

ANALYSIS OF COTTON FABRICS

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ANALYSIS OF COTTON FABRICS

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PARTICULARS TO BE DETERMINED BY ANALYSIS

INTRODUCTION

1. An important part of every designer's duties is the analysis of fabrics that are sent to the mill from commission houses, from abroad, or from other sources with a view to their reproduction, either as exact duplicates or with certain modifications that the requirements of the buyer or the mill may demand. This analysis, while seemingly of a secondary nature, is of the utmost importance, not only in cases where a mill desires to manufacture certain fabrics for which there is, or is likely to be, a large demand, but also for the purpose of gaining ideas for the production of other fabrics. By the term **cloth analysis** is meant the process of finding all the requirements necessary to reproduce a certain fabric from a given sample. It may not be desired to exactly duplicate the sample, as certain changes in the weight of the goods, the quality of the material used, etc., are often deemed advisable in order to produce a fabric, seemingly the same, that can be placed on the market at less cost. Thus, a sample of cloth may be given to the designer with instructions either to reproduce the goods exactly, or with certain alterations tending to reduce the cost of the goods without materially affecting the appearance. In the case of a small mill that

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does not regularly employ a designer, this duty is generally performed by the superintendent or boss weaver.

A sample of cloth may be analyzed by several methods, but it is only by the systematic application of some one method derived from a thorough knowledge of the subject that the most economical and advantageous results are obtained. This subject cannot receive too much study, since it is one with which a designer must of necessity be in daily contact. A designer or student of designing should therefore avail himself of every opportunity to analyze such samples of cloth as he may encounter. By this means he will become acquainted with many weaves and characteristic effects and learn to associate them with certain fabrics, thus understanding them much better than it would be possible to understand the bare designs marked out on design paper.

2. In analyzing a sample of cloth, the following list of particulars should be found, the desired finished width of the cloth being given, of course, in all cases:

- | | |
|--|-----------------------|
| 1. Sley of cloth (average sley if necessary) | 8. Width at reed |
| 2. Ends in the warp | 9. Yards per pound |
| 3. Warp pattern (if any) | 10. Counts of warp |
| 4. Number of patterns in the warp | 11. Counts of filling |
| 5. Picks per inch | 12. Weave |
| 6. Filling pattern (if any) | 13. Harness draft |
| 7. Reed to be used | 14. Chain draft |

There are also other particulars that should be considered when reproducing a fabric; these, however, will be dealt with later. Several of the items in this list of particulars belong to the subject of cotton-cloth calculations and consequently need no explanation here. In demonstrating the methods of obtaining the other requirements to be found, the same cloth sample will be used that was adopted to exemplify methods of making cotton-cloth calculations.

WARP PATTERN

3. The warp pattern is a requirement that is necessary only when the cloth contains warp yarns of different colors, counts, or materials. To illustrate the method of making out a warp pattern it will be assumed that it is arranged as follows: 1 end 30s light blue, 1 end 2/20s white, 10 ends 30s dark blue, 1 end 2/20s white, 10 ends 30s dark blue, 1 end 2/20s white, 1 end 30s light blue, 4 ends 30s white, 1 end fancy, 4 ends 30s white, 1 end fancy, 4 ends 30s white, 1 end fancy, 4 ends 30s white.

The above shows the warp pattern, but this can be shortened somewhat and made to appear to better advantage by arranging the list in the form of a column, enclosing with a brace each portion that is to be repeated and indicating the number of times the part thus enclosed is to be repeated, as follows:

1 end 30s light blue
 1 end 2/20s white
 2 × { 10 ends 30s dark blue
 1 end 2/20s white
 1 end 30s light blue
 4 × { 4 ends 30s white
 1 end fancy
 4 ends 30s white
 49 ends in pattern

Another convenient method of showing this pattern and one that is to be recommended is as follows:

WARP PATTERN

30s light blue .	I					I													2
30s dark blue .			10	10															20
30s white . . .							4	4	4	4	4	4	4	4	4	4	4	4	20
30s fancy . . .								I	I	I	I	I	I	I	I	I	I	I	4
2-ply 20s white		I	I	I															3
Total number of ends in pattern																			49

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Or this could be somewhat shortened, as follows:

WARP PATTERN

30s light blue	I				I				2
30s dark blue			10						20
30s white						4		4	20
30s fancy							I		4
2-ply 20s white		I		I					3
			2 ×			4 ×			
Total number of ends in pattern									49

The marks 2 × and 4 × show that the ends enclosed with a brace are to be taken two times and four times, respectively. By carefully comparing these last two forms, the method adopted in the second one will be readily understood.

In the case of a piece of cloth like the sample that is to be used for analysis, the warp pattern would be known as all white, while the stripe effect produced in the cloth would be obtained by the method of drawing the ends in the reed and the order of raising the harnesses.

FILLING PATTERN

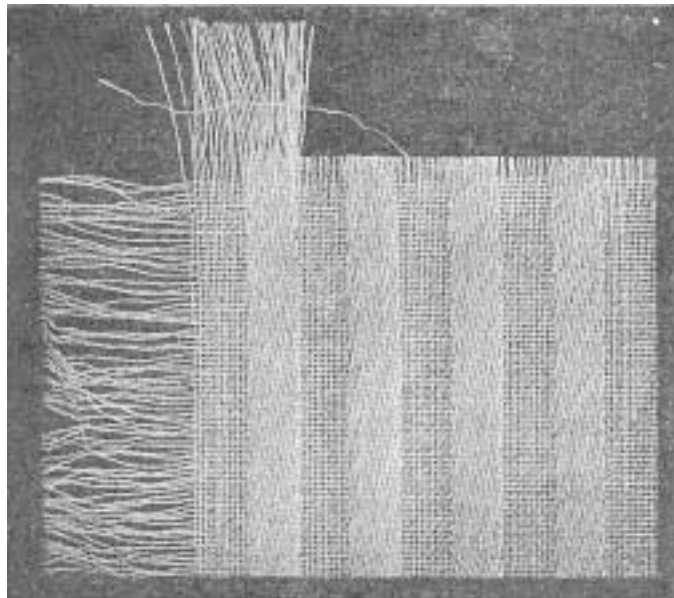
4. By the term **filling pattern** is meant the manner in which the filling is inserted in the cloth either as regards different colors, materials, or different counts of yarn. In making out the pattern of the filling in any cloth, it is simply necessary to give the number of picks of each color or count in one repeat of the pattern; this can be shown in the same manner as was the pattern of the warp. In case the filling is all one color, material, and counts, there will, of course, be no pattern and it will simply be stated as all white, all black, etc., according to whatever color of yarn is used. With the sample of cloth used for analysis, the filling is white and is all of the same counts; consequently, the pattern of the filling would be stated as all white.

PICKING OUT

5. The *weave* is one of the most important particulars concerning a sample of cloth, as without the correct weave it is impossible to reproduce the fabric with a satisfactory resemblance to the original appearance, especially if the fabric has a pronounced weave effect or a color effect depending on the weave for the disposition of the color on the face of the cloth. The method of obtaining the weave from a sample of cloth will require considerable study and practice, although after the weaves of a few samples have been studied and successfully obtained it will be a comparatively easy matter to obtain the weaves of other samples; in fact, many samples will be met with that will not require much more than a glance to determine the weave. The process of obtaining the weave of a woven fabric is known as **dissecting**, or **picking out**, although these terms are sometimes applied to the entire process of cloth analysis. The weave obtained from picking out a sample of cloth is often spoken of as a **pick-out**. By the term **weave** is meant the manner in which the warp yarns and the filling interlace, and is shown on design paper by means of filled-in squares and blanks; that is, by looking at the weave as shown on design paper it is possible to determine just how each thread of the warp is lifted and lowered.

6. When obtaining the weave of a sample of cloth, the first thing necessary is to determine the face and back of the fabric and also which threads form the warp and which the filling. These two points will be dealt with more fully later, but the importance of determining them before commencing to obtain the weave should be mentioned here. If the back of a cloth were taken as the face, the warp ends would be up when in reality they should be down; the reverse would also be true. On the other hand, if the filling were considered as the warp, a correct reproduction of the sample would not be obtained, because the resulting weave would be turned one-quarter way around on the design paper instead of occupying its actual position as in the cloth. In a twilled

cloth this would have the effect of making the twill run in the wrong direction. If the filling were considered as the warp, the weave would also be reversed, since the filling threads would be marked up on the design paper when in reality, since they are filling threads, they should be left blank where they float on the surface of the cloth. After the face and back, also the warp and filling, have been deter-



mined, the sample should be held in such a manner that the face side will be up and the filling will run from side to side.

7. The operation of finding the weave of a sample of cloth consists of picking out one pick of filling at a time and setting down on the design paper the way in which it interlaces with the warp. Thus, if the filling passes over the first end, the square on the design paper representing where that end intersects with the pick under consideration will be left blank, showing that the warp is depressed and that the

filling is on the face of the cloth at that point. If the filling passes under the next end, the square on the design paper representing where the second end intersects with the pick of filling will be filled in, showing that the warp end is raised over the filling at that point.

8. Preparation of Sample.—Before commencing to pick out a weave, the sample of cloth needs certain preparation in order to facilitate the operation. Several ends from the left of the sample and several picks from the top should

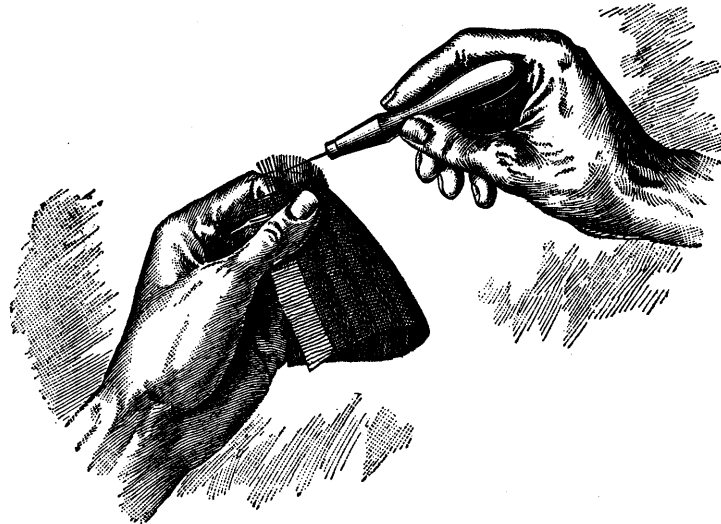


FIG. 2

be pulled out. After the picks have been pulled out, all the loose ends should be cut off, with the exception of those needed to determine the weave. It is not desirable to leave too many ends at the top, only sufficient to form one repeat of the weave being needed. As this number cannot always be determined accurately until the picking out is completed, a number slightly in excess of those probably required should remain. When prepared, the sample will appear as in Fig. 1, which is a slightly enlarged photographic reproduction of the sample under consideration when ready to be picked out.

9. After preparation, the sample should be held in the left hand and laid over the first finger, as shown in Fig. 2, so that when an end has been dealt with, it can be drawn under the thumb and held out of the way while determining the intersection of the next end; in this manner it is possible to keep the ends separate and determine their interlacings more readily. For manipulating the ends and picks when determining the interlacings of the weave and when removing the picks from the cloth, an instrument known as a *pick-ing-out*, or *dissecting, needle* is used. This consists simply of a stout needle, usually inserted in a wooden handle so that it may be conveniently grasped.

A method that may be used to advantage in many cases is to lay the sample on a white surface if it contains dark-colored yarns, and on a black surface if the yarns are light-colored. By this means the interlacings will often show up much more prominently, especially when working by artificial light. When this second method is used, a *pick glass* will often be of great aid in determining the interlacings of the warp and filling, especially if the sample is woven of fine yarns or if it contains a large number of ends and picks per inch. A *pick glass*, or *linen tester*, as it is sometimes called, is a simple lens, or magnifying glass, contained in a suitable support; it is also used to enable the number of ends or picks per inch to be readily counted. A pick glass with a field of less than 1 inch is undesirable for purposes of analysis.

In either method, the next step is to draw the top pick up a little from the cloth until its interlacings with the ends that have been left can be readily seen. Beginning with the end on the left and taking each end in successive order, indicate on the design paper whether the pick of filling is above or below each end; that is, if the pick is above an end, the square on the design paper is left blank; if the pick of filling is below an end, the square is marked. Proceed in like manner with each end until a repeat is found. It is well to carry the first few picks out two repeats in order to make sure that a repeat of the weave has been found, after which the extra ends may be cut off, as shown in Fig. 1.

The interlacings of the first, or top, pick should be placed on the top row of squares on that portion of the design paper that is intended to be used and the interlacing of the first end, or the end at the left, with the first pick should be shown on the first row of squares at the left on the design paper; that is, the interlacing of the first, or left, end with the first, or top, pick will be shown by the square in the upper left-hand corner of the design paper. The top pick, however, will not be the first pick to be placed in the loom, since this would produce the cloth with the top for the bottom and vice versa. The last pick of the pick-out will therefore be the first pick to be placed in the loom, and consequently the lower left-hand corner of the weave when shown on design paper is considered to represent the interlacings of the first end and first pick. This is difficult for a beginner to understand, but it is simply necessary in this connection to know that when a piece of cloth is picked out after the manner described, the lower left-hand square of the design paper represents the first end and the first pick; this is important when building a harness chain from the draft.

After its interlacings have been found and placed on the design paper, the first, or top, pick should be drawn out of the cloth entirely, and the next pick then drawn up among the loose ends, as when dealing with the first pick. The interlacings of this pick are found and marked on the design paper on the next horizontal row of squares below the row marked for the first pick. After marking the interlacings of the second pick, the third and each successive pick is dealt with in a similar manner until one is found that interlaces in a manner similar to the first pick taken out. This generally indicates that the weave repeats at this point, but it is always a good plan to pick out 3 or 4 picks of filling after it is thought that the weave has commenced to repeat, and compare these with the first picks taken out, to make sure that the weave does repeat at this point. These extra picks must of course be ignored afterwards and only one repeat of the weave used when obtaining further particulars. When one repeat of the weave is obtained, it represents what is repeated as many

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times as required in the length and width of the same piece of cloth, and therefore, is all that is necessary.

Some designers prefer to commence at the bottom of a piece of cloth to pick out. In this case, after the interlacings of the first pick have been marked on design paper it is removed from the cloth and the next pick above it examined and marked on the design paper, but in this case it is set down immediately above the one that was first marked. The interlacings of the third pick taken from the cloth are placed above the second, and so on, so that whether the pick-out is commenced at the top or the bottom of the sample, the final result as shown on design paper will be the same.

Some designers also pick out the warp ends instead of picks of filling, marking squares for picks depressed and leaving squares blank for picks raised.

10. The quickest plan of indicating the weave on the design paper when picking out is to prick, with the picking-out needle, the squares that represent warp ends lifted, and then, after the weave has been found, fill in these squares with ink or pencil. This makes it unnecessary to lay down the picking-out needle and take up the pen or pencil every time a square needs to be marked.

If the sample of cloth to be dissected contains a large number of ends and picks per inch, or warp and filling yarns of the same shade, the yarns are liable to become crossed and the wrong end marked on the design paper. To prevent this, it is an advantage first to place the warp threads in a comb, attaching the ends together with mucilage between two pieces of paper in order to prevent their slipping back. If the ends are crossed or in a wrong order when placed in the comb, this fact will be noticed before the weave repeats, and by making a note of where these crossed ends should be, they may be recopied in their proper order after the repeat of the weave is found. This method will be found useful with any cloth difficult to dissect.

A good aid in dissecting warp-backed and double cloths is to cut the backing ends, after the necessary number of picks

have been taken out, about $\frac{1}{8}$ or $\frac{1}{4}$ inch shorter than the face ends. If the fabric is hard felted or has a nap, singe it and scrape off the fiber, being careful not to injure the body of the yarns. In many cases, where the weave of a cloth is regular and one commonly used, such as a regular twill, it will not be necessary after a little experience to pick out more than 1 or 2 picks, since these will show the manner of the interlacings in the whole weave, which can readily be completed without dissecting.

11. Fig. 3 shows one repeat of the weave of the cloth sample. Several different results might be obtained in picking out this one sample of cloth, and yet each be correct. This would be due to the fact that the different pick-outs were not started on the same end or the same pick, in which case the first end of one pick-out would not be the first end

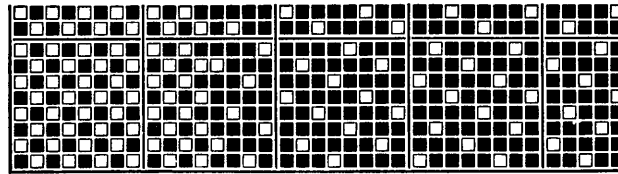


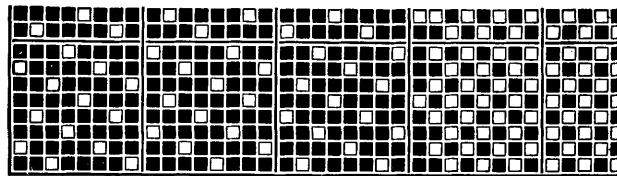
FIG. 3

of the other, or the first pick of one would not be the first pick of the other; or perhaps the pick-out might have been started on both a different end and a different pick.

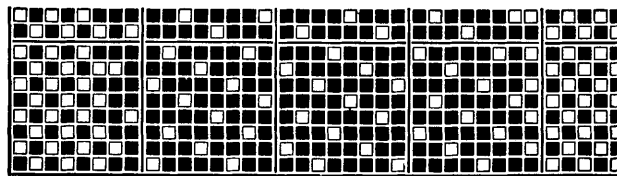
For instance, if the cloth sample under consideration had been so prepared that the thirteenth end of Fig. 3 was the first end at the left of the sample, with the top pick as there shown still the top pick, the weave in Fig. 4 (a) would have resulted. If the sample had been so prepared that the seventh end of Fig. 3 was the first end at the left, the weave obtained would be that shown in Fig. 4 (b). Again, if the sample had been so prepared that the twenty-eighth end of Fig. 3 was the first end at the left, the pick-out shown in Fig. 4 (c) would have resulted. Though each weave appears to be different from the others, and from Fig. 3, in reality they are all exactly alike, since if repeated severa

times in the cloth the same effect will be produced, yet the difference in their appearance is due only to the end on which the pick-out is started.

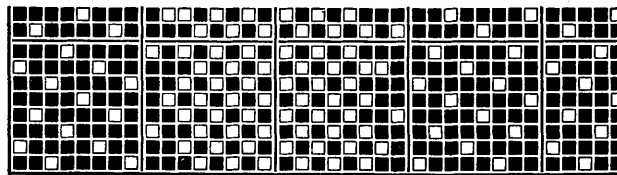
In a similar manner, if the pick-out had been started on a different pick, it would have had a different appearance, or if it had been started on a different end and different pick from those shown in Fig. 3, the resulting weave would have



(a)



(b)



(c)

FIG. 4

appeared still different. It is usually customary to arrange a combination weave of this character after the manner shown in Fig. 3 or in Fig. 4 (a). Designs are sometimes, however, arranged as shown in Fig. 4 (b) and (c).

By referring to Fig. 3, it will be seen that the first 12 ends of the cloth sample consist of the plain weave, which is complete on 2 ends and 2 picks. Consequently, when pick-out a weave of this kind it is only necessary to take out

2 picks in order to learn the weave, after which it may be continued for as many ends and picks as may be desired by simply repeating the first 2 ends and picks. With weaves as simple as this it will be possible, after a little practice, to place the weave on the design paper by simply observing the cloth by means of the pick glass. After the first 12 ends, as shown in Fig. 3, a different weave is employed, and one repeat of this weave is complete on 5 ends, although the entire weave occupies 25 ends. This weave is known as a 5-end warp satin.

One of these weaves, namely the plain weave, is complete on 2 ends and 2 picks, while the satin weave is complete on 5 ends and 5 picks. It might naturally be supposed that in order to show the complete weave only 5 picks would have to be taken out, but the two weaves must repeat together, and a plain weave cannot repeat on an odd number of picks. Consequently, while the satin weave would repeat on 5 picks, the plain weave would not. When two separate weaves are combined in a cloth similar to this one, the weave for the sample will not repeat in its picks until it is continued for a number of picks that is a multiple of the numbers representing the picks on which each weave is complete. Naturally, the least common multiple will give the number of picks on which the entire weave repeats. For example, the plain weave is complete on 2 picks and the satin weave on 5 picks. The least common multiple of 2 and 5 is 10. Therefore, the entire weave is complete on 10 picks.

Another important point that can be illustrated from this sample is the matching up of two weaves when used in the same cloth. By again referring to Fig. 3 it will be noticed that the plain weave is finished on the twelfth end and the satin weave commences on the thirteenth end. In order to have the cloth show as neat an effect as possible, these two ends should *cut*, or oppose, each other; that is, where a square is marked on the twelfth end, the next square to it on the thirteenth end should be left blank. By referring to Fig. 3 it will be seen that on the first pick the twelfth end is down, while the thirteenth end is up; thus they oppose each other.

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On the second pick the twelfth end is up and the thirteenth end down, thus causing the 2 ends to oppose each other. They also cut on the third pick, but on the fourth pick both ends are up and consequently do not cut. The effect at this point will not be as neat in the cloth as it is where the ends oppose. However, it is not possible to have a plain weave cut at every point when combined with a 5-end satin.

When desiring to have two weaves cut, both places where the weaves join should be carefully noticed; thus, in Fig. 3 it will be seen that the two weaves not only join at the twelfth and thirteenth ends but also at the first and last, since in showing a second repeat of the entire weave, the first end would be brought next to the last end.

All cloths are not made up of two or more weaves, as this is the exception rather than the rule, and generally a cloth will be found to be made from but one weave repeated a number of times.

HARNESS, OR DRAWING-IN, DRAFTS

12. It is comparatively easy to make the **harness draft** from the weave, but regard should always be had to the best manner of weaving the cloth. Thus, by referring to Fig. 3, which is the weave of the cloth sample shown in Fig. 1, it will be seen that there are more than twice as many ends of the satin stripe as there are of the plain, and by examining Fig. 1 it will be noticed that these ends are cramped or crowded together. In such cases as this it is generally better to place these ends on the front harnesses. As the ends of the satin weave will take at least 5 harnesses, since there are 5 ends working differently, the ends forming the satin stripe, or the last 25 ends in Fig. 3, will therefore be placed on the 5 front harnesses. The reason for placing these ends on the front harnesses is that, as there are more of them, more of them are liable to break during weaving, and it is much easier for a weaver to draw a broken end through a front harness than through a back one. There is also not so much strain on the ends drawn through the front harnesses as there is on those drawn through the back;

consequently, this lessens to a certain degree the liability of these ends breaking.

The ends forming the plain weave will be drawn through the harnesses next to the five on which the ends forming the satin are drawn. The first 12 ends of Fig. 3 could be drawn through 2 harnesses, since they weave plain and every other end works alike, but it will no doubt be found better to draw the ends through 4 harnesses instead of 2 harnesses, since by this means there will be fewer ends drawn through a harness, which will be found to be an advantage in many ways. This draft then will call for 9 harnesses—five for the satin ends and four for the plain. If the loom in which this cloth is to be woven cannot take this number of harnesses but can take seven, the weave must be drafted to 7 harnesses, which is the smallest number on which it is possible for it to be woven.

In many cases there will be found circumstances that will influence the number of harnesses on which to draft a weave. Some of these have been pointed out but many others will be met with in practice; consequently, a student of designing should be constantly looking for new information, especially in a weave room where there is an opportunity for examining a sample of cloth and finding the lowest number of harnesses on which it can be woven and also the actual number of harnesses on which it is being made. If more harnesses are being used than the lowest possible number, the reason should be learned; or on the other hand, if the weave is drafted to the lowest number of harnesses, the reason that extra harnesses are not necessary should be ascertained. It should be stated here that with many weaves it will not be possible to learn the exact number of harnesses that it will take by simply glancing at the pick-out, but it will be necessary to study the interlacings of each end separately and learn if it is similar to any other end in the weave.

13. Beginning with the first end of the pick-out as shown in Fig. 3, this end will be drawn through the sixth harness, the second end through the seventh harness, the third end through the eighth harness, the fourth end through the

ninth harness, and then the ends will commence to repeat; that is, the next end will be drawn through the sixth harness; and so on for the first 12 ends. Commencing next with the thirteenth end, or the first end of the satin weave, this end will be drawn through the first harness, the fourteenth end through the second harness, the fifteenth end through the third harness, the sixteenth end through the fourth harness, and the seventeenth end through the fifth harness. At this point the ends will begin to repeat; that is, the eighteenth end will be drawn through the first harness, and so on. Fig. 5 shows the harness draft complete. In *Cotton Cloth Calculations* it was shown that this cloth contains eighty-eight patterns and 8 ends over, and since the draft shown in Fig. 5 shows how the ends in only one repeat are drawn in, it must be repeated eighty-eight times in order to draw in all the

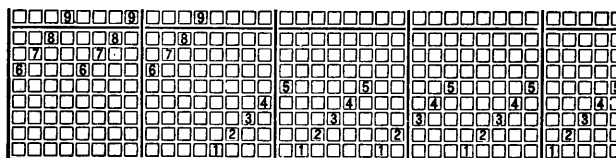


FIG. 5

ends in the warp. The 8 extra ends are to be used for the plain; therefore, the person drawing in the warp will finish by drawing in 8 ends of plain after finishing drawing in the eighty-eight repeats.

By referring to Fig. 5, it will be seen that if, after one repeat has been drawn in, the first end of the second repeat is drawn through the sixth harness, this will bring the same number of ends on each of the last four harnesses. But for the purpose of illustration suppose that there are only 10 ends of plain; then the last end of plain, as shown in the drawing-in draft, will be drawn through the seventh harness, and if the first end of the second repeat is drawn through the sixth harness, this will bring more ends on the sixth and seventh harnesses than on the eighth and ninth. Consequently, the person drawing in the warp can begin the first end of plain in the second repeat on the eighth harness instead of the sixth.

This will give the same effect in the cloth, since the sixth and eighth and the seventh and ninth harnesses work alike; it will also give the same number of ends on each harness.

14. It is always advisable when making out a harness draft first to make it out in such a manner that it will be as nearly a straight draw as possible; this is a great aid to the weaver when drawing in broken ends. Second, as nearly as possible the same number of ends should be placed on each harness; this is a great aid to the good running of the loom. Third, if it is necessary to have more ends on certain harnesses than on others, those harnesses with the most ends should be placed at the front of the loom, unless there is a good reason for not doing so.

CHAIN DRAFT

15. Since the chain draft is obtained from the pick-out and the harness draft, it is necessary to have these two items before this draft can be obtained. By referring to Fig. 5 which shows the harness draft, it will be seen that the first end is drawn through the sixth harness; therefore, the interlacings of the first end, as shown in the pick-out, must be the workings of the sixth harness; or in other words, the interlacings of the first end, as shown in the pick-out, give the manner of raising and lowering the sixth harness. The second end is drawn through the seventh harness; therefore, the interlacings of the second end, as shown in the pick-out, give the manner of raising and lowering the seventh harness. The third end is drawn through the eighth harness, and consequently the eighth harness will be raised and lowered as indicated by the third end of the pick-out. The fourth end is drawn through the ninth harness, and the operation of this harness, as shown in the chain draft, will be the same as the fourth end shown in the pick-out. The fifth end is drawn through the sixth harness, but since the working of this harness has already been obtained nothing more needs to be done with this. The same is true of all the ends until the thirteenth

is reached, which is drawn through the first harness; consequently, the interlacing of the thirteenth end, as shown in

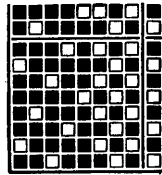


FIG. 6

the pick-out, will give the workings of the first harness. For the same reason, the second harness will work like the fourteenth end of the pick-out; the third harness will work like the fifteenth end of the pick-out; the fourth harness, like the sixteenth end; and the fifth harness, like the seventeenth end.

This will complete the chain draft, since the manner of raising and lowering all the harnesses has been learned. Fig. 6 shows the completed chain draft made from the harness draft, Fig. 5, and the pick-out, Fig. 3.

ADDITIONAL POINTS TO BE DETERMINED BY ANALYSIS

16. In addition to the requirements listed in Art. 2, there are several items that must in most cases be determined when analyzing a fabric. Some of these items are unnecessary in themselves, but must be ascertained in order that still others may be accurately found. These items are as follows: (1) determination of face and back of fabric; (2) determination of warp and filling; (3) determination of the direction of twist in warp and filling; (4) finding the percentage of contraction in the length of the warp during weaving; (5) the number of beams necessary for the warp yarn; (6) the raw material.

DETERMINATION OF FACE OF FABRIC

17. As previously explained, when desiring to find the pick-out of a sample of cloth it is always necessary first to determine which is the face and which is the back, in order that the results obtained may be accurate for reproducing the cloth.

In most fabrics this is easily done, although some cloths baffle the most experienced designer. The face of a cotton

fabric will sometimes show a much clearer and better pattern than the back. By noticing the cloth sample that has been dealt with, it will be seen that the satin stripe on one side of the cloth shows up much more prominently than it does on the other side. The side that shows the design more prominently is the face. When the fabric is a backed or double cloth, the face can be readily distinguished from the back by means of the style of the cloth or the finish. When dealing with warp-backed fabrics, the face can be readily distinguished from the back, since in this case there will be ends floating for some distance at the back. In a filling-backed fabric, the backing filling floats on the back of the cloth and is generally a soft-twisted yarn in order to give bulk to the cloth.

DETERMINATION OF WARP

18. There are several methods by which the warp may be distinguished from the filling. If the sample submitted for analysis contains a part of the selvage, the warp can be readily distinguished from the filling, since the selvage ends always run in the direction of the warp. In many cases the body of the cloth will be found to be woven from single yarn, while the selvage is woven from 2-ply, or double, yarn. If the yarns in one system are harder twisted, or have more turns of twist per inch, than those in the other, the harder-twisted yarns are generally the warp yarns. If the sample of cloth has what is called a face finish, or nap, the direction of the nap indicates the warp, since these cloths have passed through the machine in the direction of the warp. The counts, or numbers, of the yarn used in each system will often assist in indicating which is the warp and which is the filling, since in many cases the warp yarns are of coarser counts than the filling. If in any case one series of yarn is of different materials, such as cotton and wool or cotton and silk, while the other series of yarn is of one system, the series of yarn that is composed of different systems is generally the warp yarn, although this is not an invariable rule. If one system of yarns has been sized and the other has

not, the former is the warp. This is difficult to determine after the cloth has been finished, but is a good test for brown—i. e., unbleached—cotton goods. If the sample contains reed marks, they will indicate the warp, since they always run warp-way. These marks are caused by the reed wires getting out of place, thereby crowding some of the ends near them and allowing others too much space. In any fabric of a striped character, or in a checked effect in which one direction of the lines is prominent compared with the other, the direction of the stripes or the prominent lines in the check usually indicate the direction of the warp. The twill, if the design is a twill, generally runs up diagonally from the left to the right, so that if the face of the cloth is ascertained it will be readily seen which is warp and which is filling. If one series of yarns is ply and the other single, the ply yarns are generally the warp. In samples of cloth similar to that considered in this Section, the stripes always run warp-way.

DETERMINATION OF TWIST

19. By the term *twist* of yarn is meant both the direction of the twist and also the amount of twist; that is, the number of turns of twist per inch placed in the yarn. The direction of the twist of the yarns in a cloth becomes an important matter when reproducing cloth, since a different effect will sometimes be produced by simply changing the twist in either the warp or filling. Yarns may be twisted in one of two directions, which are technically known as *right twist* and *left twist*. There is considerable difference of opinion as to what constitutes a right-twist or a left-twist yarn, as some mills consider as right-twist what other mills consider left-twist yarn. However, the character of the yarns to which these names are most commonly applied will be explained here.

By holding the yarn between the thumb and forefinger of each hand, the direction of the twist may be learned. If when turning the yarn from the body with the right hand it is twisted harder, it is left-twist; but if the yarn is untwisted

when turned in this manner, it is right-twist. Another method of determining the twist of the yarn is to observe which way the twist marks on the surface of the thread are inclined when the thread is held upright. If they slant up to the left, the yarn is left-twist; if up to the right, it is right-twist. This is the method adopted with screws for determining the twist of the screw thread. Fig. 7 represents a yarn that would be known as a right-twist yarn, while Fig. 8 illustrates a left-twist yarn. By closely examining the warp yarns in the sample, it will be seen that they are right-twist.



FIG. 7 FIG. 8

As previously stated, twist also refers to the number of turns of twist that are put in the yarn in 1 inch. In case of a ply yarn this can be readily ascertained by putting the yarn under the pick glass; or it can be found with more accuracy by untwisting a given length of yarn and dividing the number of turns of twist by the number of inches measured.

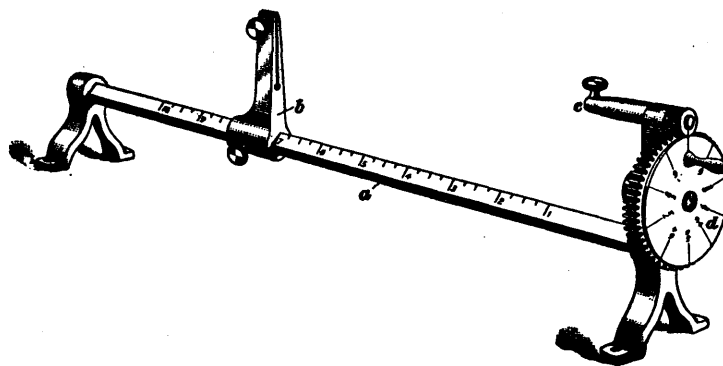


FIG. 9

20. Twist Counter.—The amount of twist in any yarn may be determined by means of an instrument made for the purpose of untwisting the yarn and registering the number of revolutions made in taking out all the twist; this instrument is known as a **twist counter**. The simplest and most commonly used form is shown in Fig. 9. It consists

primarily of two jaws, one of which b is capable of adjustment on a bar a ; the other jaw c may be rotated, the exact number of turns that it makes being indicated on a graduated dial d . The counter is adapted for finding the number of turns in a sample of yarn from 1 to 10 inches in length, whether right or left twist. The yarn is held firmly by the jaws at a given distance apart as indicated by the position of b on a ; the jaw c is then rotated until all the twist is taken out of the yarn, the instrument recording the number of turns on the dial d .

TAKE-UP IN WEAVING

21. In making out an order for the amount of warp yarn to be run through the slasher for any loom beam, it will be necessary to learn the probable percentage of contraction that will take place during weaving. For instance, if it is desired to produce 500 yards of cloth from a warp on one loom beam, a somewhat larger number of yards of warp yarn will have to be placed on the beam, owing to the contraction that will take place during weaving. The manner of ascertaining the contraction of any cloth during weaving was dealt with in *Cotton Cloth Calculations*, but it should be borne in mind that no hard-and-fast rules can be laid down for contraction of warp yarns, as this is largely a matter of experience, since some weaves take up much more than others during weaving. The kind of weave, the counts of the warp and filling, and the number of picks per inch are the most important factors that regulate the take-up of the warp, and these should always be carefully considered when desiring to learn the number of yards of warp necessary to weave a certain number of yards of cloth.

NUMBER OF BEAMS REQUIRED

22. In many cases, when desiring to reproduce a sample of cloth, it will be necessary to place the warp yarns on different beams. In some cases as many as four beams are used. For instance, in case a weave that interlaces only once in 6 or 8 picks is combined with plain cloth, the part of

the warp yarn that forms the plain weave will be taken up more rapidly than the other. In such a case it will be necessary to place those ends that form the plain weave on an entirely separate beam, since if this were not done the ends of the plain weave contracting so much more than the other ends would cause the latter to work slack and thus cause a defective cloth. In some cases a cloth may be regular, therefore apparently requiring only one beam, with the exception that at certain intervals there will be a fancy thread that will have different interlacings from the body of the cloth in order that it may produce some desired effect. In this case the fancy threads are placed on a separate beam or, if there are only a few, they are wound on a spool, which may be adjusted at the back of the loom.

When dissecting any cloth, to determine the number of beams required, the weave should be carefully considered. If the cloth is made entirely from one weave, it will be simply necessary to use one beam, but in cases where the cloth is woven with separate weaves, it will be necessary to study these weaves carefully and to ascertain whether one will take up more than the other. The most essential point to notice is the number of interlacings that each weave makes in a certain space. For instance, the ends of one weave may interlace with the filling six times in a certain number of picks, while the ends of another weave may interlace twelve times in the same number of picks. When such is the case, the ends interlacing the greater number of times will, of course, take up much more than the others, on account of their having to bend around the filling much more frequently; consequently, it will be found best in such instances to place the two systems of yarns on separate beams.

Double cloths and cloths backed with warp often require two beams, one for the face warp and one for the back warp, since the back weave is generally different and also because coarser yarns are used for the back of the fabric. If the same yarn and weave are used for the back as for the face of a double cloth, both warps can be put on one beam.

DETERMINATION OF RAW MATERIAL

23. In many fabrics there is a mixture of materials; for instance, cotton and woolen or worsted yarns are often used in the same fabric, as well as cotton and silk. In such cases it will be necessary to determine which yarns are of one material and which are of another. The readiest method of ascertaining the difference between animal and vegetable fibers is to burn some of the yarn. Vegetable fibers are composed of carbon, hydrogen, and oxygen, and when burned will make a flame, emit no odor, and leave an ash. Animal fibers are composed of the same elements together with nitrogen, and when burned will not flame, but smoulder, coil up, and form into a small, crisp globule. They are also distinguished by a peculiar odor that is similar to that of burned horn or feathers. A knowledge of the different fibers is also a great aid in determining the different materials in case threads of different fibers are used in the same fabric. Silk can generally be distinguished from either cotton, wool, or worsted by its incomparable luster and also by the fact that it is generally finer. However, mercerized cotton, which also has a remarkable luster, should not be confounded with silk. These two yarns may be distinguished by burning, as silk is an animal fiber while cotton is a vegetable fiber.

Linen may be distinguished from cotton from the fact that the thread is rougher and contains uneven bunches. It may also be distinguished from cotton by its harsher feeling.

In case it is desired to learn the percentage of the different materials in fancy threads, such as cotton and wool or cotton and silk mixed, or to determine the proportions of each material in a yarn made from two or more different kinds of raw stock, it will be necessary to make chemical tests. When a sample of yarn or cloth is to be tested in this manner it should first be thoroughly washed so as to remove any sizing or foreign matter that may exist. Afterwards dry it thoroughly and weigh it if the percentage of each kind of material is desired.

24. The following tests will cover the separation of silk, cotton, wool, or linen that may be combined in one yarn or cloth. To separate wool from cotton, leaving the cotton: Clean, weigh, and then boil the sample gently for 2 hours in an 8° B. solution of caustic potash; then wash and dry. During the boiling a few drops of water are added from time to time to prevent the alkali from becoming too concentrated. After drying at 100° C. (212° F.), the residue is weighed, which gives the weight of cotton, the loss being the weight of the wool. Instead of potash, a 7° B. solution of caustic soda may be used, and the sample boiled for 15 minutes.

NOTE.—B. means Baumé and refers to the graduated scale on Baumé's hydrometer used for determining the density of a solution.

25. To separate cotton from wool, leaving the wool: Immerse the sample in ammoniacal copper oxide for 20 minutes, after which add water to the solution; then filter and wash, dry and weigh the residue. The weight will be the amount of wool in the mixture.

26. To separate silk, cotton, and wool: Take two samples each of the same weight; boil them from $\frac{1}{4}$ to $\frac{1}{2}$ hour in a 3° B. solution of hydrochloric acid to remove the sizing, etc.; then wash them. Immerse one sample in a boiling solution of basic zinc chloride for a short time; then wash thoroughly, first in acidified and then in clean water, and dry it. The loss in weight gives the amount of silk. Boil the second sample for 15 minutes in a 7° B. solution of caustic soda, and then wash and dry it. The residue is cotton, to the air-dry weight of which must be added about 5 per cent. to compensate for the loss of the fiber during the operation. The difference between this and the original weight represents the weight of wool.