of moisture and impurities = 1·4

∴ 10·6 : 1·4 : : 100 : 13·2 per cent of moisture and impurities.

Weight of residue (cotton) after treating with caustic soda and drying } = 8 grains.

∴ 9·2 : 8 : : 100 : 87 per cent of residue (cotton).
2 per cent loss incurred in soda bath.
89 per cent of cotton.
11 " " " silk.

Method 2.—When the yarns of the fabric are a mixture of cotton and wool fibre.

(1), (2), and (3) as in the first method.

(4) Dissolve the wool and ascertain the absolute dry weight of the residue by :—

(*a*) Boiling the sample in a solution containing 10 per cent of caustic soda, until the wool dissolves.

(*b*) Wash thoroughly in several changes of cold water.

(*c*) Neutralize the caustic soda and repeat (*b*).

(*d*) Dry in oven and cool in desiccator.

(*e*) Weigh in grains.

5. In calculating the percentage, add 2 per cent to the weight of cotton, on account of loss which occurs in the soda bath.

Example.—A sample of cloth is composed of cotton and wool mixed yarn.

Grains.

Weight of sample before extracting impurities and drying = 13·3
" " after " " " " = 11·5
1·8

∴ 13·3 : 1·8 : : 100 : 13·5 per cent of moisture and impurities.

Weight of residue (cotton) after treating with caustic soda and drying } = 5 grains.

∴ 11·5 : 5 : : 100 : 43·5 per cent of residue (cotton).
2 " loss incurred in soda bath.
45·5 per cent of cotton.
54·5 " of wool.

Separation of Silk and Wool.—These fibres may be separated

by boiling in hydrochloric acid, in which the silk is readily soluble, whilst the wool merely swells up.

Removing Rubber from Rubbered Waterproof Cloth.—Steep the sample for about fifteen minutes in benzine, which causes the rubber to slightly swell and become soft. The rubber may then be scraped off with a knife.

Note.—The above result does not give an absolutely clean cloth, owing to the rubber penetrating into the interstices of the cloth and also that vulcanized rubber will not dissolve. The cloth, however, may be so cleaned that it can be easily analysed.

Fastness of Colour.—Cut two patterns and have ready boiling solutions of 10 per cent ammonia and 10 per cent sulphuric acid. Place the patterns into these solutions for one minute. Wash thoroughly in cold water and dry. Should the colour be altered to any great extent the colour of the cloths may be stated as " not fast ".

Nitric Acid Test for Indigo.—A test applied to cloths of navy blue shades, to detect whether they have been dyed with indigo, is to drop on the fabric some fairly strong nitric acid, allowing the acid to soak in. After washing and drying the characteristic spot for pure dyed indigo is of a yellow colour with a distinct green rim. This kind of spot, considering also the tone of the colour of blue, is taken by many cloth merchants as a sufficient guarantee that the cloth is indigo dyed; by practice and experience, the bloomy appearance of the colour, together with the nitric acid spot, the cloth under inspection can be judged fairly accurately as to whether it has been dyed with indigo or not.

This test is by no means an absolutely accurate one, because many low qualities of indigo when dyed upon the cloth, result in the nitric acid producing a reddish-brown spot, in which the green rim in many cases is entirely absent. Further, indigo vat dyeing is such that it is impossible to dye to certain shades of blue by indigo alone. In these cases the goods have to be what is termed " topped " with another colour to bring them up to the requisite shade. When such cloths be spotted with nitric acid, the result will not be the yellow spot of indigo, but the spot will be the result of the action of the nitric acid on the " topping " colour. There have been many cases where goods have been refused by the merchant, because the characteristic spot for indigo has not

been the result of the nitric acid test, the merchant taking it for granted that the fabrics were not indigo dyed, whilst, as a matter of fact, they possessed a good bottom of indigo and are simply " topped " with other colouring matter to bring them up to shade. In the dyeing of these goods, however, the dyer can evade this test by a little skilful manipulation, and cause the dye on the cloth to produce with nitric acid the requisite spot.

As a matter of fact, if a merchant orders some goods to be indigo dyed, and relies solely for a test on the nitric acid spot, it is quite possible for the dyer to dye the goods with other materials which will give a most typical indigo spot, while the goods have no trace of indigo on them. The only reliable method of testing indigo dyed cloth, is to place it in the hands of a colour chemist who, by a few simple tests and an application of his own experience, will quickly detect whether the sample of cloth is indigo dyed or not and to what extent.

Tests for Indigo Dye.—*Test* 1. (1) Cut a few samples into half inch squares and place into test tube.

(2) Barely cover the samples with glacial acetic acid, and boil for two minutes and then allow to cool.

(3) Add water until the test tube is three quarter full and then add some methylated spirit ether SP 720 and shake up.

When this mixture is allowed to settle, it will be found that the water and acid are in the bottom of the tube and the ether floating on the top with the indigo (if any) situated between the two, possessing a flaky appearance.

Test 2.—Boil a small quantity up in a test tube containing chloroform ; should indigo be present a light blue colour will be formed.

Test for Mercerized Cotton.—A solution of iodine in saturated potassium iodide solution, colours both ordinary and mercerized cotton a deep brown.

On washing with water mercerized cotton changes to a blue black, which fades very slowly on long washing, whereas ordinary cotton rapidly becomes white on washing.

Note.—For further details of indigo testing consult the recently published research of Green, Gardner, Lloyd & Frank in the " Journal of the Textile Institute ".

CHAPTER XIV.

THE COSTING OF WOVEN FABRICS.

To give a clear idea of the unit cost of producing worsted and woollen fabrics is a very difficult matter. In the case of producing cotton goods, the material, machines, and processes are so standardized, and uniform wage lists compiled by organizations representing the manufacturers and the workers, that the costing of cloths is very much simplified. In the manufacture of wool fabrics, there is not only a great difference between the two branches, i.e. woollen and worsted, but in each case there is a wide variation in methods and prices paid for commission work and to the workers.

There is a great variety of materials employed in the production of wool fabrics, and great variation in qualities and proportions of mixture of these materials, with consequent variation of cost. As neither the employers nor employees are strongly organized, there is an absence of any universal wage lists. Certain sections of the trade are able to make certain classes of goods more profitable than others, and in consequence a weaver earns more money in one class of trade than another. There is a difference in the prices paid in mills of different localities manufacturing the same class of goods, hence the weaver in one town earns more money than the weaver of a neighbouring town. Frequently there is a considerable difference in the prices paid in mills of the same town manufacturing the same cloths.

Conditions of and Costing in the Bradford Textile Trade.—The textile trade of Bradford has divided itself up into sections, each making a speciality of its own particular stage of manufacture. There is (1) the wool merchant, (2) the comber or top-maker, (3) the spinner, (4) the weaver or manufacturer, (5) the dyer and finisher, (6) the merchant. Of these the manufacturer or the merchant must be considered the chief agent in the cloth

manufacture. Each of these sections has a separate staff for administration and selling, and makes its own charges for profit and financing.

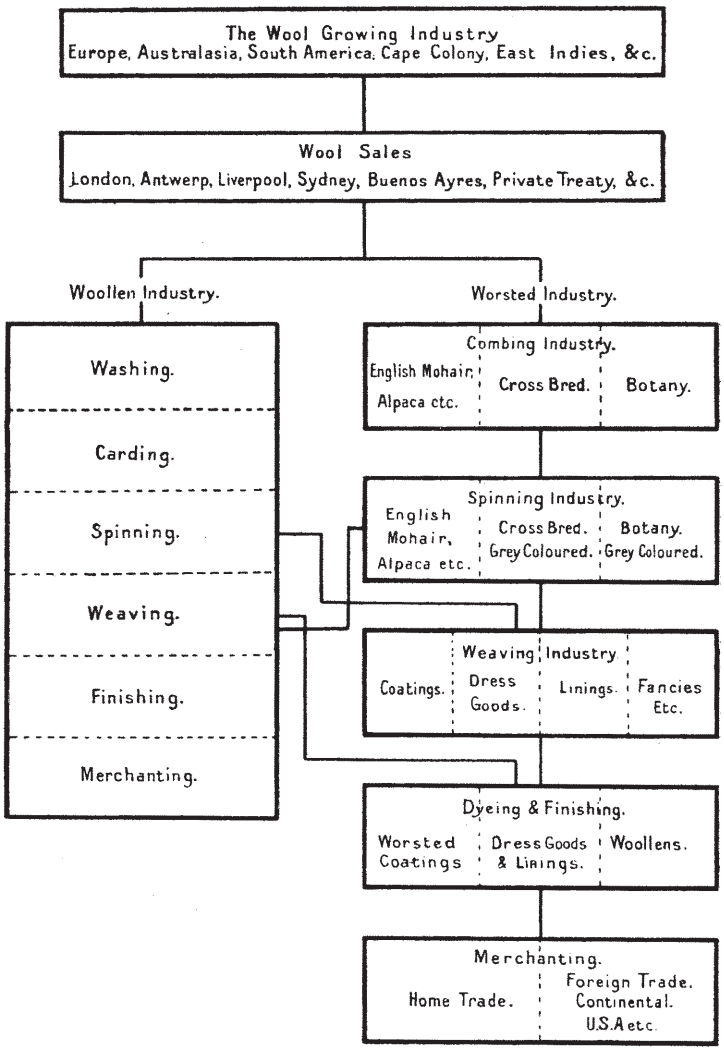

FIG. 82.—Organization of the woollen and worsted trades.[1]

Thus the items which enter in the costing of cloths are :—

[1] From "Textiles," published by Messrs. Constable & Co., London.

1. Cost of yarns (Lists 1*a*, *b*, *c*).
2. ,, ,, warp dressing (List 2).
3. ,, ,, looming, sleying, and twisting in (List 3).
4. ,, ,, weaving (List 4).
5. ,, ,, burling and mending (Lists 5*a* and *b*).
6. Other expenses involving:—
   - (*a*) Interest and sinking fund.
   - (*b*) Repairs.
   - (*c*) Gas and insurance.
   - (*d*) Wages for loom tuning, taking in, weft and grey room expenses. (Lists 7*a* and *b*).
   - (*e*) Depreciation.
   - (*f*) Miscellaneous expenses.
   - (*g*) Cost of room and power (List 6).
7. Cost of dyeing and finishing (Lists 8*a*, *b*, *c*, *d*).

Note.—As previously stated there is a variation in the prices paid for the different classes of work. The tabulated prices given can be considered the average paid for the various types of work.

For price lists employed in other localities for the same and other types of work, see appendix.

Cost of Material. (Yarns).—The prices of yarn are so liable to variation, and the price up to date can be so readily obtained, that there is no advantage to be gained by inserting here lengthy lists, but the following particulars will at least be useful in ascertaining the cost of worsted yarns when only the price of combed top is available.

List 1a. To Estimate the Price of Yarn Spun from a Botany Top:—

Standard.—1/40's grey; price of top per lb. + 7d. = price per lb. of yarn.

Variations:—

½d. per lb. less for every four counts from 40's to 32's.

¼d. ,, ,, ,, ,, ,, ,, 32's to 20's.

Other lower counts the same as 20's.

½d. per lb. more for every four counts from 40's to (say) 52's.

For other higher counts there are special prices.

1/40's colours and mixtures = price of top per lb. + 1s. = price per lb. of yarn.

1/40's black = price of top per lb. + 11d. = price per lb. of yarn.

Two-fold Yarns.—Price per lb. for single yarn + ¾d. for doubling.

Coloured Twists.—1d. per lb. more than solid colours.

Marl Yarns.—2d. per lb. more than solid colours.

Contracts.—Over 350 lb., 1d. per lb. less. Over 600 lb., 2d. per lb. less.

List 1b. To Estimate the Price of Yarns Spun from Crossbred, Lustre, and Mohair Tops.

(*a*) *Cap-Spun Yarns.*—Standard 1/16's : price per lb. of top + 2½d. = price per lb. of yarn.

For higher counts than 1/16's add ⅛d. per count up to 1/40's.

(*b*) *Flyer-Spun Yarns.*—Standard 1/16's : price per lb. of "top" + 3d. = price per lb. of yarn.

For higher counts than 1/16's add ⅛d. per count up to 1/24's and ¼d. per count from 1/24's to 1/40's.

(*c*) *Ring-Spun Yarns.*—In crossbreds, ring-spun yarns are being substituted for flyer-spun yarns at a price midway between the above "flyer" and "cap" spun yarn prices—say 2¾d. added to price of top for 1/16's counts ring spun.

Two-fold Yarns.—¾d. per lb. more than singles.

Melange Yarns.—Add 1s. to price per lb. of "top" for 1/30's counts.

Note.—The well-known 1/30's demi-lustre flyer-spun yarn is often spun at 1s. 3d. per gross hanks, i.e. 3⅛d. per lb. This indicates the divergence from above prices (1/30's would be 5½d.) brought about by big weight orders, contracts, etc.

Woollen Yarns.—Owing to the fact that almost every producer of woollen cloths spins his own yarns, costing is most varied and complicated. There is little exaggeration in saying that woollen yarns may be bought at any price from 6d. to 3s. or even more per lb. according to the materials combined and the counts spun to. Perhaps the best method of indicating the method of costing a woollen yarn is to give an example :—

List 1c. The Cost of 12 Skein (Two-fold 24 Skein) Woollen Warp :—

(*a*) *Price of Materials :—*

		s.	d.	
6 lb. wool, at 1s. 3d. (scoured) .	=	7	6	
6 ,, mungo, at 8d. . . .	=	4	0	
8 ,, cotton, at 6d. . . .	=	4	0	
20 lb. – 5 per cent for waste = 19 lb.	=	15	6	= 10d., price of the blend per lb.

(*b*) *Cost of Production* :—

2s. per wartern (6 lb.) = 4d. per lb. for carding { (condensing to 12 skein).
1s. 2d. ,, ,, = 2½d. ,, ,, spinning (to 24 skein).
6d. ,, ,, = 1d. ,, ,, twisting.

7½d. = 7½d. per lb., cost of production.

Thus, 12 skein (two-fold 24 skein) woollen warp costs 1s. 5½d. per lb.

The Cost of 12 Skein (Single) Woollen Weft:—

(*a*) *Price of Materials* :—

		s.	d.
4 lb. of botany noil, at 1s. 2d.	=	4	8
12 ,, mungo, at 4d.	=	4	0
4 ,, cotton, at 6d.	=	2	0
20 lb. – 10 per cent. = 18 lb. at		10	8 = 7d. per lb.

(*b*) *Cost of Production* :—

9d. per wartern (6 lb.) = 1½d. per lb. for carding (condensing to 6 sk.).
9d. ,, ,, ,, = 1½d. ,, ,, spinning

3d. per lb., cost of production.

Thus, 12 skein (single) woollen weft costs 10½d. per lb.

The chief points to note in the above are : (1) the predominance of wool and cotton in the warp yarn calculation to spin to the 24 skein, as against a large proportion of mungo in the weft calculation to spin only to 12 skein; (2) owing to the poorer material in the weft there is more waste; (3) the extra prices for condensing and spinning in the case of the warp yarn.

Note should be made that the wool is calculated upon the cost scoured: thus, the wool here given might be taken at 7½d. greasy, and, losing 8 lb. in 16 lb. in yolk, etc., thus costs just double.

Preparation for the Loom.

Evidently the first additional expense to the actual cost of the materials will be incurred in preparing a warp for the loom, i.e. in winding, warping, sizing, dressing, twisting-in, looming, and sleying.

Winding.—This is necessitated by the anxiety of the manu-

facturer to deal with pure yarn alone; the difficulty of estimating the tare, should the yarn be purchased upon cops or paper tubes, and the difficulty of estimating and returning the tare if spun upon bobbins, resulting in most manufacturers buying in the hank and winding for themselves, the extra cost being reckoned at ½d. to 1d. per lb. There has been a tendency of late to spin or twist upon bobbins of a stable weight, thus rendering the estimation of yarn more stable; but there is still the difficulty in returning the tare.

Yarns may usually be obtained in the form required, from the spinner; but the foregoing considerations tend to render every manufacturer his own winder for weft yarns. In both the ordinary cotton and worsted trades the warp yarns are purchased in the warp form at no additional expense, while in some cases they may also be obtained warped, sized, and beamed on to the manufacturer's own beam, at a slightly increased expense.

Warping.—This is effected in so many different ways that it is practically impossible to estimate the cost save to given particulars. The various methods may be summed up as follows :—

(1) Warping of solid colours, usually effected by the spinner.

(2) Two or more warps made by the spinner, but dressed by the manufacturer to pattern.

(3) Warps made by the manufacturer to pattern upon one of the many machines used in the trade.

Sizing or Slashing varies considerably in the wool and cotton trades. In the former trade animal or vegetable size is put on according to the roughness or tenderness of the warp to make the yarn weave well, being extracted in the finishing process : in the latter case size is put on not only to facilitate weaving, but also to weight the cloth. Thus the percentage of size to cloth may be taken as follows :—

For a light size	10 per cent.
For a medium size	50 ,, ,,
For a heavy size	200 ,, ,,

According to the price and weight of the various ingredients used in the composition of the size, and the percentage, will the cost, then, be estimated.

Warp Dressing.—The object of dressing is to ensure that the threads of warp all weave at equal tensions; to clear tangled places; and, generally, to put the threads in the best possible

condition for weaving. Possibly no other operation in manufacturing is subjected to so much variation as this one, according to the various classes of materials dealt with, and also according to the particular ideas of the manufacturer.

Dressing is often effected along with warping and sizing, on machines specially constructed for the work. With warps received in the "ball form," however, dressing and beaming imply extra labour.

For assistance in costing, the following warp dresser's price list is given. This list is worked to by a commission warp dresser, and compiled so as to be applicable to almost all types of warps which are dressed in connection with the trade of Bradford.

Price List 2. Warp Dressing (Double Twist Coloured Warps).

No. of Colours.	Number of Threads.											
	10 / 600	601 / 1200	1201 / 1800	1801 / 2400	2401 / 3000	3001 / 3600	3601 / 4200	4201 / 4800	4801 / 5400	5401 / 6000	6001 / 6600	From to
1	1½d.	1½d.	3d.	4½d.	7¼d.	10d.	12¾d.	17d.	19¾d.	22½d.	25¼d.	per cut
2	1½d.	3d.	4½d.	6d.	8¾d.	11½d.	14d.	18½d.	21d.	24d.	26¾d.	,, ,,
3	3d.	4½d.	6d.	7½d.	10¼d.	13d.	15½d.	19¾d.	22½d.	25½d.	28d.	,, ,,
4	4d.	5½d.	7d.	8½d.	11¼d.	14d.	17d.	21d.	24d.	26¾d.	29½d.	,, ,,
5	5½d.	7d.	8½d.	10d.	12¾d.	15½d.	18¼d.	22½d.	25¼d.	28d.	31d.	,, ,,
6	7d.	8½d.	10d.	11½d.	14½d.	17d.	19¾d.	24d.	26¾d.	29½d.	32½d.	,, ,,
7	8½d.	10d.	11½d.	13d.	16¾d.	18¼d.	21d.	25¼d.	28d.	31d.	33¾d.	,, ,,

Starting per Warp :—

From 10 to 1800 threads 1s. 6d.
,, 1801 ,, 3000 ,, 2s.
,, 3001 ,, 4800 ,, 2s. 6d.
,, 4801 ,, 6600 ,, 3s.

Extras :—

1. 1d. per cut for single twist warps.
2. 1s. per warp above 42 in. wide.
3. Cutting warp in two (in dressing frame) 4d. per 1000 ends.
4. 2d. per cut. Running back.
5. For mercerized cotton 25 per cent on above prices.
6. 1s. per warp for odd end patterns.

Deductions.—For grey warps, 1d. per cut off above prices.

Warp Dressers' Cut.—55 yds. – 28 yds. above a number of cuts is an additional cut.

Time Work—7½d. per hour.

Twisting-in, Looming, and Sleying.—Having sized, dressed, and beamed the warp, it must now be drawn through the mails in the shaft or harness.

There are two methods of effecting this—firstly, by twisting or tying in the fresh warp to the threads of a previous warp, left in the mails with this idea; secondly, by drawing the threads separately through the mails of the shafts or harness.

Sleying is carried out after twisting-in or looming by passing the warp threads through the reed according to requirements.

It is, perhaps, needless to point out that the twisting-in, looming, and sleying wage covers a number of pieces according to the cuts in the warp, and should be divided by that number.

List 3. Price List for Twisting-in, Looming and Sleying.

(*a*) *Twisting* (*In Twisting Frame*) :—

1. Plain, double twist, cotton, worsted and silk	5½d.	per 1000 threads.
2. Single twist, stripes, artificial silk, fancy worsted, mercerized cotton, finer counts than 2/70's for poplins and venetians	6d.	,, ,, ,,
3. Under 2/20's to 2/11's plain .	7½d.	,, ,, ,,
4. Under 2/20's to 2/11's stripes .	8d.	,, ,, ,,
5. Polished cotton and glissades .	9d.	,, ,, ,,
6. 2/10's and under. To be loomed.		

Twisting-in *at the loom*, 1d. per 1000 threads extra on above.

(*b*) *Sleying* :—

1. Over two in a dent . . .	4d.	per 1000 threads.
2. One in a dent (all dents to count)	9d.	,, ,, ,,

(*c*) *Looming* (*Drawing-in and Sleying*) :—

1. *Ordinary healds* :—

Straight draft up to 8 shafts	1s.	per 1000 threads
,, ,, 9 ,, 12 ,,	1s. 1d.	,, ,, ,,
,, ,, 13 ,, 16 ,,	1s. 2d.	,, ,, ,,
Drafted up to 8 shafts .	1s. 2d.	,, ,, ,,
,, 9 ,, 12 ,, .	1s. 3d.	,, ,, ,,
,, 13 ,, 16 ,, .	1s. 4d.	,, ,, ,,

Extras :—

Above 16 shafts .	½d. per shaft per 1000 threads.
Varnished healds . . .	2d. ,, ,, ,,
Wire healds	4d. ,, ,, ,,

All stripes to be paid, the same rate as drafted. If sleyed one in a dent, 4d. per 1000 threads on above.

2. *Jacquards :—*

Ordinary mails, 8 in a row	1s. 2d. per 1000 threads.
,, ,, 12 or 16 in a row	1s. 5d. ,, ,, ,,
Wire mails, 8 in a row .	1s. 5d. ,, ,, ,,
,, ,, 12 or 16 in a row	1s. 8d. ,, ,, ,,

If sleyed one in a dent, 4d. per 1000 threads extra.

3. *Side Threads (Edges) :—*

Ordinary healds . . .	2d. per 100 threads.
Varnished healds . . .	2½d. ,, ,, ,,
Wire healds and jacquards .	3d. ,, ,, ,,

If sleyed one in a dent ½d. per 100 extra.

4. *Extras :—*

Rollers up to 400 threads .	4d.
Rollers over 400 threads .	8d.
Two beams	1s.
Broken lease	1d. per 1000 threads in warp. 3d. as minimum.
Casting out up to 10 setts .	2d.
,, ,, above 10 up to 30 setts	4d.
Casting out above 30 setts .	6d.
Two pairs of rods in the warp with pattern to make . .	1s.

Heald dressing to be time work.

(*d*) *Douping :—*

1. Up to $\frac{1}{10}$ of threads in warp . . .	3d. per 1000 threads extra on total.
2. Over $\frac{1}{10}$ and up to $\frac{1}{6}$ of threads in warp .	4½d. ,, ,, ,, ,,
3. Over $\frac{1}{6}$ and up to $\frac{1}{3}$ of threads in warp .	6d. ,, ,, ,, ,,

4. Over $\frac{1}{3}$ of threads in
warp . . . 1s. per 1000 threads extra on total.
Re-douping as above, with sleying extra.

(*e*) *Ordinary Time Rate*, 7d. per hour.

(*f*) *Day men*, 8d. per hour.

Cost of Weaving.—If there is variation in the foregoing items, still more will there be cause for variation in the cost of weaving. The following are the principal modifying influences :—

1. Breadth of loom, or reed space.
2. Number of looms, attended to by one weaver.
3. Speed of looms.
4. Type of loom, whether plain or box, and also whether tappet, dobby, or jacquard loom.
5. Type of work.
6. District in which cloth is to be woven.

Of course all these depend more or less upon one another, but some idea of the complexity of the question may be gained from the perusal of the above.

Payment is made in the several great centres of the weaving industry in many ways: thus, while the worsted trade follows the Lancashire system, based upon the price per pick per $\frac{1}{4}$ in. to the standard given in the following lists, the woollen trade has a system of its own, based upon the price per string of 10 feet. Again, when dealing with fancies, it is well-nigh impossible to fix any definite price; and particularly is this so in the case of fancy woollens and worsteds.

The following particulars will give an idea of the cost of weaving in the Bradford District.

List 4.—Standard Wage List for Weavers.

(As suggested by committees appointed by the Bradford Chamber of Commerce and the Bradford Trades and Labour Council.)

Dress Goods, Linings, etc.

70 yds. Warp.

		Price per pick per $\frac{1}{4}$ in.
All weaves up to and including 8 shafts, woven with any one colour of warp with white weft.	Up to and including 38 in. reed space . .	2d.
	Above 38 in. but not exceeding 47 in. reed space	$2\frac{1}{8}$d.
	,, 47 ,, ,, 57 ,,	$2\frac{1}{8}$d.
	,, 57 ,, ,, 66 ,,	$2\frac{2}{8}$d.
	,, 66 ,, ,, 76 ,,	$3\frac{1}{4}$d.

Extras.	Up to and Including 57 in. Reed Space.	Above 57 in. Reed Space.	Price.
1. White mohair and mixture or coloured weft other than alpaca	¼d.	½d.	per pick per ¼ in.
2. (*a*) Alpaca, grey; plain weave (1 × 1)	⅜d.	1⅛d.	,, ,,
(*b*) Alpaca, grey; twills	½d.	1d.	,, ,,
3. (*a*) Single twist botany warps, over 72 sett, and with more than 18 picks per ¼ in.	¾d.	1d.	,, ,,
(*b*) All other single twist worsted warps	¼d.	½d.	,, ,,
4. Stripes in warp, up to 8 shafts inclusive:—			
(*a*) Up to 4 colours inclusive	⅛d.	¼d.	,, ,,
(*b*) 5 colours or more	¼d.	½d.	,, ,,
5. Drafted stripes, with or without extra shafts	¼d.	½d.	,, ,,
6. Shafts above 8, whether dobbies or tappets	1d.	2d.	per shaft.
7. (*a*) Boxes up to and including 3 shuttles	½d.	¾d.	per pick per ¼ in.
(*b*) Boxes, above 3 shuttles	⅝d.	1d.	,, ,,
(*c*) Skip or drop boxes	¾d.	1¼d.	,, ,,
8. Pick and pick looms	¾d.	1¼d.	,, ,,
9. (*a*) Jacquards	½d.	⅞d.	,, ,,
(*b*) ,, with alpaca weft	1½d.	2d.	,, ,,
10. Cop weft	¼d.	½d.	,, ,,
11. Weft of 16s. count and thicker	¼d.	½d.	,, ,,
12. One weaver to one loom (for special weaves)	—	1¼d.	,, ,,
13. Rollers or extra beams	4d.	8d.	per piece.
14. Below 9 picks	2d.	4d.	,,
15. Warps of 140 yds. or shorter	6d.	6d.	for the whole warp.
16. One end of warp in one reed	3d.	6d.	per piece of 70 yds.
17. Extra for finding pick, excepting all plain (1 × 1) weaves and goods made from alpaca	3d.	6d.	,, ,,

Coatings.

Up to 84 in. reed space. Speed 120/130 picks minute. 70 yds. warp.

	One weaver to 1 loom.	2 looms.	Price.
All weaves up to 8 shafts	—	3¾d.	per pick per ¼ in.
,, ,, 12 ,,	5½d.	—	,, ,,

Extras.		Price.
1. Plain drafted stripes up to 3 cols.	¼d.	¼d. per pick per ¼ in.
2. ,, ,, 4 cols. or more*	⅜d.	⅜d. ,, ,,
3. Cross-drafted stripes up to 3 cols.*	¾d.	¾d. ,, ,,
4. ,, ,, 4 cols. or more*	1d.	1d. ,, ,,
5. Coloured weft, except where colour is paid for in the warp, as in extras 1 to 4	¼d.	¼d. ,, ,,
6. Revolving boxes	1d.	1d. ,, ,,
7. Skip or drop boxes	1¼d.	1¼d. ,, ,,
8. Jacquards	⅜d.	⅜d. ,, ,,
9. Looms running 110/119 picks per minute	1d.	1d. ,, ,,
	Per piece.	
10. Above 8 shafts	—	1½d. per shaft.
11. ,, 12 ,,	1½d.	— ,,
12. ,, 80 sett	1d.	1d. each 5 setts.
13. ,, 2 shuttles	9d.	9d. per shuttle.
14. A second beam	1s.	9d. per piece.
15. Below 9 picks	9d.	9d. ,,
16. Warps shorter than 140 yds.	1s. 6d.	1s. for the whole warp.

* There was a difference of opinion as to these three items; the Chamber's representatives contended that they should be a ¼d. lower in each case.

Perching, Picking, Burling, and Mending.—When a woven texture leaves the loom, and before it is subjected to any dyeing and finishing processes, it is carefully examined, looked over, or perched, and any imperfection that may be observed is, if at all possible, eliminated in the department of burling and mending. Especially is this the case in the manufacture of worsted goods, as the grey cloth defects are developed during the finishing treatment, and if not remedied will result in a damaged fabric. The clear type of finish imparted to worsteds, necessitates evenly spun yarns and regularly woven fabrics.

In cloths, such as woollens, which are severely milled and raised during finishing, the high standard of perfection is not so essential, as the above treatments develop a "face" on to the cloth which minimizes to a great extent any defects there might be; hence the process of burling and mending is not so important in the making of cloths which are subjected to a "face" finish as those which are "clear" finished.

The defects to be found in wool cloths may be classified under two headings:—

1. Those arisIng in the preparing, combing, and spinning processes which are responsible for the presence in the woven fabric of burrs, straws, kemps, hairs, knots, thick and thin yarn, and slubs.

2. Such irregularities as missing threads of warp and weft, known as "broken warp threads" and "broken picks" or "picks out," and oil stains, may be considered due to defective weaving.

The amount and type of treatment involved during burling and mending is dependent on the nature of the defects, the type of fabric, and subsequent finished appearance, some textures will be "picked" only, others "picked" and "burled," whilst other makes of cloth necessitate "picking," "burling," and "mending". A definition of the three treatments mentioned, of eliminating imperfections in woven fabrics, is as follows:—

Picking.—Taking out from the face of the cloth all hairs, slubs, kemps, straws, etc.

Burling.—First, from the back of the cloth, taking out all slubs, straws, etc., drawing out and replacing thick warp threads and picks of weft and opening the knots. Afterwards carefully looking over the face of the cloth, and pushing such irregularities

as remain (loose ends and curls) on to the back, in order that the face of the fabric is as clear of irregularities and imperfections as possible.

Mending represents the inserting of yarn, where, in the woven cloth, there are any warp threads or weft picks missing.

When goods are delivered into the burling department, it is clearly indicated, whether they are to be "picked," "burled," or "burled and mended". Where the instructions are "to be burled" the operative or burler considers the cloth is not to be "mended": but when the instructions are "to be burled and mended" the burler understands that everything has to be done to eliminate all imperfections.

Cost of Burling and Mending.—The price paid for burling and mending varies considerably and is dependent on the particular type and quality of the woven fabric and the amount of imperfections to be repaired. The list on next page contains the particulars of a number of standard cloths, with the treatment given to them and the price paid to a commission burler and mender. (See Price Lists 5a and 5b.)

A number of dress fabrics do not require mending.

Silks (plain and fancy) 45 to 50 yds.

This class of goods are not often burled and mended, but are usually "picked" of straws, hairs, slubs, etc., and the oil stains washed out.

The price varies from 6d. to 1s. 9d. per piece.

"Other Expenses."

General Expenses (*Wages and Salaries*).—This item should consist of all wages paid except to loomer or twister, warp dresser, weaver, and burler and mender as stated under list prices. The wages of over-lookers; staff of piece-room, weft room, designing room, and office, and of all foremen, mechanics, and assistants should come under this heading.

Working Expenses. Depreciation.—No costing can be complete unless ample allowance is made for the wear and tear of machinery and depreciation in value of plant generally.

This item is as much a current expenditure as is wages or any other working expenses, the only difference being that it is not annually expended, but nevertheless it ultimately falls due in some shape or form. In some instances the amount for deprecia-

tion will be taken into account with the capital expenditure and in other instances a fund is created from which renewals and repairs of buildings and machinery are paid.

Rates, Insurance, Fuel, Lighting, Water, Carriage of Yarn and Cloth.—This might be defined to include the cost of everything received, with the exception of those items in the yarn account such as those above enumerated with the addition of taxes and rates if any.

Price List 5a.—Burling and Mending.

Grey Worsted Coatings (Burling and Mending). *About 65 yds., over 60 in. wide.*

	Type.	Weight.	Price per Piece.	Extras.	
				per yard Warp Threads.	for Sewing-in per Pick above 2.
1	2/2 twill	16½ oz. per yd.	1s. 9d. to 2s. 9d.	1d. to 2½d.	1½d. to 3d.
2	,, ,,	18½ to 20 ,, ,, ,,	2s. 9d. ,, 3s. 6d.	1d. ,, 2½d.	2d. ,, 3d.
3	,, fine	,, ,, ,, ,, ,, ,,	3s. ,, 3s. 9d.	1d. ,, 2½d.	2d. ,, 3d.
4	,, imperial cloth		2s. 9d. ,, 4s. 6d.	1d. ,, 2½d.	2d. ,, 4d.
5	3/3 twill	18 oz. per yd.	2s. 9d. ,, 4s.	1d. ,, 2½d.	2d. ,, 4d.
6	Corkscrews	16½ ,, ,, ,,	3s. ,, 5s. 9d.	2d. ,, 4d.	4d. ,, 6d.
7	,,	Heavy	5s. ,, 7s.	2d. ,, 4d.	4d. ,, 6d.
8	Venetians	16 oz. per yd.	2s. 6d. ,, 6s. 6d.	2d. ,, 4d.	2d. ,, 6d.
9	,,	Heavy	3s. 6d. ,, 7s. 6d.	2d. ,, 4d.	2d. ,, 6d.
10	Fancy fine	Light	3s. ,, 5s.	2d. ,, 4d.	2d. ,, 6d.
11	,, ,,	Heavy	5s. ,, 7s.	2d. ,, 4d.	2d. ,, 6d.
12	Union cloths	Light	2s. 3d. ,, 3s. 6d.	1d. ,, 4d.	1d. ,, 6d.
13	,, ,,	Heavy	3s. 6d. ,, 7s.	1d. ,, 4d.	1d. ,, 6d.

Coloured and Mixture Coatings (Burling and Mending).

The price for Coloured Coatings is from 3d. to 1s. 6d. per piece more than Grey Coatings.

14	2/2 twill	16½ oz. per yd.	2s. 9d. to 3s. 6d.	1d. to 4d.	2d. to 4d.
15	3/3 and 4/4 ,,	Light	3s. ,, 4s. 6d.	2d. ,, 4d.	3d. ,, 4d.
16	,, ,, ,, ,,	Heavy	4s. ,, 5s. 6d.	2d. ,, 4d.	3d. ,, 4d.
17	Fancies 3d. to 1s. 6d. per piece more than 14, 15, 16.				

Grey Worsted Coatings (Burling Only).

18	Corkscrews		1s. to 2s.		
19	Venetians		1s. ,, 2s.		
20	For cutting loose picks from edges where 2 or more wefts have been employed 4d. to 6d. per piece.				

Price List 5b.—Burling and Mending.

Grey Dress Fabrics about 60 yds. over 40 in. wide.

Type.	Price per Piece.
1 Plain twills	1s. 6d. to 1s. 9d.
2 „ mohairs	10d. „ 2s.
3 Figured „	9d. „ 1s. 9d.
4 Plain lustres	1s. 3d. „ 1s. 9d.
5 „ voiles	1s. „ 1s. 6d.
6 Striped „	1s. 3d. „ 3s. 1d.
7 Poplins	1s. 6d. „ 2s. 3d.
8 Panamas	1s. 6d. „ 2s. 3d.
9 Orleans	1s. 6d. „ 2s. 6d.
10 Sateens	1s. „ 1s. 9d.

Coloured Dress Fabrics.

11 Plain	2s. to 3s. 6d.
12 Fancy	2s. „ 4s. 6d.

Grey Dress Fabrics (Burled only).

13 Plain twills	1s.	Burled back and face.
14 „ „	9d.	„ on face only.

15 For "picking" only (hairs, straws, and washing out grease spots) from 3d. to 1s. 6d. per piece.

Interest on Capital.—In the costing of cloths the item of interest on the capital invested must be considered and taken into account. When money is invested in an industrial or manufacturing concern, the investor takes a certain risk for which he is entitled to the ordinary rate of interest and in addition a "profit".

An investor might place his money, say, in mortgages and obtain, say, 4 per cent with absolute safety; therefore when money is placed at a risk, the investor is entitled to look for something over and above the 4 per cent interest. Thus in making out the working expenses involved in cloth production a certain percentage—say 4—must be allowed as interest on the capital laid down in plant, buildings, etc. In addition, the interest on any banker's or other loan should of course be included. However, it must be remembered in costing cloths, that "interest" and "profits" are two separate items and in no way should one item include the other.

List 6. Price Paid in Bradford for Room and Power:—

3/4 looms	14d. to 15d. per week		
4/4 ,,	15d. ,, 16d. ,,	,,	
5/4 ,,	16d. ,, 18d. ,,	,,	Dress goods.
6/4 ,,	18d. ,, 20d. ,,	,,	
7/4 ,,	20d. ,, 24d. ,,	,,	
8/4 ,,	30d. ,,	,,	coatings.

Including room for warehousing. The prices vary slightly according to the warehouse room provided.

List 7a. "Other Expenses" involved in the Manufacture of Worsted Coatings.—In a weaving plant of 100, 9/4 box looms, the following details have been worked out, covering the "other expenses" in weaving a worsted coating, made to the following particulars:—

Loom Particulars:—

Warp.

2/44/60 botany.
78 threads per inch.
70 in. reed width.
60 in. finished cloth.

Weft.

1/20/60 botany.
72 picks per inch.
70 yds. warp.
61 yds. finished cloth.

Warped.	*Wefted.*
4 threads dark	4 picks dark
4 ,, light	4 ,, light

Weaving Plant:—

100 9/4 looms.
Speed 110 to 120 picks per minute.
54 hours per week.
30 per cent stoppages.

with 72 picks per inch and 66 yds. of cloth woven, will result in the following number of pieces per (fifty weeks) year:—

$$\frac{120 \times 60 \times 54 \times 50 \times 70 \times 100}{100 \times 72 \times 36 \times 66} = 7955,$$

say 7960.

Capital Expenditure.	£	s.	d.
100 9/4 looms at £38 each	3800	0	0
,, straps, shuttles, temples, etc., at 18s. 6d.	92	10	0
,, pulleys and belts at 16s.	80	0	0
Extra fittings	30	0	0
Healds, reeds, etc.	300	0	0
Miscellaneous expenses	300	0	0
Total	£4602	10	0

Annual Cost.	£	s.	d.
[1] Interest and sinking fund (10 years) on £4600 at 5 per cent	586	10	0
Repairs, including new healds, reeds, etc.	180	0	0
Rent for room and power, 100 looms at 30d. per week (52 weeks) including rates	650	0	0
Gas £20, insurance (plant £103, materials £150).	273	0	0
Wages :—			
(*a*) Loom tuner at 40s.: 2 loom tuners at 37s. 6d. per week (52 weeks)	299	0	0
(*b*) Weft room: man at 30s., 2 boys at 10s. 6d. (52 weeks)	132	12	0
(*c*) Piece room: taker in at 36s., youth at 16s., boy at 11s. (52 weeks)	163	16	0
(*d*) Clerk and assistant (52 weeks)	180	0	0
Designer manager's salary	250	0	0
Office material, postage, etc.	100	0	0
Cartage of pieces, etc.	80	0	0
Miscellaneous expenses	50	0	0
Depreciation of machinery, etc., 10 per cent.	460	0	0
Total	£3404	18	0

£3404 18s. ÷ 7960 pieces = 8s. 6½d. per piece "other expenses".

List 7b. "Other Expenses" involved in the Manufacture of Dress Goods.—In a weaving plant of 100 6/4 tappet looms, the following details have been worked out, covering the "other expenses" in weaving a mohair lustre dress cloth made to the following particulars :—

Loom Particulars :—

Warp.

2/100 cotton.
64 threads per inch.
49¾ in. reed width.
49 in. grey cloth.
44 in. finished cloth.

Weft.

1/32 mohair.
70 picks per inch (grey cloth).
70 yds. warp.
61 yds. grey cloth.
67 yds. finished cloth.

[1] This item applies to loan capital ; being repaid in 10 years, the item then becomes £4600 at 5 per cent = £230.

Weaving Plant :—

100 6/4 tappet looms.
Speed 160 picks per minute.
54 hours per week.
30 per cent stoppages.

with 70 picks per inch and 61 yds. of grey cloth woven, will result in the following number of pieces per (fifty weeks) year :—

$$\frac{160 \times 60 \times 54 \times 50 \times 70 \times 100}{100 \times 70 \times 36 \times 61} =$$

11,147 say 11,150.

Capital Expenditure.	£	s.	d.
100 6/4 tappet looms at £13 each	1300	0	0
,, straps, shuttles, temples, etc., at 18s. 6d.	92	10	0
,, pulleys and belts at 16s.	80	0	0
Extra fittings	30	0	0
Healds and reeds, etc.	200	0	0
Miscellaneous expenses	150	0	0
Total	£1852	10	0

Annual Cost.	£	s.	d.
[1] Interest and sinking fund (10 years) on £1860 at 5 per cent.	237	0	0
Repairs, including new healds, reeds, etc.	180	0	0
Rent for room and power (100 looms at 19d. per week (52 weeks).	411	13	0
Gas £14, insurance (plant £45, material £90)	149	0	0
Wages :—			
(*a*) 2 loom tuners (40 looms each) at 36s., an improver at 24s. per week (52 weeks)	249	12	0
(*b*) Weft room man at 30s., 2 boys at 10s. 6d. per week (52 weeks)	132	12	0
(*c*) Piece room, taker in at 36s., youth at 16s., boy at 11s.	163	16	0
(*d*) Clerk and assistant	180	0	0
Designer manager's salary	250	0	0
Office material, postage, etc.	100	0	0
Cartage of pieces	80	0	0
Depreciation of machinery at 10 per cent	185	0	0
Miscellaneous expenses	50	0	0
Total	£2368	13	0

£2368 13s. ÷ 11,150 pieces = 4s. 3d. per piece "other expenses".

The cost of weaving the worsted coating indicated in List 7*a* is 8s. 8d. per piece, and for the same type of work in producing the dress fabric in List 7*b* the cost is 4s. 3d. On these being compared with the amount per piece for "other expenses" it will be found, in each case, that cost of weaving is about identical with the item "other expenses".

	Other Expenses.	Cost of Weaving.
Worsted coating	8s. 6½d.	8s. 8d.
Lustre dress fabric	4s. 3d.	4s. 3d.

[1] When capital is repaid, this item becomes £1860 at 5 per cent = £93.

This result is supported by practical experience. Consequently in costing a woven fabric, the amount stated as "other expenses" may safely be taken to be *equal to the cost of weaving*.

Dyeing and Finishing Woven Fabrics.—The following lists indicate the costs of dyeing and finishing the various classes of goods produced in the locality of Bradford.

List 8a. Dyeing and Finishing :—

Finishing only. Dress Goods, etc. :—

(*a*) All wool (plain finish) 1½d. per lb. (grey).

(*b*) "Milled" or "vicuna" finish 2s. 6d. per piece (extra).

(*c*) "Pirle" finish 1d. per yard (extra).

(*d*) "Permanent" finish 5s. 6d. (average) per piece (extra).

(*e*) "Proofing" 1½d. per yard (extra).

(*f*) "Stove white" 3s. per piece over colour price.

(*g*) "Permo" finish 3d. per yard.

(*h*) Fancy coloured lustres and mohairs, melanges, etc., 7/4 width, 3s. 6d. per piece (60 yds. warp).

Dyeing and Finishing. Dress Goods, etc. :—

1. Ordinary low crossbred serges. (Mattings and similar fabrics.) Blacks 2½d. per lb. Colours 3¼d. per lb.

2. Estamenes. Blacks 2½d. per lb. Colours 3½d. per lb.

3. Panamas, armures, and similar fabrics, usually finer in make and qualities than No. 1. Blacks 3d. per lb. Colours 4d. per lb.

4. Wool sateens (venetians, etc.). Blacks 3d. per lb. Colours 4d. per lb.

5. Cheviots (milled). Blacks 4d. per lb. Colours 5d. per lb. (Some dyers charge more.)

6. Amazons. Blacks 4½d. to 5d. per lb. Colours 5½d. to 6d. per lb. (Some dyers include a non-spot finish for these prices.)

7. Worsted italian linings. 56 yds. warp, 54 in. finished width.

22/26 lb. Blacks 9s. 6d. Colours 11s.
26/30 ,, ,, 11s. ,, 12s. 6d.

8. Cotton warp serges and dress goods.

Grey warp { Blacks 3d. per lb. / Colours 4d. ,, ,, } average.

9. Lustre linings (cotton warp and lustre weft).

70 yds. warp, 32 in. finished width.
12/16 lb. Blacks 2s. 9d. Colours 3s. 6d.

10. Cashmeres (black cotton warp and grey botany weft).

Blacks—16/22 lb. 4s. 3d.
22/26 ,, 4s. 9d.
26/30 ,, 5s. 3d.
Colours 1s. 6d. to 2s. advance on above prices.

11. Brilliantines, sicilians, etc. (cotton warp, mohair, alpaca and lustre weft).

18 lb. 40/45 in. Finished width, 56 yds. warp.
50 ,, grey cloth.

(*a*) *Mohair and Alpaca Wefts*—

White warps—9s. per piece for white and colours.
Coloured ,, 7s. 3d. ,, ,, crossdyed colours and navy blue.
Black ,, 4s. 6d. ,, ,, crossdyed blacks.

(*b*) *For Lustre and Demi-lustre Wefts*—

1s. per piece less on white and coloured warps.
9d. ,, ,, black warps.

(*c*) *Above* 18 *lb.*

White warps—6d. per lb. for white and colours.
Coloured ,, 5d. ,, ,, crossdyed colours and navy blue.
Black ,, 3d. ,, ,, crossdyed blacks.

(*d*) Base heavier and lighter fabric on the same footing.

List 8b. Woollens and Worsteds:—

Finishing only :—

(*a*) Scour, mill, and finish woollens. 1 hour's milling, 8s. 9d. per piece.

(*b*) Scour and finish worsteds. (Plain finish.) 18 oz. per yard. 9s. per piece.

(*c*) Soap scouring woollens. 1s. 6d. per piece extra.

(*d*) Soap scouring worsteds. 1s. 9d. per piece extra.

Dyeing and Finishing :—

1. Woollens (23 oz. per yard) vicuna finish. Black 20s. per piece. Colour 22s. per piece.

2. Worsteds (18 oz. per yard) plain finish. Black 18s. per piece. Colour 22s. per piece.

3. Worsteds (22 oz. per yard) plain finish. Pure alizarine 45s. per piece.

4. Woollens not dyed alizarine. Indigos from 34s. per piece to 8d. per lb. and 10s. for finish.