ANALYSIS OF WOOLEN AND WORSTED 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 always be desired exactly to 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 else with certain alterations tending to reduce the cost of the goods without materially affecting the appearance. In the case of a small mill that

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 color 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. Weight of 1 yard, given width
2. Ends per inch in finished cloth
3. Picks per inch in finished cloth
4. Warp pattern (if any)
5. Ends in pattern
6. Ends in warp
7. Patterns in warp
8. Filling pattern (if any)
9. Counts of warp in finished cloth
10. Counts of filling in finished cloth
11. Weight of warp yarn, each color
12. Weight of filling yarn, each color
13. Reed and ends per dent
14. Width in reed, including selvages
15. Weight from loom, including selvages
16. Weave
17. Harness, or drawing-in, draft
18. Chain draft

Many of these items belong to the subject of cloth calculations and therefore will not require any further explanation. In demonstrating the methods of obtaining the other requirements to be found, reference will be made to the same sample of cloth that was used in dealing with the subject of woolen- and worsted-cloth calculations. In addition to the requirements given in the above list there are several of minor importance that should be considered when reproducing a fabric; these, however, will be dealt with later.

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. There are several methods according to which a warp pattern may be made out. The best is that which employs a diagram to separate the colors, since there is then less liability of confusion and mistakes. In the sample of cloth under consideration the yarns are arranged in the warp 12 ends of brown and 12 ends of white; its pattern is indicated, according to the method above, as follows:

WARP PATTERN

Brown	12		12
White		12	12

Total number of ends in pattern 24

4. As the above is a very simple pattern, a more complicated one will also be taken for the purpose of illustration. Suppose this pattern to be as follows: 1 end of light blue, 1 end of white, 10 ends of dark blue, 1 end of white, 10 ends of dark blue, 1 end of white, 1 end of light blue, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate, 1 end of fancy, 4 ends of slate. The same method is applied to this pattern as to the previous one, thus:

WARP PATTERN

Light blue . .	1						1										2
Dark blue . .			10		10												20
Slate							4		4		4		4		4		20
Fancy								1		1		1		1			4
White		1		1		1											3

Total number of ends in pattern 49

In a pattern like the one given, where there is a repetition of certain combinations of ends in the pattern itself, the representation of the pattern can be reduced as follows:

WARP PATTERN

Light blue	1				1				2
Dark blue			10						20
Slate						4		4	20
Fancy							1		4
White		1		1					3
			2×			4×			

Total number of ends in pattern 49

The marks 2 × and 4 × indicate that the combinations of ends enclosed with a brace are taken two and four times, respectively. By carefully comparing these two forms the method adopted in the second will be readily understood and it will be seen that both patterns are the same. Another common method of indicating a warp pattern is to arrange the list of colors in the form of a column, enclosing with a brace each portion that is to be repeated and indicating the number of times that the part thus enclosed is to be repeated. With the pattern previously shown this would be as follows:

1 end light blue
1 end white
2 × { 10 ends dark blue
1 end white
1 end light blue
4 × { 4 ends slate
1 end fancy
4 ends slate
49 ends in pattern

FILLING PATTERN

5. 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 counts of yarn. In making out the pattern of the filling of 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 the pattern of the warp. In case the filling is all of 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. In the sample of cloth under consideration the filling pattern is exactly the same as the warp pattern, which has previously been given.

DISSECTING, OR PICKING OUT

6. 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, especially if the fabric has a pronounced weave effect or a color effect depending largely on the weave for the disposition of the color on the face of the cloth. The method of obtaining the weave will require considerable study and practice, although after the weaves of a few samples of cloth 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 from a woven fabric is commonly known as **dissecting, or picking out,** although these terms are sometimes applied to the whole 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 of interlacing the warp and filling, this being shown on design paper by means of filled-in squares, or *risers*, which represent the warp

floating over the filling, and blank squares, or *sinkers*, which represent the filling floating over the warp.

7. When a sample of cloth is to be picked out, the first thing to be determined is the face and back of the fabric and also which system of threads constitutes the warp and which the filling. These two points will be further discussed later, but the importance of determining these particulars before starting to pick out the weave should be mentioned here. If the back of the cloth were taken for the face, the warp ends would be up when in reality they should be down and down when they should be up. On the other hand, if the filling were considered as the warp, a correct pick-out could not be obtained, since filling threads would be marked up on the design paper when in reality, since they are filling threads, they should be left blank; and at the same time the weave obtained would be turned one-quarter way around. In a twilled cloth this latter would have the effect of making the twill run in the wrong direction. After the face and back, and also the warp and filling, have been determined, the sample should be held in such a manner that the face side will be up and the filling will pass from side to side.

8. As the term *picking-out* implies, the operation of finding the weave from a sample of cloth consists in picking out each pick of filling separately and setting down on design paper the manner in which it interlaces with the warp. Thus, if the filling passes under the first warp end, the square on the design paper representing where that end intersects with the pick under consideration will be filled in, showing that the warp end is raised over the filling at that point. If the pick of filling passes over the second warp end, the square on the design paper representing where the second end intersects with the pick of filling will be left blank, showing that the warp is depressed and the filling is on the face of the cloth at that particular point.

9. Preparation of Sample.—Before commencing to pick out the weave, the sample of cloth needs a certain amount of preparation in order to facilitate the operation.

Several ends from the left side of the sample and several picks from the top should be pulled out, after which all loose ends, except those needed to determine the weave, should be cut off. Generally it is sufficient to leave only enough ends for the repeat of the weave, but before cutting them off be sure that enough ends for a repeat have been left. When

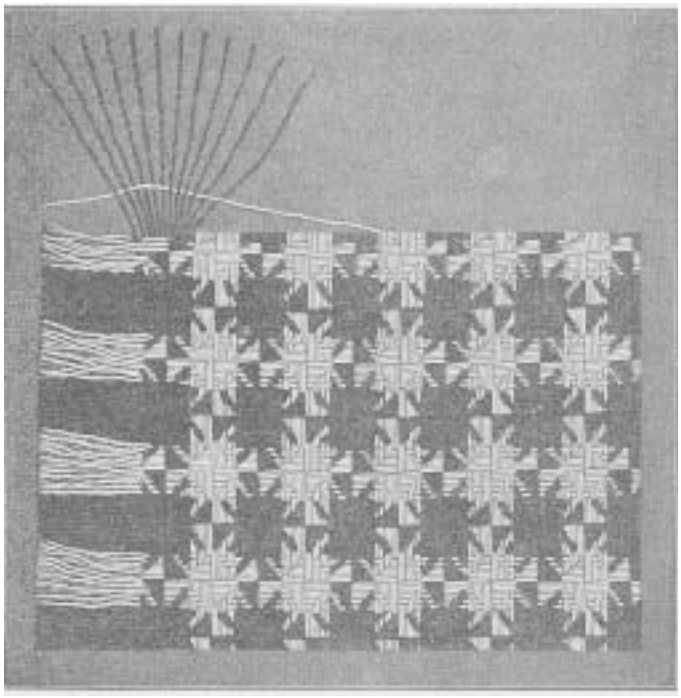


FIG. 1

the preparation of the sample is completed it will have an appearance similar to that shown in Fig. 1, which is a slightly enlarged photographic reproduction of the sample when ready to be picked out.

10. 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 the intersection of each end with the first, or top,

pick has been determined, that end may be drawn under the thumb and held out of the way while determining the intersection of the next end. In this manner it will be possible easily to keep the ends separate and determine the interlacing of each consecutive end with the pick.

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 *picking-out*, or

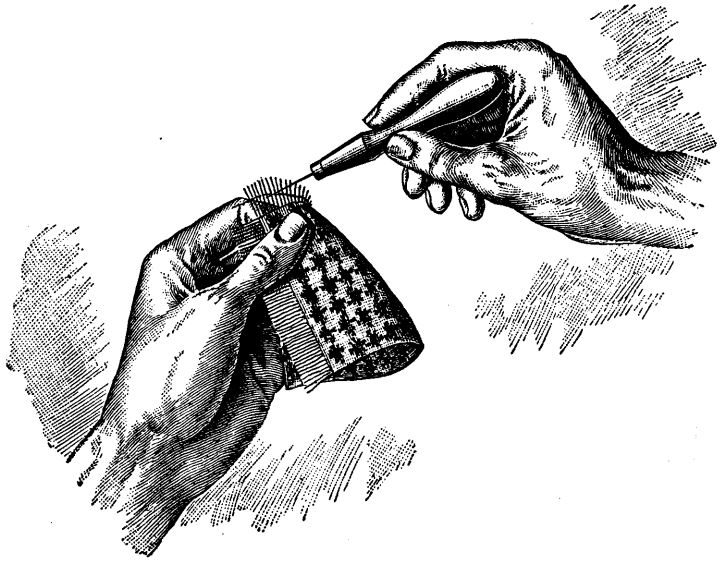


FIG. 2

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 it contains light-colored yarns. By this means the interlacings and individual threads will stand out much more prominently, especially when working by artificial light. When this 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 counted readily. A pick glass with a field of less than 1 square inch is undesirable for purposes of analysis.

In either method, the top pick should be drawn slightly from the body of the cloth until its interlacings with the ends can be plainly seen. Then commencing with the end of the warp at the left and taking each end in succession, indicate on design paper whether the end is above or below the pick of filling. If the first end is above the pick of filling, it will be represented by a filled square on the design paper; if it is below the pick, the square will be left blank. 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 be sure of a repeat of the weave, 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 the design paper and the interlacings of the first end, or the end at the left, with the first pick should be placed on the first square 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. It should be understood that the top pick is not the first pick that is put in the loom, although it is the first pick picked out. If the top pick of the weave were the first one put in the loom the weave would be reproduced in reverse order; that is, top for bottom. This being the case, it will be seen that the last pick of the weave removed will be the first pick put in the cloth in the loom; consequently, the lower left-hand corner of the weave, when placed on design paper, is then considered to represent the intersection of the first end and first pick. This is difficult for a beginner to comprehend, but must be

thoroughly understood, since it is an important point 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 raised among the loose ends, so that its intersections may be found in the same manner as those of the first pick. The intersections of the second pick should be placed on the horizontal row of squares directly below the row of squares on which the intersections of the first pick were marked. After marking the interlacings of the second pick, proceed in a similar manner with the third and each successive pick until a pick is found that interlaces with the warp in the same manner as the first pick. This generally indicates that the weave repeats at this point, but it is a good plan to pick out three or four more picks and compare them with the first ones taken out, in order to be sure that the weave does repeat at this point. These extra picks must be ignored afterwards and only one repeat of the weave used when finding further particulars. When one repeat of the weave is obtained, it represents what is repeated as many times as required in the width and length of the cloth, and is therefore 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 is 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.

11. The best plan of indicating the weave when picking out is to prick with the picking-out, or dissecting, needle the squares that are required to be marked and afterwards mark them with ink or pencil. This method 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 a sample contains a large number of ends and picks per inch, or warp and filling yarns of the same color, the yarns are liable to become crossed and the wrong end marked on the design paper. To prevent this it is an advantage, before starting to pick out, to place the warp threads in a comb, fastening the ends together between two pieces of paper with mucilage, in order to prevent their slipping back. If the ends are crossed or in the wrong order when placed in the comb, this fact will be noticed before the weave repeats, and by making a note of the places 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 cloth difficult to dissect.

It often happens that a certain sample, owing to the large number of warp ends that it contains, is much easier to pick out if the ends are removed from the cloth instead of the picks, but in this case the squares must be filled in for those picks (considered as ends) that are down and left blank for those that are up. Unless this is done the reverse of the weave in the sample will be obtained on the design paper.

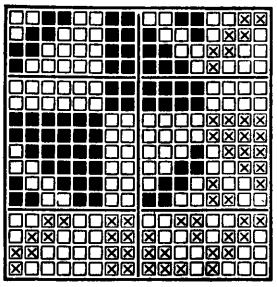
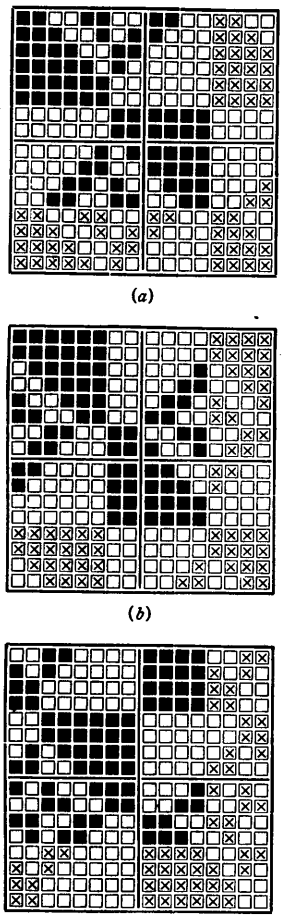


FIG. 3

A good aid when picking out warp-backed and double cloths is to cut the backing ends about $\frac{1}{8}$ or $\frac{1}{4}$ inch shorter than the face ends, after having removed a sufficient number of picks for dissecting purposes. If the fabric is hard-felted or has a nap, singe the sample with a match and with a knife scrape off the fiber, being careful not to injure the body of the yarn. In many cases where weaves are of regular order, as twills or weaves that are very frequently used, it will not be necessary to pick out the weaves, since they will be readily recognized from the appearance of the fabric.

12. In Fig. 3, the pick-out for the cloth sample under consideration is shown. It will be noticed that 4 ends and 4 picks are marked with crosses, while the rest of the weave is filled in solid. These are extra ends and picks that have been picked out, in order to make sure that one repeat of the pattern has been obtained. When greater confidence has been obtained, it will not be necessary to pick out many extra ends and picks in simple weaves. This is desirable, however, in the more complicated weaves. The solid, or filled-in squares, represent one repeat of the weave, which it will be seen is a check weave on 12 ends and 12 picks.



(*a*)

(*b*)

(*c*)

FIG. 4

Several correct but apparently different results might be obtained in picking out a sample of cloth, owing to the fact that the pick-outs might not have been started on the same end or the same pick; in this case each end and pick will be the same in each pick-out, but arranged in different order.

For instance, if the cloth sample had been so prepared that the seventh end of Fig. 3 was the first end at the left of the sample and the top pick of Fig. 3 was still the top pick of the sample, the weave shown in Fig. 4 (*a*) would have resulted. If the sample had been so prepared that it corresponded in its ends to Fig. 3, but the top pick was the tenth pick of Fig. 3, the weave obtained would be as shown in Fig. 4 (*b*). Again, if the sample had been so prepared that the eleventh end of Fig. 3

was the first end of the sample and the fourteenth pick the top pick, the pick-out would have resulted as shown in Fig. 4 (*c*). If these three weaves are examined carefully, it will be seen that although the weaves are apparently different from one another and from Fig. 3, they are all in reality exactly alike, since if repeated several times in the cloth, the same effect will be produced, the difference in their appearance being due only to the end and pick on which the pick-out is started.

After having obtained a pick-out of a greater number of ends and picks than is actually necessary to show one repeat of the weave, it is always best to so select the ends and picks for a repeat that the weave will have the appearance that it naturally would if constructed by a designer. Thus, if one repeat of the weave, as shown by the filled squares in Fig. 3, be compared with one of the weave shown by the filled squares in Fig. 4 (*c*), the lack of a logical and natural arrangement of the weave is very noticeable in the latter as compared with the former. The impression conveyed by Fig. 3 is that the weave is a simple check weave, consisting of four equal sections of 6 ends and 6 picks each. It is also apparent that in the upper left-hand and lower right-hand sections the filling predominates on the face of the cloth, while in the upper right-hand and lower left-hand sections the warp predominates. No such impressions are conveyed by the repeat of the weave as shown in Fig. 4 (*c*), nor is the arrangement of the weave as clear, even in Fig. 4 (*a*) and (*b*), as in Fig. 3. It will thus be seen that there are advantages in selecting the most suitable end and pick as the first end and the first pick of a weave, and especially is this true in weaves that are combinations of two or more simple weaves.

There are several points that may be learned from the weave of the sample under consideration. In the first place, it will be noticed that this weave is an evenly bal anced check; that is, the total area of 12 ends and 12 picks occupied by the weave is divided into four areas of 6 ends and 6 picks each. The check is obtained by transposition and cuts perfectly; that is, the warp floats of one section

oppose the filling floats of the adjacent sections and vice versa. When the yarns used are colored as in the sample under consideration, this weave produces what is sometimes known as a *star check*.

It should not be thought that every sample of cloth is made up of a weave design, or combination of weaves, as in the case of this sample; many cloths consist of simply one weave.

HARNESS, OR DRAWING-IN, DRAFTS

13. The **harness draft** indicates the order in which the warp ends are drawn through the harnesses. When making it, each end that interlaces with the filling in a different manner from other ends must be drawn in on a separate harness. As a result, as many harnesses will be required for any given weave as there are ends having different interlacings.

By carefully examining each end in one repeat of the weave obtained from the cloth under consideration, it will be seen that of the 12 ends in the weave all have different interlacings with the filling except the fifth and sixth ends, which are alike, and the seventh and eighth, which are also alike. The fifth and sixth ends, therefore, could be drawn in on the same harness, since they work exactly the same; this is also true of the seventh and eighth ends. But as this would make an irregular drawing-in draft and result in the saving of only 2 harnesses, it is best to draw the warp through the harnesses straight for this fabric. This will make a straight drawing-in draft on 12 harnesses, as shown in Fig. 5.

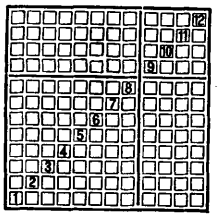


FIG. 5

The horizontal rows of squares in Fig. 5 represent the harnesses, while the figures in the draft show on which harness each end is drawn in. In making out the drawing-in draft, commence with the first end of the weave at the left and draw it in on the first harness. The second end of the weave must in this case be drawn in on a separate harness, as it has different interlacings from the first end, and so is

drawn on the second harness as indicated. Proceed in the same manner with each end of the weave in succession, always working from left to right.

14. If any end in a weave has interlacings exactly the same as the interlacings of any other end in the weave, it may be drawn in on the same harness, in which case the same number of harnesses as ends in the weave will not be required. However, as explained previously and illustrated by the weave under consideration, it is sometimes desirable to use more harnesses than are absolutely necessary, because of the increased simplicity of the drawing-in draft thereby obtained. The drawing-in draft will always occupy the same number of ends as one repeat of the weave, but if more than one end is drawn on any harness it is evident that the same number of harnesses as ends in the weave will not be used.

It should be borne in mind that the color of the ends does not make any difference in the manner of drawing each end through the harnesses, the only distinction being the manner in which the end interlaces with the filling, except that in some cases, where there is a fancy thread in a design, these threads are all drawn on one harness if possible. Many weaves may be drafted down to a very small number of harnesses, but this is not always advisable, as in many cases the draft will become so complicated that the weaver will have considerable trouble in drawing in a broken end on the correct harness. Then, again, if the whole warp is drawn in a small number of harnesses, especially in goods having a large number of ends per inch, the heddles on the harnesses become so crowded that the ends break much oftener, owing to the chafing that results from operating the harnesses when they are crowded. In many cases other circumstances will be found that influence the number of harnesses on which a weave or combination of weaves is woven. A student of designing should constantly seek information on these points, especially in a weave room where there is an opportunity of examining samples of cloth from the various fabrics and of knowing how they are woven. He may then

find, by analysis, the lowest number of harnesses on which it is possible to weave the sample, and also the actual number of harnesses on which it is being woven in the weave room. If more harnesses are used than the lowest number possible, the reason should be learned. With many weaves it will not be possible to tell at a glance the number of harnesses necessary, as was the case with the weave in the sample of cloth under consideration. Such weaves must be carefully examined and the interlacings of each end studied separately, in order to determine which ends have similar interlacings.

15. When making out the harness, or drawing-in, draft for any weave, the following particulars should be noted in each case: (1) It is always desirable to make out a harness draft 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, as he can thus find the proper harness more readily. (2) Try to have the same number of ends on each harness; this is a great aid to the smooth and easy running of the loom, as it equalizes the strain on each harness. (3) If it is necessary to place more ends on some harnesses than on others, try to have these harnesses at the front, as the majority of broken ends will occur on these harnesses and, if they are at the front, the ends are much more easily tied in. The front harnesses also are easier on the yarn, since they are not lifted as high in shedding as the other harnesses.

CHAIN DRAFT

16. The **chain draft** is obtained from the weave and drawing-in draft, and therefore these must first be obtained. By referring to Fig. 5, which shows the harness draft for the weave under consideration, it will be seen that the first end in the weave is drawn in on the first harness; therefore, the interlacings of the first end must show the working of the first harness; or in other words, the interlacings of the first end show the manner of raising the first harness. The

second end is drawn through the second harness; therefore, the interlacings of the second end as shown in the weave illustrate the manner in which the second harness is raised. The same method is continued throughout, proceeding in regular order, as this is a straight draft. However, where a weave is drafted to a lower number of harnesses than there are ends in the weave, that is, where the drawing-in draft is not straight and more than one end is drawn in on any harness, that harness will control two or more ends of the weave; but in the chain draft only one of these ends will be needed to govern the method of raising the harness. Consequently, when obtaining the chain draft, begin at the left of the weave and take only those ends that are drawn in on different harnesses, taking each end only once. In the weave under consideration, each end is drawn in on a different harness; therefore, each end will have to occur in the chain draft as shown in Fig. 6, which in this case is the same as the weave, or pick-out, in Fig. 3, in consequence of the drawing-in draft being straight. When the harness draft is not straight, the chain draft becomes a reduced weave—reduced according to the harness draft.

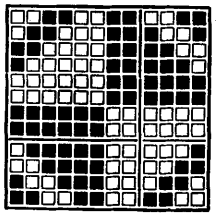


FIG. 6

ADDITIONAL POINTS TO BE DETERMINED BY ANALYSIS

17. In addition to the requirements listed in Art. **2**, there are a few other items that must in most cases be determined when analyzing a fabric. Some of these are unnecessary in themselves, but must be ascertained in order that other items may be accurately found. They are as follows: (1) determination of the face and back of the fabric; (2) determination of warp and filling; (3) determination of the direction of twist in warp and filling; (4) the shrinkage of the cloth; (5) the number of beams necessary; (6) the raw material.

DETERMINATION OF FACE AND BACK OF FABRIC

18. The face and back of a fabric must always be decided on before finding the pick-out, in order that the correct weave may be obtained. In most fabrics this is easily done, although some cloths baffle the most experienced designer. The face of a worsted fabric that has a prominent design will be found to show a much clearer and better pattern than the back. The finish on the face side is also better in practically every case, the cloth being generally sheared or singed closer; it will also be more lustrous, since it receives more brushing and attention in the finishing. Often the back of such a cloth will show more or less loose fibers, while the face will be devoid of the same. Often the effect of the weave is such that the face of the fabric is readily determined. When a fabric is a backed or a double cloth, the face can often be distinguished by the style of the finish. The backing yarns in a double cloth are also frequently coarser and of poorer quality than the face yarns. 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 the cloth a warm feeling. Warp-backed fabrics have long floats of the backing warp floating on the back of the cloth, and therefore the face is readily determined.

When a fabric has a stripe design, the stripe usually shows up more prominently and has a more finished appearance on the face of the fabric. In milled and napped fabrics, the face of the cloth is mostly smoother and more lustrous than the back, and the nap is generally brushed in one direction and sheared to an even length, thus making a smooth and velvety surface on the face of the goods.

DETERMINATION OF WARP

19. There are several methods by which the warp may be distinguished from the filling: (1) If the sample submitted for analysis contains a part of the selvage, the warp can be readily distinguished from the filling, since the selvage always runs in the direction of the warp. (2) If in any

fabric one series of yarn is found to be harder-twisted—that is, has more turns of twist per inch—than the other series, the former will in all probability be the warp, because harder-twisted yarns are stronger and it is customary to use them where the most strain occurs, which is always in the warp. (3) If the sample has been gigged and a fairly long nap raised on the cloth, the direction of the nap will always indicate the direction of the warp, since all cloth, in being finished, is passed through the finishing machines in the direction of the length of the piece, or the warp. (4) The counts, or number, of the yarns will often indicate which series of yarn is warp and which is filling, since in many cases the filling will be of finer counts than the warp. However, the student should not assume that this is true in every instance. (5) If in any case one series of yarn is found to consist of threads of different materials, such as worsted and cotton, while the other series of yarn is all of one material, the former is generally the warp, although this is not an invariable rule. (6) If the sample of cloth submitted for analysis contains reed marks, these marks will indicate the warp, since they always run warpway of the goods. They are caused by the reed wires becoming bent or getting out of place, thereby crowding some ends together and giving others too much space. (7) Any fabric of a striped character, such as trouserings, etc., will usually indicate the warp at once, as the stripe nearly always runs in the direction of the warp. (8) If the design is a twill, it generally runs up to the right, thus indicating the warp. This, however, is not an invariable rule, as many cloths are twilled to the left. (9) If one series of yarn is composed of ply yarn and the other series of single yarn, the ply yarn may usually be considered the warp and the single yarn the filling. In woolen cloths, however, ply yarns are frequently used in the filling. (10) In union fabrics in which one series of yarn is all cotton, this series is generally the warp yarn.

DETERMINATION OF TWIST

20. By the term **twist** both the direction of the twist and the amount of twist, or number of turns per inch, placed in the yarn is meant. The direction of the twist of yarn becomes an important matter when reproducing cloth, since with some weaves a different effect will sometimes be obtained by simply changing the twist of the warp or the 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 as left-twist yarn. However, the method of indicating the twist that is most commonly applied will be explained here.

By holding the thread between the thumb and forefinger of each hand the direction of the twist may be easily learned. If, when turning the yarn from the body with the right hand, it is untwisted, it is right-twist; if it is twisted up harder, it is left-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 yarn in the sample under consideration, it will be seen that all the yarn in the warp is a 2-ply yarn twisted to the left, or left-twist, while the filling is a single right-twist yarn. The single yarns twisted for the warp thread would be spun right-twist and when folded would be twisted to the left, since the ply yarns are always twisted in the opposite direction to the single yarns of which they are composed.

FIG. 7 FIG. 8

As previously stated, twist also refers to the amount of twist, or the number of turns per inch, in a given yarn.

In the case of a ply yarn this can usually be readily ascertained by putting the yarn under a 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.

21. 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

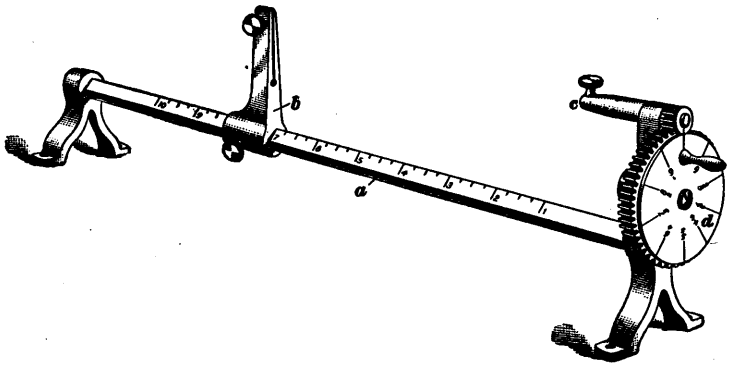


FIG. 9

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*.

SHRINKAGE

22. The shrinkage of the cloth is an item that can be determined only by the experience and the judgment that will come to the student of designing after becoming familiar with various cloths and their peculiarities in finishing.

It must be understood that while it is true that certain goods shrink a given percentage within certain limits, yet there is some leeway, and the finisher can produce goods of any width and weight required within reasonable limits. The shrinkage, of course, varies largely with the raw material as well as with the class of goods; some wools will full up much more quickly than others and thus shrink more. It must be remembered that goods can be shrunk almost any desired amount, depending on the nature of the fabric that is desired.

23. The following table shows the percentages usually allowed for different classes of goods, thus giving an idea of how wide they should be reeded, in order to finish easily to the desired width:

Class of Goods	Percentage of Shrinkage
Beavers	25 to 30
Kerseys	25 to 30
Meltons	25 to 30
Pilots	25 to 30
Doeskins	15 to 20
Cassimeres	12 to 15

Woolen goods shrink more than worsted goods and consequently should be reeded wider and warped longer for the same finished width and length. Goods that are fulled also shrink more than goods that are not fulled. Heavy woolen goods with heavy fulling, such as triple-milled goods, will sometimes shrink as much as 30 per cent. and will average from 25 to 30 per cent. For light-weight, fulled

woolens a shrinkage of from 12½ to 18 per cent. in the width should be allowed, while if not fulled a smaller allowance, say from 10 to 15 per cent., is sufficient. As a general rule goods do not shrink so much in length as in width, especially those that are not fulled, the action in passing through the finishing machinery being to keep the goods stretched in length.

For light-weight worsted goods with a clear finish from 8 to 12½ per cent. shrinkage in width is sufficient to allow, while if fulled (which is rarely done) from 12½ to 15 per cent. should be allowed. For heavy-weight worsted goods with a clear finish from 12½ to 15 per cent. shrinkage in width should be allowed, while if the cloth is fulled an allowance of 15 to 20 per cent. should be made.

Goods made with cotton warps do not shrink in length, and those with cotton filling do not shrink in width, to so great an extent. Goods with a mixture of cotton and wool, either in warp or filling or both, shrink proportionately less than goods made from pure wool. When it is desired to estimate the shrinkage of a fabric from a small sample, a thread of a given length, say 2 inches, may be pulled out, moistened a little, and then stretched (but not too hard) and measured again. The amount that the thread stretches will give some indication of the amount that the fabric has shrunk. This may be done with both warp and filling.

NUMBER OF BEAMS REQUIRED

24. Although the majority of cloths are woven from one beam, yet in many cases, when desiring to reproduce a fabric, it will be found necessary to use more than one beam for the warp yarn, in order to allow for the difference in the take-up of a portion of the warp yarn. When dissecting any cloth, in order to decide this, the weave should be carefully considered. If the cloth is made from one regular weave and the warp yarn is all the same, it will be necessary to use only one beam; but in cases where two or more weaves are combined in a fabric, it will be necessary to study the

weaves carefully and ascertain whether one will take up more than the other.

When desiring to find the number of beams necessary to weave any sample of cloth, the most essential point to notice is the interlacings of each weave. 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 in the same design may interlace twelve times in the same number of picks. When such is the case, the ends that interlace the larger number of times will, of course, take up faster, owing to the fact that they bend around the filling more times. If a warp for a cloth like this is placed on one beam, those ends that take up more rapidly will grow tighter in the fabric, thus giving it a cockled appearance. In such instances it will be found best to separate the ends that do not take up alike and place them on two beams. It is unnecessary to use two beams, unless there is a marked difference in the take-up, since small differences will be overcome by the elasticity of the yarn.

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 jack-spool, which may be adjusted at the back of the loom.

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

25. In many fabrics there will be a mixture of different materials; for instance, woolen and cotton yarns, worsted and cotton, woolen and silk, worsted and silk, and other

combinations are often found in the same fabric. In such cases it will be found necessary to determine which ends are of one material and which ends are of another. A knowledge of the different fibers is of great aid in determining of what material various yarns are made, but often a single yarn may be composed of several materials, the mixture having been made in the raw stock. In this case chemical or microscopical tests must be used, in order to determine the different materials and the percentage of each.

The quickest, and an invariable, method of ascertaining whether a sample is composed of animal or vegetable fibers is to burn a sample of the yarn. Vegetable fibers are composed of carbon, hydrogen, and oxygen, and when burned will make a flame and leave a white ash, but will emit no odor. Animal fibers are composed of the same elements as vegetable fibers, but also contain nitrogen and, in the case of wool, sulphur to a small extent; when burned, they will not flame but smolder, coiling up and forming a small, crisp globule. They are also distinguished from the vegetable fibers by the peculiar odor, similar to that of burned horn or feathers, that they emit while burning.

26. Distinguishing Woolen From Worsted Yarn. To distinguish a woolen yarn from a worsted yarn, untwist the yarn and observe the disposition of the fibers in the structure of the thread. A worsted yarn is a thread composed of wool, the fibers of which lie smoothly in the direction of the thread and are parallel to each other. The surface of a worsted thread is comparatively smooth and the thread generally has a well-defined luster. A woolen yarn is also a thread spun from wool, but the individual fibers are mixed and crossed in every conceivable direction and the surface of the thread presents a uniformly rough appearance, which, however, is lacking in luster.

As a further test in distinguishing between woolen and worsted yarns, the length of the fibers that compose the thread may be observed. Fibers from a woolen yarn are usually quite short, while those from a worsted yarn are

longer. This test alone gives not sufficient data on which to base an authoritative statement, because some woolen yarns are composed of rather long fibers, while certain worsted yarns are made of comparatively short fibers; it serves, however, as a further indication to supplement the deductions of other tests. The woolen fiber is also crinkled and curled, while the fiber in a worsted thread has a straight appearance.

27. Distinguishing Silk From Other Yarns.—Silk can generally be distinguished from either cotton, woolen, 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 the silk, being an animal fiber, will burn similarly to wool.

28. Distinguishing Linen From Cotton.—Linen may be distinguished from cotton from the fact that the thread is rougher and contains uneven bunches. Linen may also be distinguished from cotton from the fact that it has a harsher feeling.

29. Ascertaining the Percentage of Each Material in Union Fabrics.—Tests have been given by means of which it should be possible to distinguish the fibers that are ordinarily met with in textile fabrics, but nothing has been said about the quantity. Where different materials are placed in a fabric in solid threads of each material it is a simple matter to determine the amount of each material, but when the different materials are mixed in the raw stock it is more difficult to find the exact percentage of each. For instance, many woolen yarns, especially warp yarns in low-grade goods, contain cotton, which not only cheapens the fabric, but makes the yarn stronger. To determine the percentage of cotton, or other vegetable fibers, in a mixed yarn composed of animal and vegetable fibers, the following method may be employed: If accurate results must be obtained, the yarn or cloth sample in which the percentage

of wool and cotton, or other animal and vegetable fiber, is to be determined should first be stripped of dye stuff by being boiled in dilute hydrochloric acid. The yarn or cloth is then immersed for 20 minutes in ammoniacal copper oxide or concentrated sulphuric acid, which destroys the vegetable matter. The fibers that are left when dried and weighed will give the percentage of wool, or other animal fiber, as compared with the weight of the original sample.

30. A method that is used perhaps more frequently than the above is to boil the weighed sample in an 8° B. solution of caustic potash for 2 hours, after which it is washed and dried. During the boiling, a few drops of water are added from time to time to prevent the alkali from becoming too concentrated. After the sample is dried, its weight will be that of the cotton in the sample and the loss in weight will be that of the wool. Instead of potash, a 7° B. solution of caustic soda may be used, the boiling being carried on for not over 15 minutes.

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

31. To separate silk, cotton, and wool: Take two samples each of the same weight; boil them from 15 to 30 minutes 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.