

what is known as Utrecht velvet, one portion of it being left uncut for the purpose of showing the loop.

Another method of making a cut pile is by making it with the weft. In this method the ground of the cloth is woven plain or twilled and the weft which is to form the plush is allowed to pass over the face of the cloth a sufficient distance to form the length of plush required. A sharp knife is then taken, having, in front of and fixed on it by means of a groove, a guide; the size of the guide being regulated by the length of the plush. The point of the guide is inserted under the loose weft on the surface of the cloth, and pressed forward, and as it slopes up it raises the weft up to the edge of the knife, which severs it. Fig. 51



Fig. 51.

shows the section of this kind of plush before and after being cut, though the length of pile is much less than usual, and Fig. 52 shows the cutting knife, *a* being the guide.

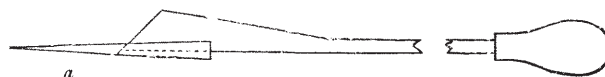


Fig. 52.

If the reader has followed carefully the foregoing he will have observed that the ground cloth is perfectly plain in both the warp pile and the weft pile cloth, and that the pile or plush is worked on the figuring principle. And to whatever extent it may be carried, whether the plush be bound down by a single end, or, as often happens the plush is woven into the ground cloth for a considerable distance, sometimes for the purpose of producing patterns and sometimes for the purpose of more securely binding the plush into the cloth, yet the same principle remains, viz., a combination of plain and figure.

Numberless combinations of these two fundamental principles may be effected, but I have selected the principal and most characteristic ones for the purpose of illustrating

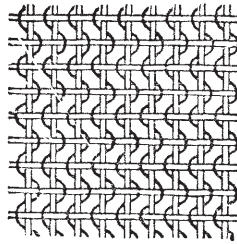


Fig. 53.

the theory I have laid down. It now remains for me to show the nature of the third of these fundamental principles, and the combinations that may be effected with one or both of the other two.

The essential feature of gauze-weaving is, that the warp ends and the weft do not necessarily cross each other at right angles, but in plain gauze, for instance, between every pick of weft the warp threads are made to cross each other, or, as it were, to twist half round each other, so that the weft threads are held separate, as shown at Fig. 53 and the section Fig. 54, and a light transparent texture



Fig. 54.

is produced. In fancy gauzes the threads are crossed so as to make a pattern. The means of producing this effect will be fully described in a future chapter, the object at present being to show the nature of the fabric and the principle of construction. By combining this kind of weaving with one or both of those previously described some beautiful effects are produced. These combinations may be in such an immense variety of forms that it

would be impossible to go through them in detail within the limits of this work, indeed much of it must be left to the taste and ingenuity of the designer. I shall content myself by giving in the chapter devoted to the practical consideration of this branch of the subject the details of a few leading effects which form the basis of gauze cloths.

COMBINATIONS AND ARRANGEMENT OF DESIGNS.

Having in the last chapter indicated the principle upon which cloths are constructed, we will now proceed to deal with the practical part of the question, and examine in detail the various combinations spoken of and the simplest and easiest methods of arriving at them, and by going carefully step by step through the various stages endeavour to place the subject before the reader in such a manner as to make it perfectly intelligible.

In designing for textile fabrics, as in designing for anything else, the first thing requisite is some system of arranging upon paper the pattern which is intended to be woven upon the fabric. This is done by having paper ruled in small squares as shown at Figs. 43 to 45. The first thing which it is necessary to impress upon the student with reference to this paper is, that the spaces between the lines are intended to represent the warp and weft, and not the lines themselves, the vertical spaces representing the warp and the horizontal spaces the weft, the pattern being arranged by filling up the desired spaces.

In the texture of plain cloth, as shown in the previous chapter, the threads cross each other, over and under,

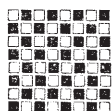


Fig. 55.

alternately. This is shown upon the design paper at Fig. 55; the squares which are filled in black showing the weft

thread passing over, and in the squares left open passing under the warp thread. That being the case, every alternate thread of warp or weft works exactly alike, that is, passes under and over the same threads, consequently two ends and two picks represent the whole pattern as in Fig. 56. It would seem at first sight that plain cloth cannot be ornamented except by an arrangement of coloured threads. Strictly speaking this is so, but plain working may be made the basis of a system of figuring exceedingly simple in itself, but very effective in certain classes of goods. If we take the example shown at Fig. 57 we have a plain cloth, but so arranged that two warp



Fig. 56.



Fig. 57.



Fig. 58.

threads work together as one throughout the piece, which will give the piece a corded appearance, the cords running lengthwise with the piece. These cords will be made more distinct as the weft is made to preponderate in the number of threads per inch over the warp. Again, in Fig. 58 we have a similar arrangement, but in this case the warp threads work separately as a plain cloth and the weft goes in two picks as one; this would produce a cord running across the piece; or in the direction of the weft. In like manner, in Figs. 59 and 60 we have a warp and a weft cord formed by

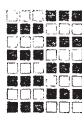


Fig. 59.

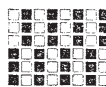


Fig. 60.

three warp or three weft threads working together. Again, we may have cords of varying sizes, large and small alternately, as shown in Fig. 61, where the cords consist

of one and three ends respectively; or we may combine the two cords and produce a decided figure as shown in

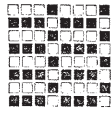


Fig. 61.

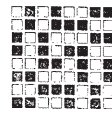


Fig. 62.

Figs. 62 and 63. In combining two workings of this kind some care and skill is requisite in joining them so as to prevent an imperfection at the junction, and it will be well to call attention to it now, so that the same

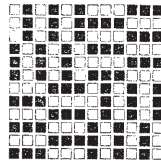


Fig. 63.

principle may be observed in future combinations. If we turn, for example, to Fig. 62, it will be seen that at the junction of the two cords the weft or warp passes under or over three threads. In some goods this might produce a little unsightliness, trivial as it may appear, but it can easily be obviated by so arranging the pattern that the first and last end or pick of each pattern becomes as

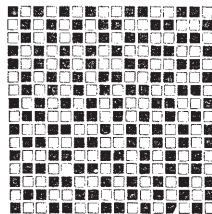


Fig. 64.

much a portion of the pattern to which it is joined as of the pattern to which it actually belongs. This may be illustrated by Fig. 64, which is the same arrangement on a larger scale, and in which the ends and picks which

form the junction of the pattern—the eight and ninth, for instance—each form part of both patterns. In this manner, and with the exercise of care and ingenuity, a great diversity of patterns may be produced upon the basis of plain cloth.

Next to plain cloth in its simplicity and extent of application comes twilling, which may be considered the first step in figuring. In twilling two objects are aimed at, viz., to give strength and weight to the cloth, and to ornament the surface in a pleasing manner. It must not be understood by giving strength to the cloth, that with a given number of threads of given strength per inch twilling would produce a cloth as strong as a plain cloth, because from the very nature of plain cloth, the threads crossing each other alternately, nothing could possibly be stronger; but by twilling a greater number of threads per inch, both in the warp and weft, can be put in than can possibly be put in plain cloth, the character of the working allowing the threads to lie closer together, and consequently produce a stouter fabric.

The number of twills which may be woven is very extensive, but they may be conveniently divided into three kinds, and treated under the following heads: regular twills, broken or satin twills, and fancy twills. The first to claim our attention, as being the first removed

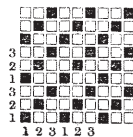


Fig. 65.

from plain cloth are the regular twills. In this kind of twill the small stripes formed by the intervals at which the warp and weft threads cross each other run obliquely across the cloth which is produced by the warp threads

being raised in consecutive order, commencing at one side and following the direction the twill is intended to take. We will commence with the first variation or change from plain cloth, viz., the three end twill shown on Fig. 65, in which every third end is raised or depressed in succession, the weft passing over or under the other two. This is done by having three healds, the warp being drawn through them, and the healds raised to allow the weft to pass through in regular succession from front to back. A simple method employed for indicating the draught or order in which the ends are drawn through the healds, is shown at Fig. 66, the horizontal lines representing the healds and the numbers the warp threads; the position of the numbers on the horizontal lines showing the healds through which the thread is drawn; or vertical lines may be substituted

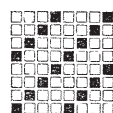
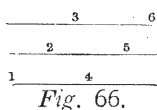


Fig. 67.

for the figures, and will be found to work even better in practice than the use of numbers. The four-end twill, Fig. 67, is similar to the three-end twill; in this case the weft passing over or under three threads and interwoven at the fourth. For this four healds are required, the warp threads being drawn through, and the healds raised in

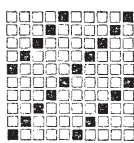


Fig. 68.

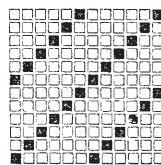


Fig. 69.

regular succession as before. Twills of five, six, or any number of ends may be worked in a similar manner, the

number of threads in the twill being drawn on a corresponding number of healds, and raised in consecutive order, as shown, Figs. 68 and 69.

It is not necessary that regular twills should be confined to one thread rising or sinking at once, but any number into which the pattern may be divided may be raised or depressed together. Take the case of a cashmere twill, Fig. 70. In this there are four ends, the weft passing over and under two. The draught of this is the same as Fig. 67, but instead of one heald being raised at a time

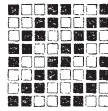


Fig. 70.

two are raised, each heald remaining up for two picks, but so arranged in their order of succession that one is depressed and another raised to take its place at every pick. Fig. 71 is a five-end twill with the weft passing over two warp

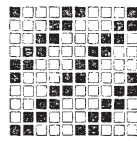


Fig. 71.

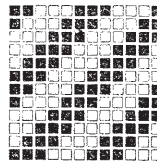


Fig. 72.

threads and under three, the order of working being precisely the same as in Fig. 70. Fig. 72 is another of the same description, the weft passing over three and under three warp threads, and so on *ad infinitum*.

Before proceeding further with twills, it will be advisable to examine the reason why a twill should be made to run in a particular direction. In nearly all twills one great object aimed at is clearness or closeness of the twill, so that the cloth may look as fine and compact in its structure as possible. To attain this result the direction of the

twill must be determined by the twist of the weft and warp, and should run in a direction contrary to both, and to do that the warp and weft should be contrary to each other in twist before being put together. This may be illustrated by Figs. 73 and 74. In Fig. 73 the warp and weft are placed at right angles to each other as they

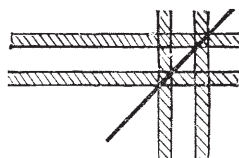


Fig. 73.



Fig. 74.

would be in the cloth, and it will be observed that in this position the twist of both runs in the same direction, but in Fig. 74, where they are laid parallel, the twists run in opposite directions; then the twill, which is represented by the dark line in Fig. 73, runs in a direction contrary to both. The result of this arrangement is that each thread of warp or weft in forming the twill becomes partly embedded over or under its immediate neighbour, and so produces a closeness and fineness which could not be obtained by any other means. If a twill cloth be examined it will be found that on one side, which corresponds with this arrangement, the appearance is all that could be desired, but on the other side of the cloth, where the reverse is the case, every thread stands out separate and distinct, and gives the cloth a very unpleasant appearance.

In some cases where the warp or the weft predominates very largely, it may not be of much importance what is the twist of the other, because being so much hid it could not have a very material effect on the appearance, but except in such cases this rule should be very carefully observed.

We may now begin to combine plain with twill, and produce a pattern which will give a firmer texture to the cloth, having somewhat of the character of the plain cloth with a twill pattern upon it. Fig. 75 is a twill of this description, and in point of texture is nearest to a plain

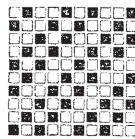


Fig. 75.

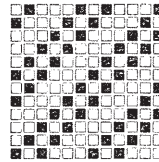


Fig. 76.

cloth, three of the five threads working plain, the weft passing over or under the other two to form the twill. Fig. 76 is another; this pattern is composed of six threads, three plain and three forming a twill. Fig. 77 is a still

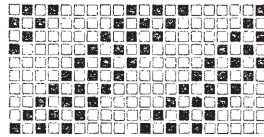


Fig. 77.

more extensive one, five threads working plain and five forming the twill.

In the three patterns, Figs. 70, 71, and 72, the twill is formed by the weft passing under and over a regular number of threads in regular succession; in the patterns Nos. 75, 76, and 77, the twill is formed by a number of plain ends and intervals of warp, over or under which the weft passes. We may now combine the two, and by this means produce beautiful and elaborate patterns, to the extent and variety of which there is scarcely any limit. Begin with Fig. 78, which is a cashmere twill with two ends plain

run along it, so making it into a six end twill ; Fig. 79, which is three weft and three warp twill, with two ends plain;

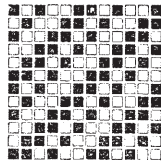


Fig. 78.

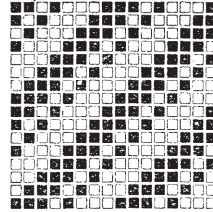


Fig. 79.

Fig. 80, with two ends plain running up between each weft and warp twill ; and Fig. 81, with four ends plain running up one side of the weft twill.

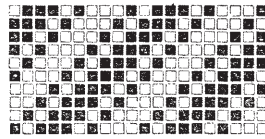


Fig. 80.

Before entering upon fancy twills it will be necessary to point out an important feature in the arrangement of the design, which is not only applicable to twills, but to every design for textile fabrics of every description. The design must be so arranged that the pattern will be continuous and unbroken all over the surface of the fabric. To do this, care must be taken that at each repetition of the pattern the joining must be complete and perfect. Take the case of the pattern Fig. 65. The complete

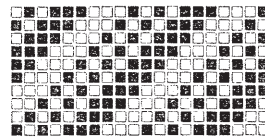


Fig. 81.

pattern is produced upon three warp threads and three weft threads, No. 1 being a repetition of No. 1, No. 2. of

No. 2₁ and No. 3, of No. 3, both in warp and weft; thus three threads constitute what is termed the round of the pattern, and however often repeated no break will occur in it. On examination this will be found to be the case with all the patterns, the point at which the pattern begins to repeat determining the number of healds that will be required to weave it. Each of the patterns given here as illustrations will be found to be repeated for the purpose of showing this clearly.

As I explained in the previous chapter, all twills are figures of a regular kind, that regularity being determined by the twill or figure running in a particular direction; the few examples just given will have served to some extent to illustrate it, but fancy twills, or, as they are more frequently termed, fancy diagonals, will more fully prove this. Fig. 82 is a pattern which is composed of plain, regular twill, and figure, the result being a decidedly fancy pattern. Fig. 83 is another of similar combinations. But the figuring of fancy diagonals need not be confined to this character of figure. Fig. 84 is an example of an altogether different type. Others of a more extensive and varied character may very easily be produced.

One important rule must be borne in mind in the arrangement of patterns of this description, viz., that the

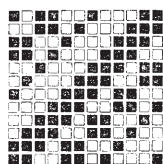


Fig. 82

number of ends occupied by the figure must be such a number as will divide in the number occupied by the diagonal, without leaving any remainder, or the pattern must be repeated over and over again, until a number of ends or picks is reached in which each will divide without

leaving any remainder, or in other words, a number of which each is a measure. In determining this the figure must be counted in a diagonal direction, because as it runs continuously in a diagonal direction, the number of ends or

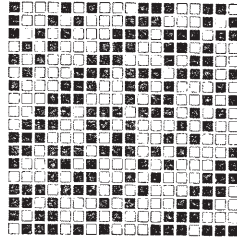


Fig. 83.

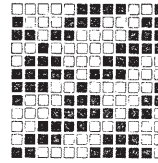


Fig. 84.

picks which it occupies could not be determined in a horizontal or vertical direction, and even if the ends and picks could be determined in the horizontal and vertical directions it would be of no avail, because it is only in the diagonal direction that it bears any relation to the other portions of the pattern.

If we examine Figs. 82 and 83, we shall see that the figure occupies a number, counted diagonally, which divides in the number occupied by the twill; consequently they are perfect at one repetition. Supposing in Fig. 83 the number

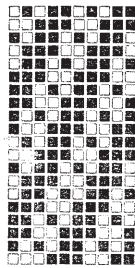


Fig. 85.

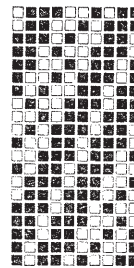


Fig. 86.

of ends occupied by the figure counted four diagonally, the twill portion occupies eighteen ends and eighteen picks; then to make the pattern complete, four not being a

measure of eighteen, the pattern would have to be repeated to thirty-six ends or picks, because eighteen is a measure of thirty-six and so is four. By adopting this method of calculating, the number of ends and picks which will be required to complete any pattern which is a combination may be determined at once.

In all the examples given here the twill moves only one thread at a time, that is, on each successive pick the pattern moves one thread to the right, so that supposing there are the same number of threads per inch in the weft as there are in the warp, the twill will run at an angle of forty-five degrees across the piece; but very excellent effects are often produced by making the twill to run at an angle of more or less than forty-five degrees. Fig. 85 is an example of a twill in which the pattern, instead of

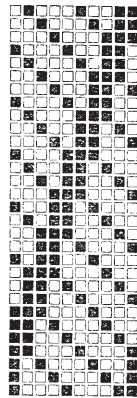


Fig. 87.

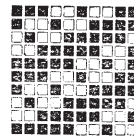


Fig. 88.

moving one thread every pick, only moves one thread every two picks, consequently the twills run across the piece at a very much higher angle. Fig. 86 is another example of twill of a similar arrangement, Fig. 85 being a single twill and Fig. 86 a double twill. To obtain variety of pattern the twills may be placed further apart, and twilling running in the opposite direction, as Fig. 87,

or figures of various kinds introduced between them. The angles of the twill may easily be altered by moving more or less frequently. Fig. 87, for instance, only moves one thread every three picks, while Figs. 88 and 89 move two threads at each pick. A comparison of the designs will show how easily an immense variety of patterns may be produced.

Similar effects may be produced, as will be shown by combination of two twills, or by elongation.

The class of twills which next claim our attention are totally different from those with which we have just been dealing, and are known in the trade as broken or satin twills. In the twills we have just had under consideration the pattern follows in regular order, but in satin twills this is not the case; instead of the threads being interwoven

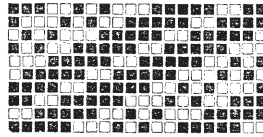


Fig. 89.

in regular succession, they are interwoven at intervals of one, two, or more.

It may be observed of satin twills that some are perfect in respect to the intervals at which the threads are interwoven, and some are imperfect. The lowest satin twill that can be introduced is the four-thread satin, which is

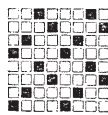


Fig. 90.

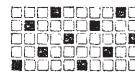


Fig. 91.

sometimes called the satinet twill. This is shown at Fig. 90, and is one of the imperfect ones, inasmuch as on two successive picks the interwoven threads are next to each other. The five-end satin, Fig. 91, is a perfect one; it

will be found that every thread is interwoven at regular intervals. Before proceeding further it will perhaps be advisable to explain the system upon which satin twills are arranged. Take Fig. 91 as an example; the pattern is twice repeated, so as to show more clearly how it runs; on the first pick the first thread is taken, on the second pick the third thread, on the third pick the fifth thread, on the fourth pick the second thread, and on the fifth pick the fourth thread, so that all through the pattern there is always one thread passed over between those that are interwoven. Perhaps the following method will simplify the arrangement somewhat. Make five dots to represent the number of threads, Fig. 92; under the first dot place number one, then pass one and place number two, pass one again and place number three, pass one again (this

$$\begin{array}{c} \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ 1 \quad 4 \quad 2 \quad 5 \quad 3 \end{array}$$

Fig. 92.

time it will be the first end you pass) and place number four, pass one again and place number five; passing one again brings you back to number one, thus proving that the satin is perfect, the intervals being regular throughout, or in other words, the five dots are treated as if they were a continuous series, and are passed over repeatedly until every end has a number placed under it. The dots are then treated as representing the warp threads, and the numbers as representing the weft threads which pass over them, thus on comparing Figs. 91 and 92, it will be seen that they exactly correspond.

A six-thread satin is an imperfect one, and may be arranged in two ways; in one case two threads come together,

$$\begin{array}{c} \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ 1 \quad 4 \quad 2 \quad 5 \quad 3 \quad 6 \end{array}$$

Fig. 93.

$$\begin{array}{c} \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ 1 \quad 4 \quad 2 \quad 6 \quad 3 \quad 5 \end{array}$$

Fig. 94.

in the other case they do not. The two arrangements

are annexed, Figs. 93 and 94, and Figs. 95 and 96 being the corresponding designs.

A seven-thread satin, Fig. 97, is a perfect satin, passing one thread at a time, or having what is termed a basis of two, as is also an eight-thread satin, Fig. 98, passing two at a time, having a basis of three.

From the foregoing it will be seen to be an easy matter to arrange a satin upon any given number of ends, but in some cases care must be taken as to the direction of the twill to suit the twist of the material used or the character of effect intended to be produced on the surface of the fabric. It has been pointed out in page 175 that to produce certain effects on twills the direction of the



Fig. 95.



Fig. 96.

twill will be governed by the twist of the warp, or weft, or both. The same thing holds good of satins. If we take for example the five-end satin, Fig. 91, it will be seen on careful examination that a decided twill runs across the piece in the direction of the weft from left to right, or in the direction of the warp from right to left. This twill will be more decided in one direction or the other as the weft or warp predominates. In all satin cloths



Fig. 97.

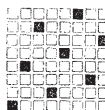


Fig. 98

one material or the other is made to predominate very largely; then if in this case the weft has that predominance, the twill will run from left to right in a nearly horizontal line, the warp being quite invisible, or, if the warp predominates, the twill will run from right to left in a nearly vertical

line, and the weft will be invisible. In the first case the twill may be made more distinct by running it to suit the weft, or less distinct by running against it; in the latter case it will be more distinct by running to suit the warp, or less by running against it. In all cases the first consideration should be, whether it is to be warp or weft face; secondly, whether the twill is to be visible or not, and then adapt the twill to the twist of the material.

It must not be supposed from the foregoing that upon any number of ends there can be but one satin arrangement, for any number which is not a measure of the total number of ends employed may be used as a basis of satin arrangement, and in many cases will produce very different effects. For example, upon seven threads there are two arrangements possible, viz., one having a base of two, and one having a base of three. The first is shown at Fig. 97, the second at Fig. 99. In one sense they are of course similar, that is, the character of the twill is similar in both cases, but one (Fig. 97) shows a somewhat decided twill running horizontally from left to right, and the other a similar twill running vertically from right to left.

From what has been suggested, that a satin may be arranged upon any base which is not a measure of the total number employed, it would seem that upon seven threads



Fig. 99.

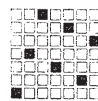


Fig. 100.



Fig. 101.

there are four possible satin arrangements; that is, there are four numbers which could be taken as bases, viz., two, three, four, and five. Of course one could never be taken as a base, because the points of intersection would follow consecutively, and would therefore form a regular twill. That being so, six being one less than seven, a regular twill

would be formed in the opposite direction. Again, five being two less than seven, an arrangement exactly similar to that having a basis of two would be produced, thus, Fig. 100, is exactly the reverse in effect to that shown at Fig. 97, and four being three less than seven, the same effect would be produced as if a basis of three were employed, so that Fig. 101, with a basis of four is exactly the reverse of Fig. 99.

It must not be supposed from this that upon all numbers of ends there can be only two arrangements possible, and that those would virtually produce the same pattern, but running vertically and horizontally respectively. Upon some numbers, such as eight and twelve for example, there is but one possible for eight, viz., a basis of three, for although five appears to be available, it is simply three less than eight, and consequently must produce the same result. In

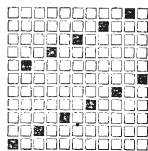


Fig. 102.

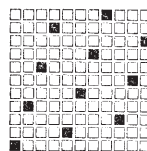


Fig. 103.

the same way with twelve, only a basis of five is available. Again, nine threads correspond with the conditions which govern seven, and ten with those which govern eight, but upon some other numbers, such as eleven and thirteen, there is more scope, and the result of this difference may be to produce what might be called a decided twill, with one base, and very even distribution with another. Take for example the two patterns, Figs. 102 and 103, the first of which shows a decided twill, and the second a tolerably even distribution. The effect upon the cloth would be that one would show a much more decided pattern than the other.

Upon other numbers of threads similar results may be obtained, the one thing to bear in mind being that whenever the number upon which the satin is based is more than half

the total number of threads employed the result will be the same as another which has less than half the total number for its base.

Before we proceed further with the production of new patterns or new combinations, we may venture to return to those we have already gone over, and examine what extent and variety of patterns may be produced upon a given number of ends, and what variety of combinations may be produced with a given pattern as the basis. In the plain cloth it has already been shown that, strictly speaking, there can only be one working for plain, but that a variety of patterns may be produced with plain as the basis. The same may be said of a three-end twill, which is the first removed from plain cloth. Confining ourselves to three ends, nothing but twill could be produced, but, based upon this twill, different patterns



Fig. 104. Fig. 105. Fig. 106. Fig. 107.

may be produced. This will be dealt with later, for the present confining ourselves to what can be done upon a given number of ends. Confining ourselves then to three, little more than the twill given at Fig. 65, page 172, can be formed, but one or two effects might be produced, such as Fig. 104, which is nothing more or less than alternate picks of the same twill, the one with weft and the other with warp preponderating. Then taking four ends, we find that we have considerably more scope. Three patterns have already been given, Figs. 67, 70, and 90, which are worked upon four ends, Figs. 67 and 70 being regular twills, and 90 a broken twill or satin. Then let us examine the nature of these arrangements and see of what they consist and how they may be varied, and for that purpose we will reproduce them here, Figs. 105, 106, 107. Then assuming

that the black dots represent the weft on the face, and the vacant spaces the warp on the face, each pick in Fig. 105 passes over one warp thread and under three, each succeeding pick moving one thread to the right. This may be varied by running the twill to the left, in that case the figure or pattern moving one thread to

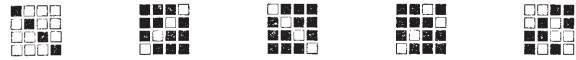


Fig. 108. Fig. 109. Fig. 110. Fig. 111. Fig. 112.

the left at each pick, Fig. 108, but in both cases there will be the same preponderance of warp on the face of the cloth. Then Figs. 109 and 110 represent the same twill, but with weft preponderating, so that we have apparently



Fig. 113. Fig. 114. Fig. 115. Fig. 116.

four patterns, but really only one. Then if we examine Fig. 107 we shall find it is really the same working as Fig. 105, but the third and fourth ends have exchanged places. In this, as in Fig. 105, we may substitute weft for warp on the face, Fig. 111, the pattern again remaining the same, so that Figs. 107 and 111 are based upon the principle of Fig. 105. And so in like manner with Fig. 106; if we exchange the position of the third and fourth threads, or in fact of any two out of the four, we produce a different pattern, Fig. 112. Then we may go a little further, and combine two of the workings as in Fig. 113, which consists of alternate picks of 105 and 106, the combination being more clearly shown at Fig. 114, where one of the patterns is represented by the solid and the other by the shaded squares. In the same manner we may combine any two, as in Fig. 115, which consists of Figs. 106 and 109. Again,

we may carry the principle further by combining any one of them with another kind of working, as with plain, which is shown in Fig. 116, thus producing a pattern totally different in appearance from any of the others.

If we take five threads and deal with them in the same manner, we may produce considerable diversity of patterns. If we examine Figs. 117 and 118, which are



Fig. 117.



Fig. 118.



Fig. 119.



Fig. 120.

the same as Figs. 68 and 91, we shall find the difference to consist solely of a re-arrangement of the position of the threads; or take 119 and 120, the same remark applies, although the appearance of the two twills is



Fig. 121.



Fig. 122.

totally different. Then in Figs. 121 and 122 we have precisely the same arrangement as in Figs. 119 and 120, but with weft substituted for warp on the face, and *vice versa*.

It would be utterly impossible within the scope of this work, to show to what extent this principle of re-arrangement could be carried, and in this treatise it is not necessary. Since the publication of the first two editions of this work I have written two works, viz., "The Album of Textile Designs," and "Design in Textile Fabrics," the latter work published by Messrs. Cassell & Co., Limited, in which the questions of re-arrangement and combinations are fully dealt with.

It may not be amiss however to say a few words here as to the various methods of re-arrangement. Already at page 182 the method of re-arranging patterns in what is called satin order has been pointed out, but there are many other orders besides satin which may well be employed. For

instance, in the latter of the works just mentioned, the arrangement of patterns by transposition of the threads is shown, and in the "Album of Designs" a large number of patterns are given, which are the result of such transposition,

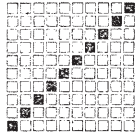


Fig. 123.

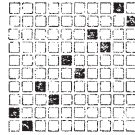


Fig. 124.

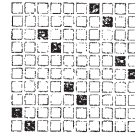


Fig. 125.

but we may not only transpose them in regular order, but we may arrange the transpositions in satin order. Take for example, the three patterns, Figs, 123, 124, and 125, the first of the three is a simple straight twill upon ten ends, the second is the same twill with the threads re-arranged in the

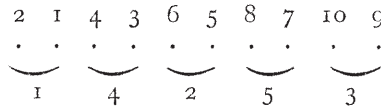


Fig. 126.

order 2.1 4.3.6.5.8.7.10.9., and the third is the second pattern re-arranged in five-thread satin order. Fig. 126 will show conclusively how this has been obtained.

The dots represent the consecutive order of the original twill, Fig. 123, the numbers above the dots the re-arrangement, by transposing the threads in pairs as shown in

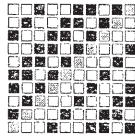


Fig. 127.

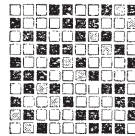


Fig. 128.

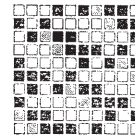


Fig. 129.

Fig. 124, and the numbers below the dots, the re-arrangement of those transposed pairs as shown in Fig. 125.

So far as those three patterns are concerned of course only the principle of the system is shown, because a single line twill of this kind cannot show any decided characteristics,

but when this principle is applied to patterns of a more elaborate character, then the value of it at once becomes apparent. Take for example the patterns shown at Figs. 127, 128, and 129. In each of those patterns the basis of the arrangement is shown by the shaded square. Thus it will be seen that the shaded squares in each of the three patterns correspond with the solid ones in Figs. 123, 124, and 125 respectively.

But we may not only divide a re-arranged or transposed pattern up in the manner shown in Figs. 125 and 129, but in like manner any original pattern may be dealt with thus, Fig. 130 is the same with 123 but re-arranged in five pairs, and Fig. 131 is the same as 127 re-arranged in the same manner, yet the resulting pattern is very different

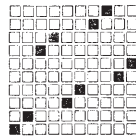


Fig. 130.

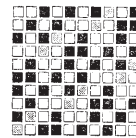


Fig. 131.

in each case, not only from the original, but from those shown at Figs. 125 and 129.

This method of re-arrangement of threads, and of combination of two or more patterns, places in the hands of the designer an immense power for the production of designs.

The combination or re-arrangement of twills, each occupying the same number of threads, will produce new effects, but these are much better, and the effects more varied, when the two patterns combined occupy different numbers of ends. If we were to commence first of all with three-end twill and four-end twill, combined end and end, and in all their varieties, we should obtain a number of different patterns. Again, take four-end twills with five-end twills, and we get another variety, take five-end twill

with six-end twill and we obtain a still greater variety. It would be almost impossible to conceive the number of new patterns which might be produced in this way. In the combination of three and four-end twills we could obtain six patterns as regular twills, and six more by combination of three-end twills, with the four-end twills, transposed as in Figs. 107, 111, and 112. In the combination of four and five-end twills, we should obtain eighteen regular twills, with the four-end twills transposed and the five-end twills straight forward we should obtain eighteen more, and with the five-end twills transposed and the four-end twills straight forward eighteen more; thus from the combination of four and five-end patterns, no less than fifty-four patterns would result.

In the arrangement of these patterns a similar rule would have to be observed as in the combination of figures and diagonals, of carrying the pattern forward to a number of ends or picks, where each will join properly at the same time. Thus, in the combination of three-end and four-end patterns, twelve is the first number of which each is a measure, so that if they are arranged end and end, twenty-four ends would be occupied, and as the picks of each pattern would be concurrent with each other only twelve picks would be required. In the combination of four and five-end patterns, end and end, twenty ends of each and twenty picks would be required to complete the pattern. But although in the latter case forty ends would be required to complete the pattern, the whole could be woven upon nine healds, simply because it consists of two small patterns, each of which can be woven upon four and five healds respectively. More will be said upon this matter when the question of drafting is dealt with.

In the same manner any number of threads may be dealt with, and an immense variety of patterns produced; the greater the number of ends used and the greater the

number of changes which may be effected. I have simply taken here some of the very simplest, for the purpose of showing as plainly as possible the principles. At a later period I shall take some more elaborate combinations. The one thing to which I wish to direct the especial attention of the student is, that every pattern, however intricate and complicated it may appear at first sight, may be reduced by careful analysis to its simplest elements, and then reproduced in an infinite variety of forms; and it is in the ability of the designer to make these combinations suitable to the nature of the fabric upon which he is working so as to produce the best appearance, that his whole success depends.



Fig. 132.

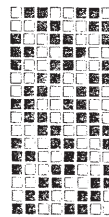


Fig. 133.



Fig. 134.

We may now proceed to the manufacture of more intricate patterns out of the simple material we have obtained. Instead of twills running regularly across the piece, by simply reversing the twill after weaving a certain distance, so as to run alternately in opposite directions, a pattern of a totally different character is produced. Fig. 132 is an ordinary four-end twill worked in this manner and forming a zig-zag pattern. Fig. 133 is a cashmere, or two weft and two warp twill altered in the same manner, and Fig. 134 is a larger twill. In each case the twill runs in one direction all across the piece for a certain number of picks, and then reverses.

Before proceeding further in the manufacture of patterns, it will be necessary to point out to the student another

important matter connected with this branch of the subject. All the examples given are woven upon what is termed the straight draft, that is, the warp threads are drawn through the healds in regular order as shown at page 173, but by varying the order of drawing the

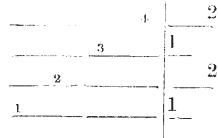


Fig. 135.

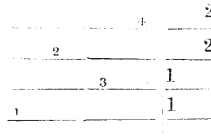


Fig. 136.

threads, an immense variety of patterns may be made upon a very small number of healds. Before entering upon any new patterns which will require a variation in the draught, I must call attention to a rule, the observance of which is absolutely necessary for the guidance of the student, viz.: In arranging the order in which the healds must be raised and depressed, the order in which the warp threads are drawn through the healds must receive the first attention; for instance, in weaving a plain cloth, every alternate end must be raised or depressed, consequently if they are drawn straight over in regular order as in Fig. 135, every alternate heald must be raised or depressed, as indicated by the numbers. If on the other hand they are drawn on alternate healds, then the first and second would rise together,

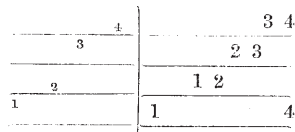


Fig. 137.

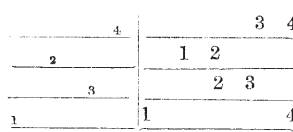


Fig. 138.

and the third and fourth, Fig. 136, the small numbers representing the order in which the ends are drawn through the healds, and the large numbers representing the order in which they are raised. It will be seen that every alternate thread rises together in both cases. Take

again the cashmere twill. Fig. 137 shows the order in which the healds rise when drawn straight over, being precisely the same as shown on the design; then draw it on alternate healds, Fig. 138, and the order in which they require to be raised is shown also.

We will now begin to alter the draught so as to alter the pattern. Fig. 132 is a pattern which would have the

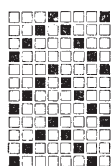


Fig. 139.

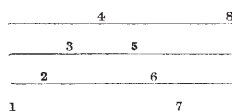


Fig. 140.

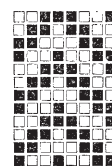


Fig. 141.

appearance of a stripe running across the piece, the pattern being produced by weaving a number of picks with the twill running in one direction, and then a number with the twill running in another direction. Fig. 139 is a zig-zag of the same kind, but instead of the stripes running across, they run lengthwise of the piece. This is done by drawing the required number of warp threads straight forward from front to back of the healds, and then reversing and drawing from back to front, Fig. 140,

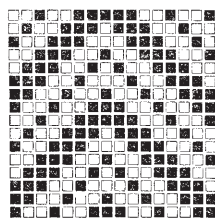


Fig. 142.

and weaving straight forward as if weaving an ordinary twill. Fig. 141 is a cashmere worked in the same manner and Fig. 142 is the same twill as Fig. 134.

In draughting in this manner it is not necessary that the same number of threads should be drawn each way,

but the number may be varied at the discretion of the designer, so as to make large and small stripes, &c.

To produce still greater variety, combine the principle of Fig. 132 with Fig. 139, that is, draw the warp as shown at

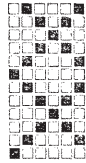


Fig. 143.



Fig. 144.

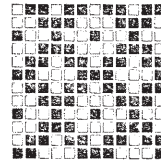


Fig. 145.

Fig. 140, and reverse the weaving to correspond; the result will be to form diamond patterns, as Fig. 143. Gradually extend the patterns, each time introducing a little more detail; for example, Figs. 144 and 145, each of these being

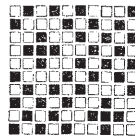


Fig. 146.

woven on the principle of the draught given at Fig. 140. An extension of this system of draughting is given in Figs. 146, 147, and 148. Instead of four healds, six and eight are employed respectively, the order of drawing being precisely

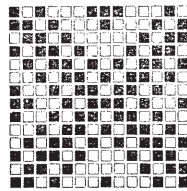


Fig. 147.

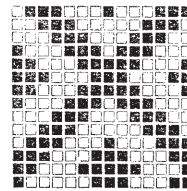


Fig. 148.

the same, viz., from one to eight, and back from eight to one. In these last examples, the first and last healds being the turning points of the draught, it will be noticed that less

threads are drawn upon them than the rest, consequently they would require to be coarser than the rest in sett, that is, would require less heald cords upon them. This may be obviated, and in some instances the patterns considerably improved, by altering the draught so as to commence reversing upon a different heald to the one upon which the last thread is drawn. Fig. 149 is a stripe pattern

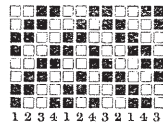


Fig. 149.

drawn upon this system. On examination of the numbers which are placed under the spaces representing the warp threads (these numbers representing the healds upon which the threads are drawn), it will be found that where the twill reverses, the first end, instead of being drawn upon No. 1 heald, as it would be if reversed in the same manner as the previous example, is drawn upon No. 4, the next upon No. 3, and so on. If it is intended to weave a diamond pattern, the same rule must be observed with regard to the picks, see Fig. 150, where the first pick of the reversed portion, instead of being the same as

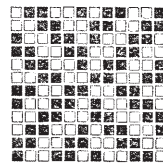


Fig. 150.

No. 1, is like No. 4. By the careful observance of the rule mentioned in pages 194 and 195, the student may now begin to make patterns of a more elaborate kind, by the simple variation of the draughts, and when necessary, reversing the twill in weaving. Fig. 151 is an example of what may

be done in this direction, and by reversing the twill in weaving, a large check effect will be produced. I might give endless examples to illustrate what might be done, but I should only be unnecessarily adding to the size and cost of the work by doing so. I have selected what seems to me the simplest patterns I could possibly find, to convey to the reader as clear and accurate an idea as possible of the principle of weaving.

Hitherto I have supposed that the draught has been arranged beforehand, and that the patterns have been made to suit the draught. I will now reverse the order of things, and, supposing the design to be made, arrange the draught to suit it. The easiest way of doing this is to follow the plan shown in Fig. 152, each horizontal space representing a heald instead of the horizontal line, as in the previous arrangement, the dots over the design representing the healds upon which the respective threads are drawn, and the numbers up the side indicating the order or position of the healds. It will thus be seen that the first dot, which is upon the first thread, is also upon the first heald, the rest following consecutively up to eight; the ninth thread is drawn upon the fourth heald. To ascertain the reason for this examine the ninth thread, and it will be found to work in precisely the same order as the fourth thread, consequently, it must be drawn upon the same heald; the tenth thread works the same as the third, and so on. By careful attention to this rule it will be found that very frequently patterns, which on the face of them appear to require a great number of healds, may be very easily worked upon a very small number, by arranging the draught and treading to suit it. I will now take another example to

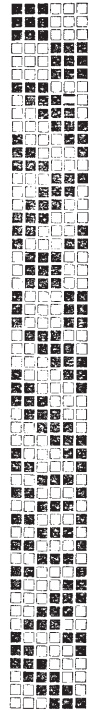


Fig. 151.

illustrate another feature of this arrangement. The example already given requires eight healds, and of course the first eight threads of the design are representative of the rest, consequently, in putting this into work, the weaver will raise

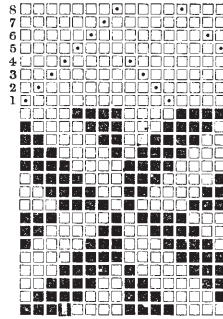


Fig. 152.

and depress his healds according to this portion of the design; but it may very frequently happen that what we may term the representative threads are not altogether in such a compact form as in this case, but scattered at various intervals over the design; in that case the draught must first be ascertained by the method described above, and

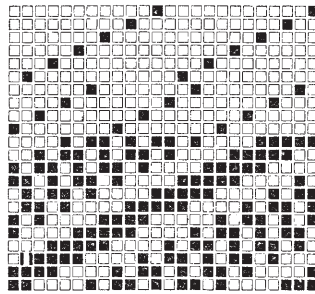


Fig. 153.

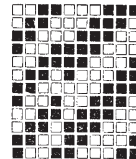


Fig. 153 a

the representative threads of the design copied on a separate piece of paper, to make what is called a working design, for the weaver to peg or arrange for whatever kind of machine it is to be woven upon. Fig. 153 is a

design which will fully illustrate this, the full design being given here as it will be in the cloth, and Fig. 153A is the working design or pegging plan from which the weaver must work, and the draft is placed just over the design.

We may now proceed a little further with our examination of the arrangement of designs, so as to show as fully as possible that some of the most intricate designs are merely combinations of very simple effects, many of which may be woven upon a very small number of healds. With two healds, as has already been pointed

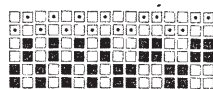


Fig. 154.



Fig. 155.

out, we have not much scope for patterns, except such as are produced by combination of colours, but as we increase the number of healds we increase immensely the number of patterns which may be produced, but even with two only, the variety is much greater than would appear at first sight. We have already a few samples in Figs. 59, 60, and 61. Again, we may carry this much further by

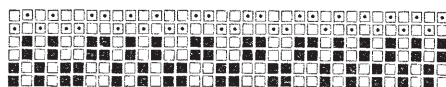
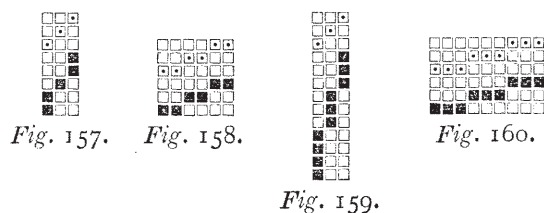


Fig. 156.

working after the manner shown at Fig. 154, combining what is shown at Fig. 155 A and B, so as to produce a stripe pattern. Again, this stripe may be varied to an infinite extent, as is shown in Fig. 156 where varying sizes of stripe are shown, consisting of the two patterns shown at Fig. 155 A and B. Then we come to another question, how to arrange the draught and order of raising the healds to produce these patterns. The simplest and readiest way of doing this is shown at Figs. 154 and 156, as already shown. Instead of drawing horizontal lines to

represent the healds, and numbering the order of the draught upon them, suppose the horizontal spaces immediately over the design, Nos. 1, 2, to represent them; then the dots in those places show through which heald the thread is drawn. For instance, in Fig. 154 the first thread on the left is marked upon the first horizontal space, thus indicating that that thread is drawn through the first heald; the second is marked upon the second space, it would therefore be drawn through the second heald; then as each alternate thread of the first eight are working exactly alike, they are drawn through the same heald. Coming to the ninth and tenth threads, they are found to be working together and in exactly the same order as the first, therefore they would be both drawn through the first



heald, the eleventh and twelfth through the second, and so on. The first and second threads are representative of the whole pattern, and therefore indicate the order of working of the two healds as shown at A 155 so each heald would remain up and down alternately for two picks.

If we deal with three healds in the same manner, we shall find that we have more scope, and can produce greater variety of pattern. Figs. 157 and 158 are practically both the same thing, one showing the twill running with the warp and the other with the weft; in one case three ends and six picks are occupied, and in the other six ends and three picks, but in both cases three healds would be sufficient, as shown by the draughts. Figs. 159 and 160 are also the same thing, and worked on the same

principle as 157 and 158, but with three picks and three ends respectively, instead of two. In Fig. 161 we have a pattern of a different character, but equally applicable to three healds. Again, each of those patterns may be varied, as shown at Figs. 162, 163, and 164, and still only three healds be used. These variations may be carried considerably further without the use of more than three healds. Using four healds the number of patterns which may be

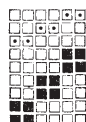


Fig. 161.

produced increases immensely; in fact, we may say there is no limit to the number of patterns, although there is a limit to the number of combinations, or rather to the number of distinct styles of working which may be combined in the same pattern. I have already shown what patterns may be produced upon four ends. Any patterns worked upon four healds must, of necessity, be

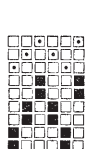


Fig. 162.

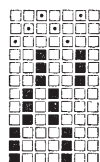


Fig. 163.

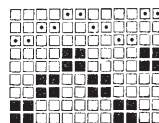


Fig. 164.

a combination of such as can be produced upon four ends, as, for example, the patterns 165, 166, and 167. In the first of these it will be seen there are two kinds of workings combined, in the second three, and in the third two; that is, a plain and a twill pick alternately; in each case the pattern may be worked upon four healds, as shown by the draught, and in each case the first four ends of the pattern to the left represent the order of working for the healds, or what is known as the pegging

plan. One thing must here be remarked. In arranging patterns of this description, care should be taken to have as far as possible the same number of ends upon each heald. If Figs. 165 and 166 be examined, it will be found that each

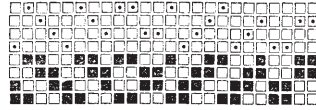


Fig. 165.

heald would have the same number of ends drawn upon it. In Fig. 167 this is not the case, as the first heald would have four ends, the second three, the third two, and the fourth three. Consequently, the first heald would have to be twice

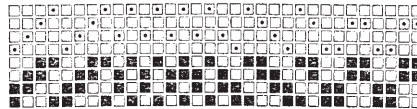


Fig. 166.

as fine as the third, and one-third finer than the second and fourth. This would entail considerable trouble in arranging the healds, and in many cases would cause considerable expense in having to provide special healds for a pattern, which would probably be of no use for any other pattern.

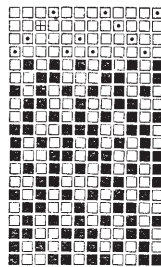


Fig. 167.

This can easily be obviated by arranging the number of ends in each stripe, so as to cause the same number to fall upon each heald. For instance, if we apply the draught, Fig. 168, to the same working as 167, it will only increase

the size of each stripe two ends, and each heald would carry the same number. The stripes may be made either equal or unequal in size, but the above rule should always be observed as far as ever possible.

We may now proceed to examine the subject from another point of view, which will perhaps tend to confirm what has been already said, and at the same time pave the way more fully for what is to follow. In almost every pattern, however intricate it may appear, the styles of

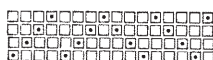


Fig. 168.

working of which it is composed may with a little care be very easily discovered, and it ought to be the first object of the designer when any combination comes before him which at first sight appears new to him, to analyse it, and find out its elements; he can then easily reproduce it, either in the same or in any altered form which his fancy might suggest. By analysing, I wish it to be distinctly understood that I do not mean the common

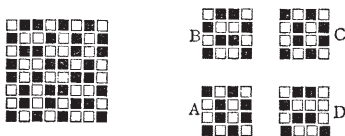


Fig. 169.

practice of picking the cloth to pieces, thread by thread, which is probably the slowest and most uncertain method which can be adopted for getting the pattern of a cloth. Except for beginners, or in extreme cases, such as in milled woollen cloths, where the pattern cannot be easily discerned, not more than very few threads ever need to be picked out of a cloth, and those only to find the basis of the pattern, after which it can be more easily and accurately followed on the face.

If we take, for example the pattern Fig. 169, which at first sight would appear a most difficult pattern to copy or reproduce, especially if a large area had to be covered with it, yet no easier pattern to reproduce could be desired, if proper means be taken to analyse it. If we divide the pattern into four equal parts, as shown at A, B, c, and D,

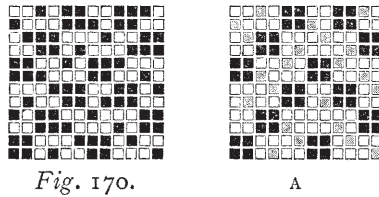


Fig. 170.

it will be found that each part is based upon plain cloth, A and c having two picks in one shed, and B and D having two ends working together, so that by bearing this simple fact in mind, the designer may reproduce the pattern with the greatest ease, and combine it with any other working at any moment. Again, the pattern Fig. 170 would be

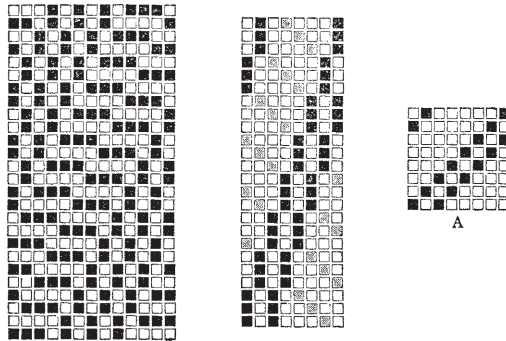


Fig. 171.

Fig. 172.

a rather difficult pattern to reproduce from memory, unless some order of arrangement were observed, but by following the plan shown at A, where the leading feature of the design is shown in black, and consists of a simple zig-zag figure, and the filling up in shaded squares, which consists

of an irregular arrangement of a four-end satin to suit the figure, the figure may not only be reproduced but varied at will with the greatest ease. Again, in Figs. 171, 172, and 173, we have designs which appear distinct in themselves, but each one may easily be reduced to a system. If we take Fig. 171, we shall find one portion of it to consist of a plain cloth, but having two picks in each shed, and the other portion is also based upon plain working, but each pick passing over three and under four ends. Coming to pattern 172, we shall find that the basis of the design

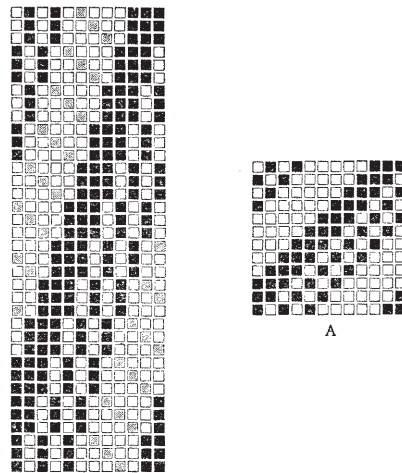


Fig. 173.

is that shown at A, each pick being three times repeated; then to fill up the large space which is produced by this elongation, an ordinary four-thread twill is introduced, as shown by the shaded squares; then, as the basis of this design is a twill composed of plain, and weft or warp floating, the whole design is a combination of twill, or simple regular figure, and plain. Again, in Fig. 173 we have a similar combination, but producing a bolder effect, the basis of the patterns being shown at A. Practically, there is no

limit to the variety of patterns which may be produced upon this principle, they are simply elongation of the original twill. We need not necessarily confine ourselves to regular twills for either the base or the filling up of the pattern, but may combine them in any style as fancy may suggest.

In design Fig. 174, we have a combination of a similar

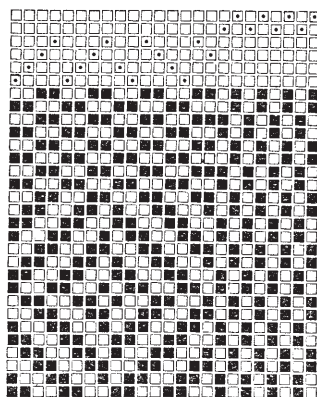


Fig. 174.

character to that in Fig. 166, but in this case the effect would be to produce a check pattern on the face of the piece instead of a stripe; but it is simply a combination of twill and plain working, and is another example of what may be produced upon a small number of healds,

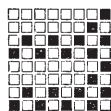


Fig. 175.

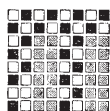


Fig. 176.

the draught which is immediately over it showing that only six healds would be required to weave it, and with a slight modification in the design it might be made upon four healds.

In the same manner the three styles of working, as in Fig. 165, may be combined, or Figs. 169 or 170 combined

with twill, or any two or three styles worked together so as to produce the desired effect. One other style of working now calls for attention. Fig. 175 shows a design which will produce a perfectly plain face on the cloth, but at the same time a line stripe will be visible running the entire length of

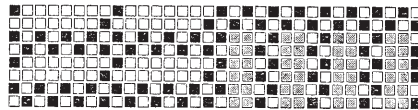


Fig. 177.

the piece. The cause of this will be apparent on examining the design; the first six ends of the pattern are only interwoven with one-half the weft, that is, two picks are woven in quite plain, and the next two pass to the back of the cloth, whereas the seventh and eighth ends are interwoven with every pick, consequently those two ends

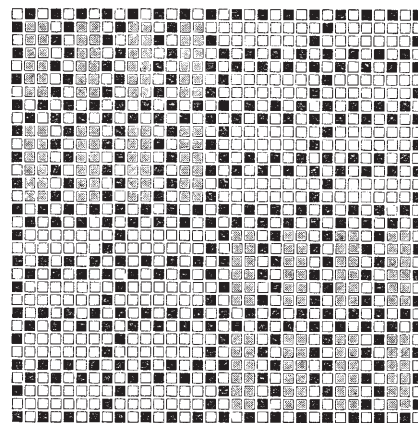


Fig. 178.

having double the quantity of weft interwoven with them, show a clear line throughout the entire length of the piece, and yet the surface of the fabric appears as a perfectly plain cloth. Fig. 176 is a similar arrangement, but in this the *warp* instead of the weft is thrown to the back for six picks, and the seventh and eighth picks are interwoven

with all the warp, consequently the line stripe would run across the piece instead of lengthwise. By a combination of the two an immense variety of patterns may be produced in a very simple manner. Fig. 177 would produce a stripe effect, the first sixteen ends of the pattern being divided by the plain threads longitudinally, and the second half laterally. Again, in Fig. 178 the whole surface of the piece would be divided into squares, each alternate square being again subdivided in opposite directions, the warp and weft predominating alternately; or, we may combine the two with some other style of working, as shown in Fig. 179, where they are combined with twill. It may be advisable again at this point to remind the beginner of what was pointed out in a previous page, viz., that whenever two styles of working are combined in one pattern they should be so arranged as to join without any imperfections being visible at the junction. If Fig. 179 be examined it will be seen that this is done simply by dividing the two plain ends and picks, and placing one on each side of what may be termed the thin portion of the cloth. In any combination it will be easy to find the best means of joining. Following out this principle of working, taking some simple design or designs as a basis, and re-arranging and combining, the designer will find little difficulty in producing an unlimited variety of patterns. All the foregoing are what are commonly known as all-over effects, that is, the design is evenly distributed over the whole surface of the fabric. This certainly represents the great majority of fabrics, but what are known as set or spot figures form no inconsiderable portion, and with them we must now deal.

SPOT FIGURES.

As has been already pointed out, set or spot figures may be produced in a variety of ways; first, by the warp

or weft, or both, which are forming the ground cloth; second, by extra spotting weft; third, by extra spotting warp; or fourth, by a combination of the two latter, using extra spotting warp and weft. A simple example of the first of these is given at Fig. 180, where the spot is formed by the weft, the ground being a perfectly plain cloth. On the back of the cloth a similar spot would be formed by the warp, therefore in this class of spots it is merely a question of leaving down the warp if a weft spot is to be formed on the face, or raising it if a warp spot is to be formed. Fig. 181 is a spot figure in which

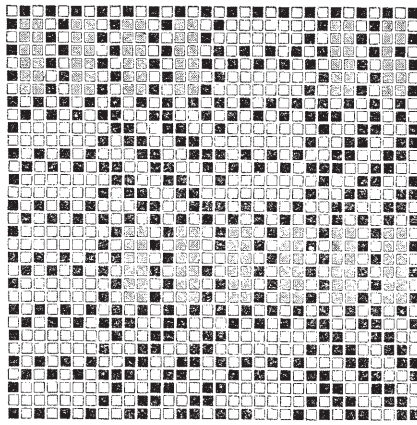


Fig. 179.

both the warp and weft of the ground cloth are made to form part of the figure, the black representing the weft, and the shaded squares the warp. The figures may be placed at any convenient distance apart, and the ground may be plain, twill, or any other working suitable to the nature of the fabric. Whatever may be the working of the ground, it has only to be marked upon paper in addition to the spot, and so reproduced upon the fabric. Then so far as this class of figuring goes little more need be said, because it is merely an adaptation of the style

of working with which we have been dealing, the figures assuming a definite form, and confined within a certain space. But this applies not only to small spots, but also to the more general principles of figuring. Very large and elaborate figures may be produced either with weft or warp, or both; in fact, the whole surface of the fabric may be covered with figuring exactly upon the same

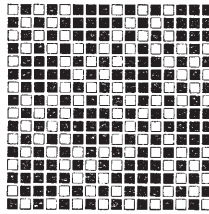


Fig. 180.

principle. When the weft or warp is not forming figures, they may be interweaving, so as to form plain or ground cloth. Then another question arises now. If there be too much figuring on the cloth, and the figure is formed by the ground weft or warp, or both, the distance over which the figure extends, or the number of threads over or under which the weft or warp passes, may represent

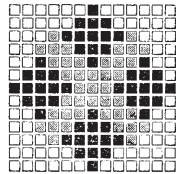


Fig. 181.

so much loose material, and so give a looseness to the fabric which would be seriously detrimental to it. In that case it becomes necessary to introduce what are termed binding threads at certain intervals in the figure. If the design be of a floral character, or simple leaves, this is comparatively easy, for then the binding threads may be

made to form the stems or veins of the figure. Where this is not feasible it may be frequently effected by introducing a little shading in the form of twill or other working, or, where it is absolutely necessary to preserve the flat unbroken appearance of the figure, then the satin working may be resorted to. In all cases the designer must be guided by the nature of his cloth, and the purpose to which it is to be applied, and make his design subservient to these considerations.

Another system is frequently adopted, which is suitable for either spots or more elaborate figuring, that is, allowing the warp and weft to exchange places with each other, and preserving the same working, whether it be twill, satin, or otherwise, both in figure and ground. An example of this is shown at Fig 182, where the ground is represented as five-thread satin, with the warp predominating, and a portion of the spot also as five-thread satin, but with weft predominating on the face; the other portion of the spot being a five-end twill, for the purpose of producing a kind of shaded effect. The two examples here given, Figs. 181 and 182, would require to be placed at suitable distances apart upon the fabric, to give effect to them. This distance may be varied at will, or to suit the nature of the cloth. The order of arrangement may also be considerably varied, that is, the figures made to assume various positions or placed at varying distances from each other, or we may go away out of the region of mere spot figuring and deal with more elaborate effects; in fact we may figure to as great an extent as we please. It might be as well at this point to call the student's attention to damask weaving, which is merely an extension of the principle of figuring shown in Fig. 182. If he will examine a piece of damask cloth he will find that to whatever extent the figure may be carried, or however large the figures may be on the fabrics, there is no looseness, the

fabrics is equally firm throughout. This arises from the simple fact that when the figuring takes place, the warp and weft merely change places. If the ground of the fabric is a satin showing a predominance of warp on the face, the figuring is also a satin, but showing a predominance of weft on the face. This class of figuring, or rather this style of working, is a most useful one, more especially when applied to fabrics where firmness

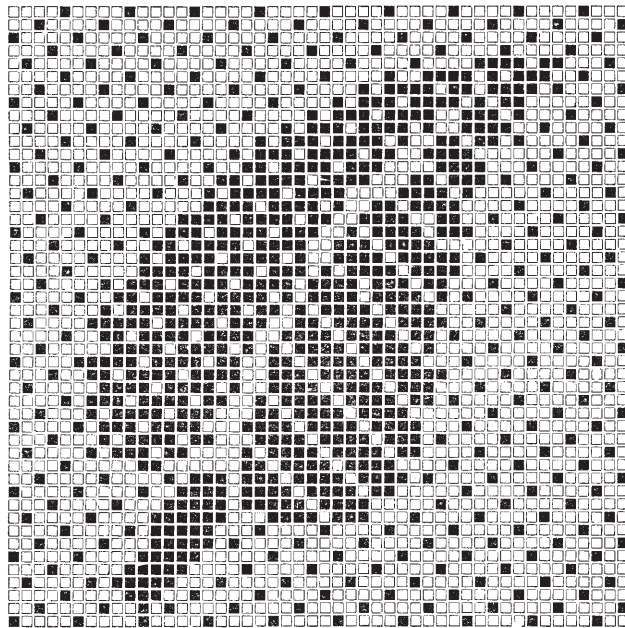


Fig. 182.

of texture must be preserved, because no matter what amount of figure may be introduced the cloth is in no way deteriorated, but preserves its firmness, and, consequently its useful wearing qualities to the fullest extent. This style of working, although as has been shown a most serviceable one, is not of course adapted for every class of fabric, but only in fact for fabrics of a very fine or

heavy character. The ground, being worked generally as a satin, necessitates the introduction of a considerable quantity of material to give the cloth sufficient firmness; it could, therefore, only be used to advantage where a large quantity of fine material is used in the formation of the fabric, or where a very heavy fabric is desired. It would, therefore, remain for the designer to select the style of working which will be most suitable to the nature of the material which he is using. The style and arrangement of his designs must also be governed by similar considerations. But this subject will be more fully dealt with under the head of designing for Jacquards, to which it more properly belongs, the object at present being to point out the various systems of arrangement and combination.

Then these three figures represent the principle of



Fig. 183.

spotting or figuring with the same warp and weft as form the ground cloth. Spotting with extra warp or weft, or both, will require a totally different arrangement upon paper to those. We will suppose that it is desired to produce the small spot, Fig. 183, with extra coloured weft upon a perfectly plain fabric; then the arrangement of the design will be as shown at Fig. 184, the picks marked *a* being the spotting picks, and the rest the ground picks, which will be seen to form a plain fabric, the spotting picks passing over sufficient threads to form the desired pattern, as shown by the shaded squares, and then passing to the back of the cloth for a certain distance, and again coming to the face to form the next spot.

Another question now arises in connection with these spots. Very frequently they are woven with healds, and with a small number of healds a great variety of patterns

may be produced, by a careful arrangement of the draughts. For this design eight healds would be required, the draught being shown over the design, the first and second healds being required for the ground cloth, the next three for the first spot, and the last three for the second spot. The working design, or that which shows the order of raising the healds, is given at Fig. 185. But with a similar number of healds, much more extensive and elaborate designs might be produced quite easily. Then in spotting with extra weft, only one thing is required to be observed, that the spotting weft passes over only as

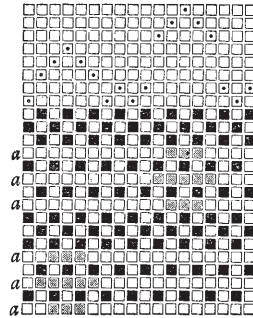


Fig. 184.



Fig. 185.

many threads as are required to form the pattern, and then goes to the back of the cloth, where it may be dealt with in such a manner as may be desirable, either by binding to the cloth or cutting off; the method of dealing with this will be shown at a later period.

In spotting with extra warp, a similar arrangement is required as in spotting with weft. Fig. 186 is the design for a warp spot, the figure being the same as that in Fig. 184. In this case the ground weaves on as in an ordinary plain piece, the spotting warp being drawn through separate healds and raised or depressed as desired, to form the figure. The draught is shown over the design, and the

working plan at Fig. 187. In this case it will be noticed that although the same kind of spot is produced as in Fig. 184, yet only six healds are required to produce the pattern. If the two designs be examined, it will be found that the healds which are used to produce the spot in Fig. 184 have also to assist in forming the ground, whereas in Fig. 186 the spotting healds work only the spotting threads,

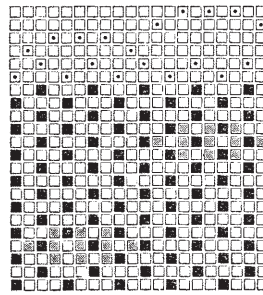


Fig. 186.



Fig. 187.

and take no part in forming the ground, consequently there is more scope for producing a variety of figures upon a small number of healds when the spot is worked in the warp than when it is produced by the weft.

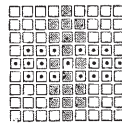


Fig. 188.

We have now only to deal with figures produced by extra warp and weft, or a combination of the two foregoing. Fig. 188 is a design which is intended to be so produced, the shaded squares representing the warp, and the dots the weft. The arrangement of the design for this upon a plain ground is shown at Fig. 189, where the warp and weft spotting are represented as in Fig. 188,

the draught for working upon healds being given immediately over the design, and the working plan at Fig. 190. It will be observed that in this case I have marked clearly the healds which are intended for the ground, those which form the ground under the spot, and those which work the spotting threads only, both in the draught and the working plan, so that the student may be able to follow them more readily.

It will be observed of the arrangement of this draught, that being a combination of the two principles of spotting already dealt with, two sets of extra healds are required, viz., that which works the ground under the spot, and that which works the spotting warp, two healds working the ordinary plain ground as in the previous cases. An examination of the design will make the necessity for this arrangement quite clear. The spotting warp must of necessity have special healds to work it, and the ground threads which come under the weft portion of the spot, although in the actual interweaving working exactly like the rest of the ground, must be so arranged that they can be depressed in the order desired for the spotting weft to pass over; consequently the warp must be drawn through special healds to enable this to be done. In fact, this spot being a combination of the two principles shown at Figs. 184 and 186, the arrangement of working is in every respect a combination of the two. Then with respect to the figure itself. If Fig. 188 be examined, it will be seen that where the weft and warp cross each other, they are made to interweave as plain cloth; and in Fig. 189, it will be seen that the same arrangement is preserved. This is produced by the simple raising or depressing of the spotting warp when the spotting weft is being thrown in. In fact, the extra warp and weft, at the point where they interweave with each other, form a cloth quite apart from the ground cloth, but this will be

more apparent to the student after reading the next chapter, on double cloth.

There is one apparent discrepancy between the spot as shown at Fig. 188 and Fig. 189. In the former it is represented as occupying nine ends and nine picks ; in the latter as occupying eleven each way. In Fig. 188 it will be found that the weft portion extends for three ends on each side beyond the warp portion, and in the same manner the warp extends three picks above and

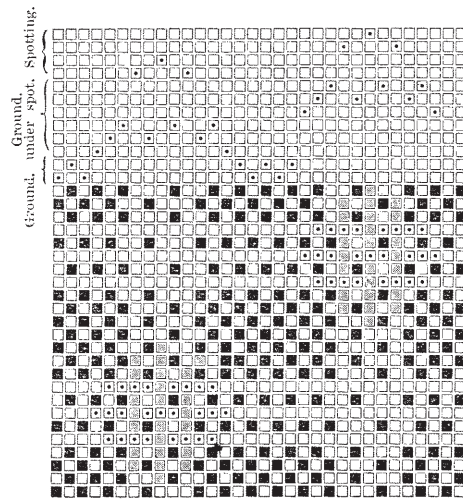


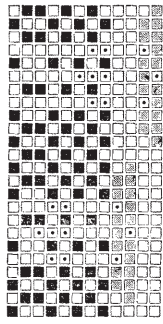
Fig. 189.

below the weft. The same thing occurs in Fig. 189, and it will be observed that between each spotting warp thread one ground thread is introduced, and between each spotting pick one ground pick ; and as these are introduced for the purpose of making the ground cloth continuous and perfect, they have no effect upon the size of the figure, consequently the figure must pass over them as though they were extra threads and picks.

There is but one other matter to which the student's

attention need be called in connection with spotting, viz., binding the loose material at the back.

It frequently happens that the spots are so far apart that the loose warp or weft at the back requires to be bound to the cloth or cut off. Under the head of double cloth this binding will be dealt with fully, so that nothing need be said upon the subject here, more than to call the student's attention to it. Very frequently spot figures are woven by what are known as swivel looms, that is, looms where there are a series of small shuttles for the purpose of weaving in the spots, quite separate and apart



Ground. Ground Spotting.
under spot

Fig. 190.

from the ground shuttle, and by this means the loose material at the back is entirely obviated, except the single thread, which having completed one figure passes to the next; but in this case the arrangement of the design will be precisely the same as for ordinary spots, the whole difference being simply the mechanical arrangement of the shuttles.

The few examples given here embrace all the principles of spot weaving, but they are capable of an infinite extension and variety of arrangement; each of the four systems may be used separately or combined, and the most beautiful and elaborate effects produced.

DOUBLE CLOTH.

Double cloth is a branch of fancy weaving which is not practised generally, being confined to the woollen and carpet manufactures chiefly, and very little used in the cotton, silk, or worsted manufacture, except occasionally in the latter branch for coatings, in which case a woollen back is woven on for the purpose of giving weight and warmth.

Double cloth is for the most part composed of similar fabrics, which are sometimes interwoven at intervals and formed into a diversity of patterns, the two cloths being of different colours, the one colour forming a pattern on the other.

Double cloths are of three kinds, one formed with one warp, and having two weft surfaces, the second formed

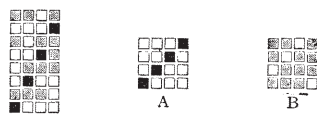


Fig. 191.

with one weft and having two warp surfaces, and the third being two distinct cloths, as indicated at pages 164 and 165. In all three cases each of the two surfaces may be of different colours and of different patterns, but it is in the latter kind that there is most room for the exercise of the ingenuity of the designer in producing patterns.

The first kind is usually used for woollen goods upon cotton warps, the second for silk faces with cotton or other wefts. By this means the cotton warp may be entirely hid, and two woollen or other surfaces presented, which may be of different colours, or one of solid colour and the other striped. Fig. 191 is a plan for a double cloth of this kind, the dark squares are the face working and the shaded ones

the back, the patterns A and B representing the face and back patterns respectively. In the face working it will be observed that only every fourth thread is raised to form

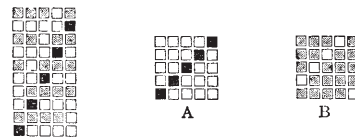


Fig. 192.

the upper portion of the shed while the pick is put in, thus allowing every fourth end only to be interwoven, and for the back only every fourth thread is left down to form

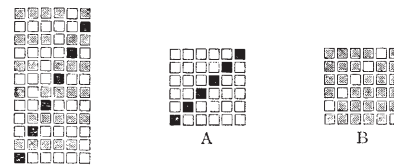


Fig. 193.

the lower portion of the shed while the pick goes in, thus each side of the piece will be a *fac-simile* of the other so far as pattern goes, but they may be of different colours by

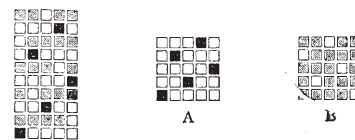


Fig. 194.

using differently coloured wefts. Fig. 47, page 165, shows a section of this species of double cloth. Fig. 192 is a similar

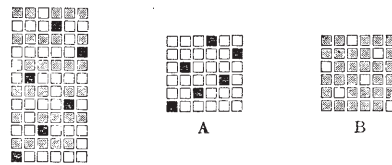


Fig. 195.

arrangement with a five-thread twill, A being the face and B the back pattern, and Fig. 193 is a six-thread twill on

the same principle. In the same manner any twill may be worked out. Fig. 194, represents a five-thread satteen, Fig. 195, a six-thread, and Fig. 196 an eight-thread satteen, all on the same principle of double-face cloth. In the same manner twill and satin may be combined, or a variety of patterns produced; or the system may be carried still further, and figures produced by bringing the back weft

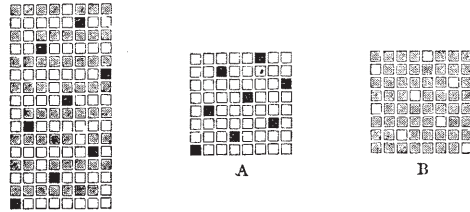


Fig. 196.

to the face, or taking the face weft to the back, as shown in the section, Fig. 197, so that if the face cloth be white and the back black, a black figure would be produced upon white ground, and a white figure on black ground



Fig. 197.

on the other side. One thing must be carefully observed in the arrangement of designs for cloths of this description, viz.; that a face and back pick successively must not be bound by the same warp thread, otherwise, if the two sides

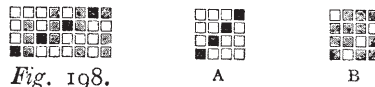


Fig. 198.

of the cloth are of different colours, one will be liable to show through the other and produce a sort of spotty appearance.

The second kind of double cloth is simply the first inverted, the warp taking the place of the weft, and the weft taking the place of the warp. Fig. 198 is a four-thread twill

arranged for double warp face, A and B being the face and back respectively, as in the previous arrangement, and Figs. 199 and 200 are five thread and eight-thread satins on the same principle.

Both these systems of making double cloths are especially valuable in making heavy goods where the pattern at the back is intended to serve as a lining only

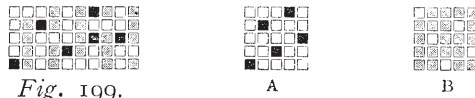


Fig. 199.

to the face ; and when the face pattern is a fancy one and the back as near plain as possible. Whenever such is the case there is no alteration in the principle of arranging the design, only a proper regard must be paid to the binding the back to the face, so as not to interfere with the pattern on the face cloth. In such cases proper regard must be paid to the relation which the two patterns bear to each other—face and back respectively—as well

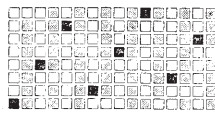


Fig. 200.



as to the relations of the two cloths in regard to fineness, and a position for the binding of the back west into the cloth must be found in strict accord with the rules which will be laid down for binding two separate cloths.

The third and most generally used double cloth consists as before mentioned of two separate cloths, which may be stitched or bound together in the process of

weaving or kept separate if desired. For the purpose of making it as clear as possible to the reader, I shall in all cases treat the two cloths as being kept separate, and afterwards explain the method of stitching or binding them together.

The simplest form of double cloth consists of two equal plain cloths, that is, two cloths having the same number of threads per inch, and of the same quality and thickness, both woven quite plain. Take for example what may be called tubular weaving, such as hose or sacking, where the two cloths are kept separate, and joined

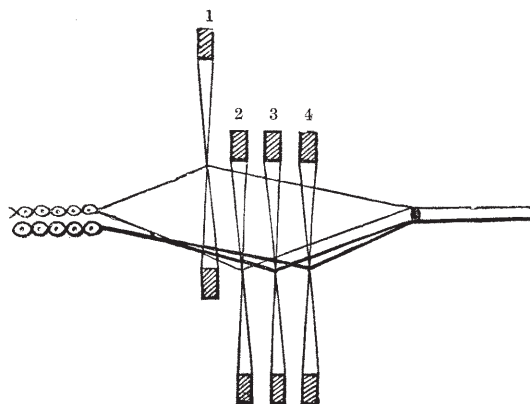


Fig. 201.

together by the weft passing from one cloth to the other at what would otherwise be the selvage, thus forming an open tube. To effect this the weft passes through the warp of the upper cloth, and in the return pick through the warp of the lower cloth, making the junction of the two cloths, as stated, at the selvages, and Figs. 201 and 202 show clearly the mode of working to produce this result. In Fig. 201 the shed is represented as being open to receive the pick for the upper cloth, and it will be observed that one half of the warp of the upper cloth is

raised and the other half is depressed, as well as the whole of the warp of the lower cloth. The pick having been thrown in, the shed is then opened as in Fig. 202, where it is shown as being open to receive the pick for the lower cloth. Here it will be observed that the reverse of what occurs in Fig. 201 takes place; the whole of the warp of the face or upper cloth is raised and one half of the lower cloth, the other half of the lower cloth being depressed. The one rule to be observed is this, that when the pick goes into the face or upper cloth, only such portion of the warp of that cloth as is necessary to form the pattern must

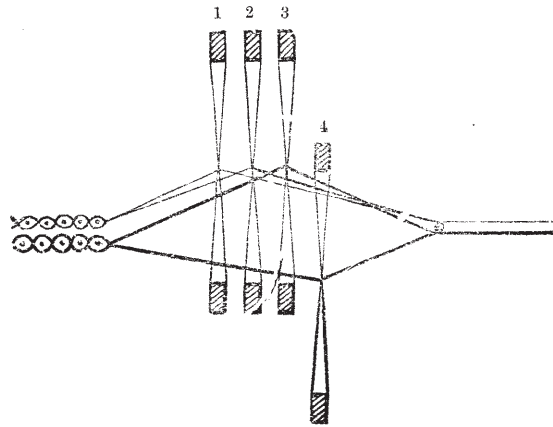


Fig. 202.

be raised, the other portion being depressed along with the whole of the warp of the back cloth; and when the pick goes into the back cloth the whole of the warp of the face cloth must be raised, and such portion of the warp of the lower cloth as is necessary to form the pattern, the remainder of the back cloth warp being depressed. On careful examination of Figs. 201 and 202 the reader will at once see that this is done, and also the necessity for doing it, so that the warp of one cloth shall never interfere with the pick of the other cloth, else the

two cloths would be bound together instead of being separate.

In the example given at Figs. 201 and 202 the healds are indicated by the figures 1, 2, 3, 4, Nos. 1 and 2 being the healds which work the face cloth, and 3 and 4 those which work the back cloth. It will now be necessary to show the student how to arrange the pattern upon paper, both for draught and for working design, or, as it is generally termed, pegging. Fig. 203 shows the draught ; 1, 2, 3,

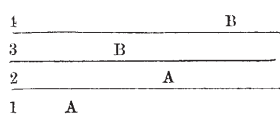


Fig. 203.

and 4 are the healds, and as before stated 1 and 2 are for the face cloth, consequently the warp threads A A are drawn upon 1 and 2 alternately ; 3 and 4 being for the back cloth the warp threads B B are drawn alternately upon them, this being repeated to the full width of the piece. The order of working is shown at Fig. 204 ; A A are the face cloth picks when one heald out of the four only is raised, as indicated by the black dots, and B B are the black cloth picks when three healds out of the four are raised, viz.,



Fig. 204.

both the face healds which are indicated by the dots, and one of the back healds indicated by the shaded square. It is not the general practice with designers to make the three kinds of marks, but it is very much better to do so, or to work in three colours, which is still better ; it is then so much easier to follow the pattern which is being made upon each cloth, and the marks which indicate the rising of the face warp when the back pick is being

put in are easily distinguishable from those forming the pattern, and so prevent confusion.

In this example it is arranged that the face healds are together and the back ones together, and are thus treated as separate sets ; but this is not always the case, though it is much simpler when it can be so. It sometimes happens that there are healds which have been working some other cloth that it is desirable to utilize, or it may be wished to draw the warp through the healds so that they can after-



Fig. 205.

wards be used for some other purpose. Then we will suppose that they are drawn straight over from front to back as in Fig. 205 ; A A are the face ends and B B the back ends. It will now be observed that A A, instead of being drawn upon 1 and 2 healds, are drawn upon 1 and 3, and B B upon 2 and 4 ; the process of weaving is precisely the same as before, the only difference being that the second and third healds have changed places. The working plan, Fig. 206, will, on comparison with the working plan in the



Fig. 206.

previous case, Fig. 204, clearly demonstrate this, the picks occupying the same position, but the healds 2 and 3 having changed places.

This arrangement shows the necessity for observing the rule laid down in a previous page, viz., that in making working designs, the arrangement of the warp threads and the order of picking must be carefully followed. The best and easiest way in making double cloths is to put upon the design paper the pattern which is to form the face cloth,

of course observing all the while that you touch nothing but the threads and picks of which that cloth is to be composed; do the same with the back cloth, and then put in the lifting marks, all three being in different colours or in different marks.

So far I have only treated the matter as if we were weaving two cloths of the same colour, or a sack, but it will be readily understood that if, instead of using only one shuttle and allowing the same weft to enter both cloths, two shuttles are used, each carrying differently coloured wefts, and the two warps of corresponding colours, then by keeping each weft to its own warp the two cloths would be of different colours; or, by using only one shuttle and

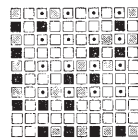


Fig. 207.

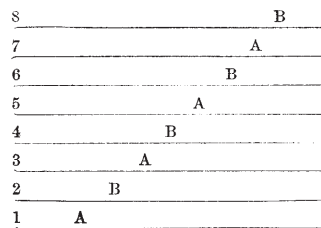


Fig. 208.

allowing two picks to be woven into each cloth alternately, a cloth would be produced which would open out to double the width which it occupied in the loom, because the connection of the two cloths would occur at one edge only, the other edge being left entirely free and open.

I have dealt at considerable length and minutely described the details of this class of cloth, not only because in the making of double plain cloth the whole principle of double cloth making is involved, but because I believe by careful attention, until a thorough mastery of double cloth making is obtained, the student acquires a habit of following the pattern upon the rule mentioned above, which he will find of incalculable service to him

in arranging patterns for other kinds of cloth, and that it will, in fact, lay bare before him the whole system of weaving to a far greater extent than could possibly be the case with the study of any other branch of weaving.

Having thus fully dealt with double plain cloth, we will now proceed to the consideration of some other makes and combinations. Fig. 207 is a design for a double cashmere twill cloth, with the draught as shown at Fig. 208, A A A A are the face threads, and B B B B are the back threads, consequently the healds, 1, 3, 5, and 7, are the four healds upon which the face cloth is worked, and 2, 4, 6, and 8 are those upon which the back cloth is worked, the dark and shaded spaces at the bottom and up the side of the

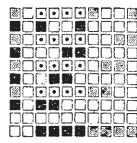


Fig. 209.

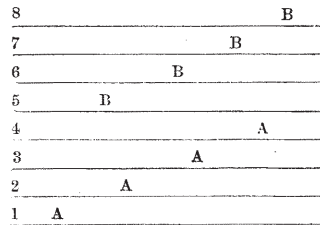


Fig. 210.

design also indicating which are face and back ends and picks. In the design the pattern for the face cloth is shown by the black squares, the back cloth by the shaded, and the dots are to raise the face warp when the back pick goes in. Fig. 209 shews the working design with the draught, as given at Fig. 210, that is, with the face and back healds treated as two sets. This will be very readily understood after carefully studying the plans for the plain cloth.

There is one feature in twilling double cloths to which I must call the attention of the beginner. In the example just given the twills for both the face and back run in the same direction on the paper, but when put into the cloth

they would run in opposite directions, because the upper surface of the lower cloth being next the upper cloth the under surface becomes the face of that cloth, and when

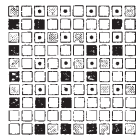


Fig. 211.

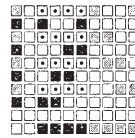


Fig. 212.

turned over presents the twill running in the contrary direction to that presented by the face cloth ; and in making twills the importance of the twill running in a

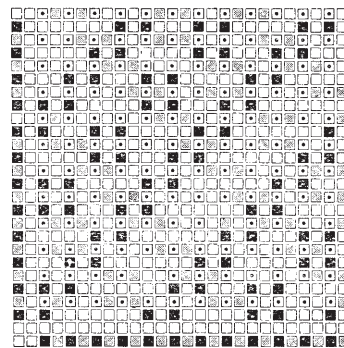
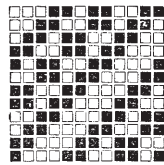


Fig. 213.

particular direction, according to the twist of the yarn, has been fully shown at page 175 ; then to prevent this occurring, the pattern must be put upon paper with the



Pattern of 213.

two twills running in contrary directions, the draught remaining the same as before. Fig. 211 shows a design for a twill arranged in this manner on the same draught

as Fig. 208 and Fig. 212 is the same thing on the draught of Fig. 210. So far we have only dealt with plain and cashmere twill but it will be easily understood that any pattern may be woven upon the same principle. Not only may any pattern be woven upon both cloths, but each cloth may be different. Figs. 213 to 216 are a few examples of what may be done ; Figs. 213 and 214 having

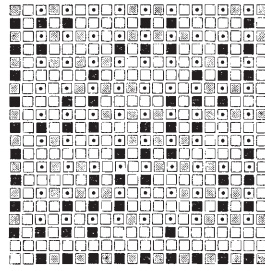
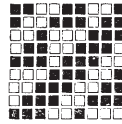


Fig. 214.

both cloths of the same pattern, and Figs. 215 and 216 having the two cloths different. The whole of these designs are arranged upon the principle of draughting shown at Fig. 208, that is, the face and back healds being alternate



Pattern of 214.

We have up to now supposed the two cloths to be equal, and so made that the cloth would be reversible ; but it very frequently happens that the two cloths are not equal, that a fine face cloth may be desired with a coarse cloth woven to the back of it for the purpose of giving weight. In this case the face cloth very often stands in relation to the back cloth of two threads to one, a pattern

being woven on the face and the back being perfectly plain. For this class of weaving, the healds upon which the warps for each cloth are drawn are treated as two sets, as in Fig. 210, and not intermixed as in Fig. 204. Fig. 217 shows the draught for a cashmere twill face and a plain back, the proportion being two threads face and one back, both in the warp and weft, and Fig. 218 is the working design for it. It will be observed that the working is precisely the same in principle as when the cloths are equal, the only difference being the relative number of threads in each cloth. Fig. 219 is another pattern arranged upon the same principle, that is, with all the healds for the face cloth together and those for the back cloth together.

Again, in Figs. 220 and 221 we have arrangements

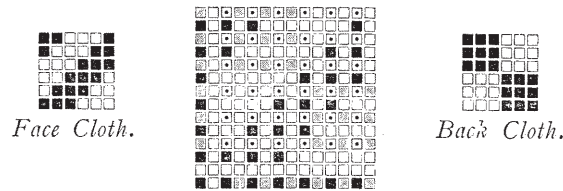


Fig. 215.

upon the principle of the face and backing healds being intermixed, as shown in the draught, Fig. 222, A representing the face, and B the back threads as before. A very little attention to these examples will convince the student that the principle of working is the same, in whatever proportion the two cloths may be to each other.

Now with regard to stitching the two cloths together, which is quite as important as the arrangement of the design. The stitching or binding is, of course, as implied, for the purpose of securing the two cloths together in such a manner as to make them appear as one cloth. Considerable care is required to do this successfully, especially in

some makes of cloth, when the two sides are of different colours, the one colour being liable to show through the

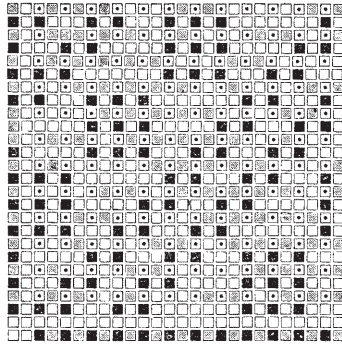
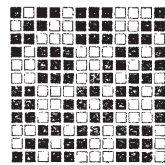
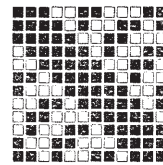


Fig. 216.

other ; or if the two cloths are very thick an effect may be produced which gives the cloth an appearance as if it



Face Cloth.



Back Cloth.

was embossed. Sometimes this latter is done purposely to produce a pattern, as in the cloth known as the matelasse, where the two cloths are bound together, and

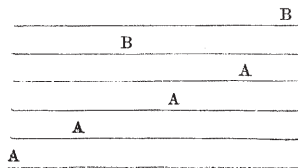


Fig. 217.

the space between them filled with thick soft yarn to give a soft wadded effect ; the same thing is also done in quilts.

To bind two cloths together so as not to be visible the best and easiest way is to take a pick of one cloth and a warp thread of the other, at some point of the pattern where both happen to be working in the same

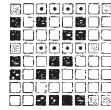


Fig. 218.

space between the two cloths, and interweave them, as shown in Fig. 223, where the two cloths are bound together at point A; and on examination it will be found that the

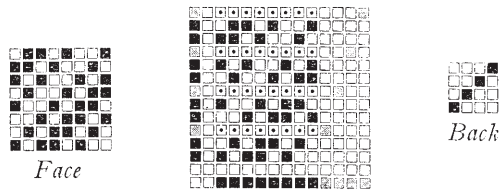


Fig. 219.

warp on one side and the weft on the other effectually hide the stitching threads. But supposing they were stitched together as shown at Fig. 224, it is pretty certain

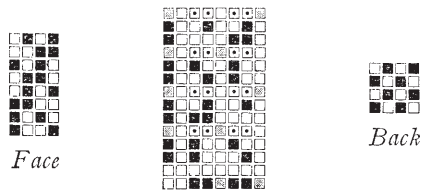


Fig. 220.

that the stitching threads would show on both sides, and if the cloths were thick, the embossed effect mentioned above would also be produced, because the stitching thread actually passes through from the surface of one cloth direct to the surface of the other, consequently at this

point the two cloths actually become one, while between the stitching threads they remain separate and distinct. The result of this kind of stitching is more marked in woollen cloths, which have to undergo the process of

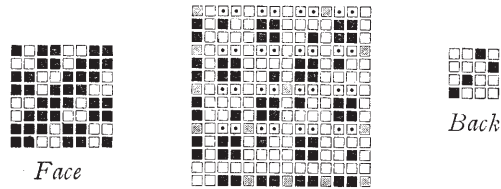


Fig. 221.

milling. The method of stitching is, as indicated in the sections given, to raise a warp thread of the back cloth when a face pick is being put in, or *vice versa*, the distance apart of the stitching threads being regulated as the cloths

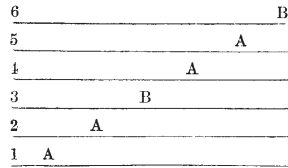


Fig. 222.

are required to be closely bound together or otherwise. If they are to be bound closely, or if the pattern is a large one on a great number of healds, one of the ordinary healds may be raised or depressed for the purpose of



Fig. 223.

stitching, but if they are not required to be closely bound, and the pattern is a small one, then special stitching healds are put on. This heald represents the regular heald upon which the thread selected for stitching would otherwise be drawn, and works all the way through with

that heald, except for the stitching pick, when it is raised or depressed as desired. For the purpose of illustrating this I will refer the reader to Fig. 225, where, supposing the two cloths to be equal, a stitching heald is introduced; the draught follows in regular order until the stitching point is arrived at; then the thread which has been selected for stitching, instead of being drawn upon the third heald

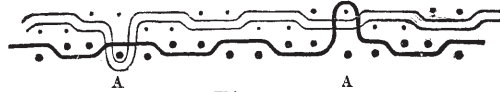


Fig. 224.

as it otherwise would be, is drawn upon the stitching heald. It is then very evident that this stitching heald must work exactly as No. 3 works—else the pattern will be broken—until the stitching pick is arrived at, this pick of course forming a portion of the contrary cloth to the one the stitching thread belongs to. The stitching heald is then raised or depressed, and the binding is effected without in any way interfering with the pattern upon

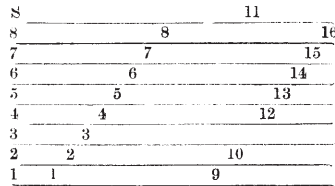


Fig. 225.

either cloth. If desired two or more stitching healds may be used instead of one, so as to avoid the stitching running in straight lines. When cloths are figured by bringing one cloth through the other, no necessity exists for stitching, as the figuring itself is sufficient to bind the cloths together. This will be dealt with further on when dealing with Jacquard figures.

JACQUARD FIGURES.

It is now necessary to deal with figure weaving on Jacquard machines. Hitherto all the figures and combinations have been dealt with and arranged for healds ; but, as before explained, by the use of healds only limited patterns can be produced, although by ingenuity in the arrangement of the draughting and treading, considerably greater diversity may be produced than would appear possible at first sight, but the figures will of a necessity be of a stiff character, consequently the Jacquard machine becomes necessary.

The Jacquard machine having been described in a previous chapter, it now remains to explain the arrangement of the designs for it, and in many respects this is a much simpler process than the arrangement of designs for healds. For instance, there are no cross draughts to contend with ; the whole of the harness being a straight draught from beginning to end, the treatment of the design is just the same as if it were being made for the number of healds which the Jacquard represents ; a three hundred and four Jacquard representing that number of threads in what is termed a division of the harness, the pattern must be made to occupy that number of threads on the paper, or such smaller number as will divide a given number of times in three hundred and four, otherwise some of the hooks in the machine will have to remain idle, and the harness threads attached to them must not in that case have any warp drawn through them. The same thing of course also applies to every other size of machine, whether two hundred, four hundred, or six hundred. Then the first question which requires to be dealt with is what is termed

casting out, or in other words, where the pattern cannot be adapted to the harness, the harness must be adapted to the pattern.

I will endeavour to give illustrations of every form of casting out, and the causes which give rise to it, for casting out has frequently to be done for other reasons, but the illustrations in this branch will have to be of a somewhat limited character. A full design for any Jacquard machine would be too large for this work, but those which are given will I trust be of such a nature as to convey fully to the reader a knowledge of the system, and enable him to understand not only the theory but also the practice of designing for Jacquards.

I will begin as I have done in the previous classes by

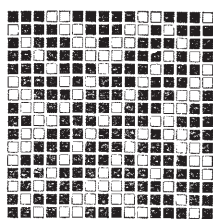


Fig. 226.

giving examples of the simplest possible description. We will suppose that the designs are to be made for a three hundred and four Jacquard (which is the machine regularly used in the Bradford worsted trade). The machine contains thirty-eight rows of hooks, eight in each row. The design paper is ruled to correspond with this, viz., thirty-eight large squares, each containing eight small ones, which represent the warp threads, and usually thirty squares of eight each in the weft way, but of course so far as the weft way of the design goes the number of squares is a matter of no moment, because the pattern may be made to go any length. The number of squares on a sheet is simply a matter of convenience as to size, &c.

Take a given pattern, Fig. 226, it is desired to arrange this pattern to be woven upon a Jacquard of the above extent. The first thing to examine is the number of times this pattern will repeat upon three hundred and four

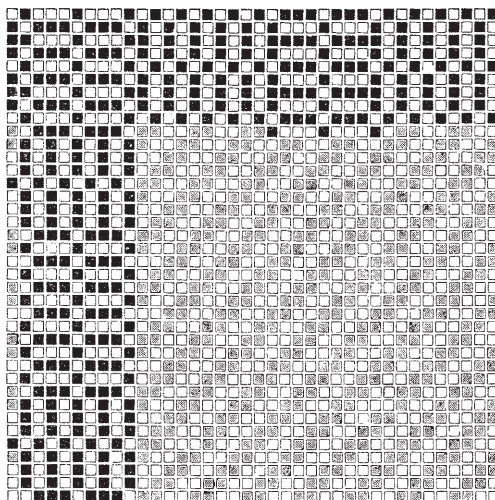


Fig. 227.

threads, or, in other words, the pattern takes sixteen threads, $304 \div 16 = 19$, so the pattern must be repeated nineteen times across the paper; or if the card cutter is expert at his work the actual repetition upon paper is not

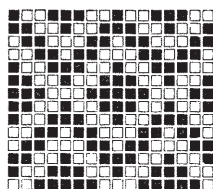


Fig. 228.

necessary, he will read it the requisite number of times upon the card. Take again the design Fig. 227, which occupies thirty-eight threads, $304 \div 38 = 8$, the pattern must be repeated eight times; but it must be understood

that although the pattern must be repeated a number of times to make up the numbers represented by the Jacquard it is not necessary that it should be repeated in the weft way. The number of threads occupied by the pattern in the weft way indicates the number of cards that will be

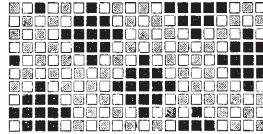


Fig. 229.

required to weave the pattern (this design might also be woven upon healds by reducing the draught). Thus in the two examples given the number of cards required would be respectively sixteen and thirty-eight. In both these cases the number of weft picks which the design occupies

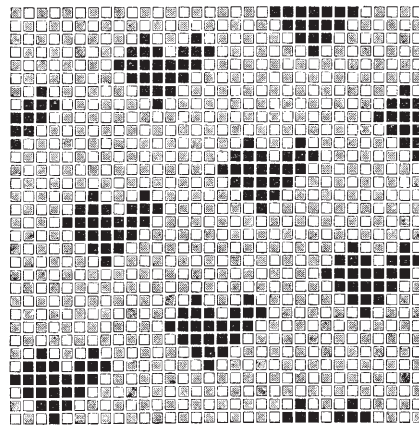


Fig. 230.

is the same as the warp threads, but this is not always the case. At all times attention must first be paid to the number of warp threads being such as will divide in the number of the machine. Fig. 228 is an example of this. The number of warp threads is such that it will divide,

thus $304 \div 8 = 38$, but the number of weft picks will not. Yet on examination it will be found that the pattern will meet on all sides, and would make a continuous pattern all over the piece. Figs. 226 to 228 are therefore all examples of designs upon such a number of threads as will divide evenly in 304.

Two of these are examples of stiff set figures or spots, two of the spots making a complete design, by simply being set across each other or alternated; but another practice prevails of so arranging the spots that they shall appear to be more evenly scattered over the surface of the cloth. To effect this the spots are arranged after the order of a satin. Fig. 229 is an example of a figure arranged in the order of a five-thread satin. Take the number of threads which the five

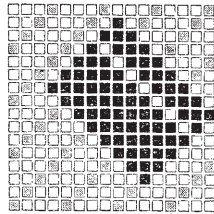


Fig. 231.

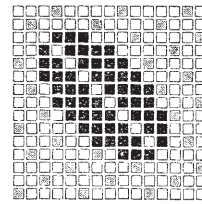


Fig. 232.

spots are to occupy, divide them equally into five, or as near equally as possible; number these spaces in the order of a five-thread satin, and place the spots in order upon the spaces as they are numbered. Fig. 230 is an example of this system of arrangement in the order of an eight-thread satin.

In these examples the figures are made upon plain grounds, but upon twilled, or any other ground, the system of arrangement is precisely the same, the only difference being made by painting the ground pattern upon the design. Fig. 231 is an example of twilled ground. Fig. 232 is an example of a sateen ground. Of course it must be understood that whatever the nature of the ground the

pattern must be so arranged that not only will the figure meet all round and make a continuous pattern, but the ground must also do the same. In both these instances only one spot is given, as the complete arrangement would occupy too much space.

It may occur to the beginner that in the arrangement of a design for a spot figure it will be difficult to determine at first sight at what distance to place the figure apart upon the paper, or if the same spots have been worked out upon one arrangement, and it is desired to alter the arrangement, as say from a five to an eight-thread satin order, it will be difficult to preserve the same distance apart. This is not so difficult as may appear. Suppose in the first place it is desired to arrange a new design, and the order of arrangement is to be a satin. To make the matter as clear as possible, I will further suppose that the design has been already arranged with two spots, for the purpose of determining the distance at which they may be placed apart; and that the whole area occupied by the two spots and the ground surrounding them consists of eight ends and eight picks, that is apparently an allowance of four ends and four picks for each spot; and consequently it would appear that if there are to be five spots instead of two, twenty ends and twenty picks would be required. We will see what is the case. Eight ends and eight picks give on the design paper an area occupying sixty-four small squares. (For this purpose the small square may be made the unit of measurement.) We have therefore thirty-two small squares allotted to each figure, that is—for the spot and the ground surrounding it. If we take the twenty ends and twenty picks we shall have $20 \times 20 = 400$ small squares; this divided amongst five spots gives $\frac{400}{5} = 80$ small squares allotted to each spot. Consequently the area in this case would be two and a half times that of the two spots on eight by eight.

If we were putting eight spots and were to adopt the

four picks and four ends for each spot we should have thirty-two picks and thirty-two ends, then 32×32 would give us 1024 small squares, this divided amongst eight spots would give us $\frac{1024}{8} = 128$ small squares each.

Then to find the proper number of ends and picks which may be used in the arrangement of a given number of spots to occupy a given area, or an area similar to another given arrangement, we must adopt another method. Taking again the two spots upon eight ends and eight picks, we find the area for each spot to be thirty-two small squares. Multiply the number of small squares for each spot by the number of spots ; that will give us the total number of small squares which must be used. Then extract the square root of that, and we shall have the number of ends and picks required, or in other words we shall have one side of the square in which the number of spots which we are to use must be placed. Thus, suppose we require to use five spots, $32 \times 5 = 160$, the number of small squares to be used, and the square root of 160 is over twelve but not quite thirteen, and as we cannot use any but full numbers we should have to use thirteen ends and thirteen picks. Again, supposing it were eight spots we required to use, then $32 \times 8 = 256$ small squares, and the square root of 256 is sixteen, consequently if we put eight spots upon sixteen ends and sixteen picks in the order of a satin, exactly the same area will be occupied by each spot as if we had two spots upon eight ends and eight picks, and the arrangement will be much better. It will invariably be found that for eight spots exactly the same area can be found as for two spots, and the number of ends occupied will almost as invariably suit the Jacquard, whereas for five spots the area cannot be exact, and the number of ends occupied will not be suitable for the Jacquard.

If the ends and picks differ in number in the arrangement of two spots, one of two courses may be adopted,

either work the square of each side separately, or get the total area, extract the square root, and find the length of each side by proportion; both methods will obtain the same result. Fig. 180, page 210, will be a good example for the student to work out as an illustration.

The examples given here are all for figures formed

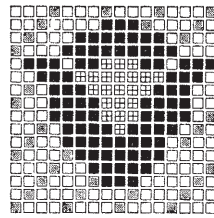


Fig. 233.

with the weft, which constitutes the ground cloth. Fig. 233 is a pattern in which the figure is formed by both warp and weft upon a twilled ground, the portion which has a cross in the square being the warp figure. This principle of figuring may be applied also to any of the other grounds, or the figures may be made entirely of warp, and no weft shown, or the pattern may be formed entirely with warp

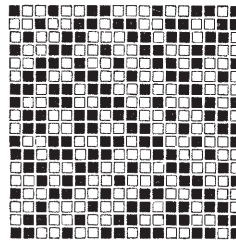


Fig. 234.

and weft figure, all over the piece, and no ground discernible, as Fig. 234.

Then another kind of figure presents itself which may be said to be made on the double cloth principle to some extent. This consists of a solid, perfectly plain, twilled, or other make of cloth, and upon this a figure is formed

by a warp or weft of a different colour. Fig. 235 is an example, the shaded squares represent a perfectly plain ground, and the black squares the figure, which is formed with a separate colour (A being the design shown separately), the order of weaving being one pick of the ground cloth, and one of the figuring. In this class of weaving it will be observed that the pattern is formed by the figuring weft passing alternately to the face and back, the point at which it changes from face to back, and *vice versa*, being determined by the form of the figure. Fig. 236 is

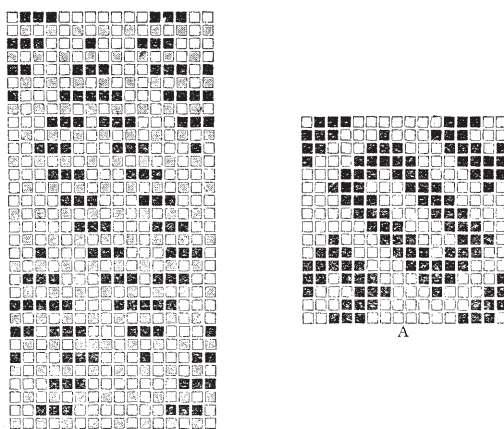


Fig. 235.

an example upon a twilled ground (A being the figure, and B the ground pattern). The same principle also applies to patterns made with the warp. Instead of weft being thrown in to form the figure, warp threads of the colour desired are drawn through the desired number of figuring healds alternately with the ground warp, the latter being drawn upon two or more healds to weave the ground, if they are to be woven in healds; or if in a harness the ground and the coloured warp threads are drawn alternately all over the harness, and the design

arranged accordingly, as shown in Fig. 237, which would produce a simple diagonal pattern, as shown at A.

Instead of the figures being made all over the piece, they may be made to run in stripes, crossovers, or in the form of checks, the longitudinal stripes being formed by the warp, and the transverse by the weft.

Small spot figures are also worked upon the same principle. The difference between working spot figures and those just mentioned is mainly that, whereas in the patterns mentioned above the whole of the figuring material

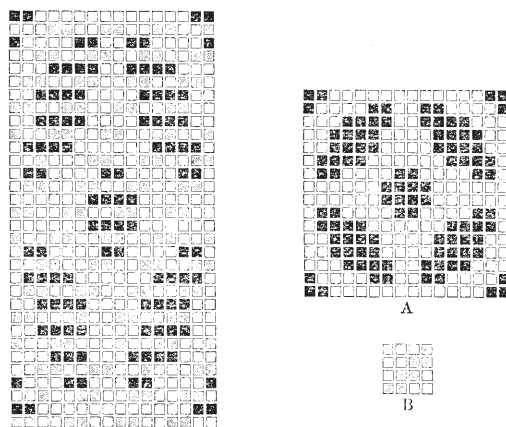


Fig. 236.

is worked loose on one or other side of the cloth; in small spots the figuring material, when not forming the pattern on the face, is thrown to the back—if the cloth is a light one—loosely, and afterwards cut off, but if the cloth is sufficiently thick to allow of its being worked in at the back, without showing through to the face, it is so worked in.

Illustrations without number might be given of this class of figuring. For instance, the spotting warp and the spotting weft may be of different colours, and each form

separate spots, or portions of the same spot ; they may be of different shades of the same colour and both be worked into the same figure so as to produce shaded effects, or in such a multiplicity of other ways that a whole volume of illustrations might be given without exhausting the

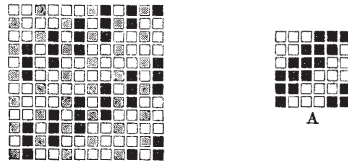


Fig. 237.

subject. The reader has only to walk through a fancy goods establishment to be at once convinced of this.

We now come to the consideration of figures upon double cloths, formed by bringing one through to the face of the other. The method of making double-faced cloths

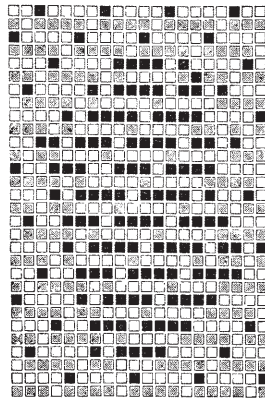


Fig. 238.

upon one warp has been pointed out at page 220, as well as the suggestion that figures may be very easily produced by using two colours of weft, one for each side, and at certain intervals bringing the weft from the back to the face, and taking the face weft to the back. Fig. 238 shows

the way to do this. It will be observed that the face pick when it comes to the figure passes to the back, and *vice versa*. Fig. 239 is an example of figure also of this kind of cloth, the figure taking the form of a diagonal.

Then with reference to figuring with two separate cloths, at page 223 the system of making double cloths has been fully pointed out, and applies also to harness or jacquard figures ; but in harnesses the warps for the two

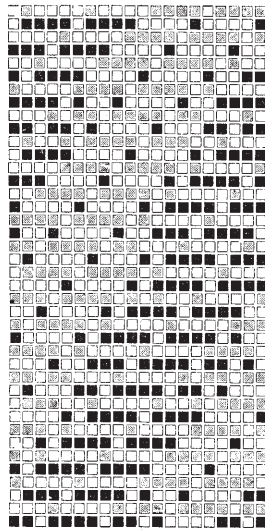


Fig. 239.

cloths must be drawn alternately, as shown at Fig. 205, page 208, and the design arranged accordingly.

Until some amount of dexterity has been acquired it is best for the student to arrange his patterns upon paper, as if they were for single cloth, and then put them on together for the double cloth, because every alternate end belonging to separate cloths, the design will appear to occupy double the amount of space upon paper which it ought to do, in addition to which the beginner is very

liable to get his dots or crosses upon the wrong lines. As pointed out at pages 223 to 226, the formation of double cloth is produced by the warp being divided into two portions, which are kept and worked separately; while the weft is being passed through one the other is kept apart from it. This is arranged upon the design by putting dots to raise the whole of the warp belonging to the face while the pick is being put in the back cloth, &c. As this is the principle upon which the two cloths are kept separate, it is also the principle upon which figures are made; the fact is that no matter what the figure is, whether large or small, the two cloths throughout retain their individuality, whether plain, twilled, or otherwise.

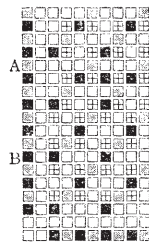


Fig. 240.

To illustrate this we will turn to Fig. 240, which, supposing the two cloths are black and white respectively, will produce a black and white stripe alternately across the piece from side to side, A being the white stripe and B the black stripe. Now, as to the cause of this change of colour, for at a glance there appears no difference between the arrangement of A and B, yet there is a difference, and one of a very important nature. If we examine the stripe B we shall find the lifting marks, which are represented by a \boxplus , as we may term them, and which are intended to lift the face warp up while the back pick is put in, are placed upon the second pick, and lift the first thread. The first thread and the first pick are supposed to be black, the second thread

and the second pick are white, consequently the black threads being lifted when the white pick goes in will bring the black cloth to the face, and the white to the back, then this accounts for the first stripe being black. If we examine the second stripe we shall find that the reverse is the case, viz., the lifting mark is on the first pick and the second thread, consequently the white is lifted when the black pick goes in, thus bringing the white cloth to the face, and in this way making alternate black and white stripes. The stripes it will be perceived, may be made any size, by weaving the length required before changing the lifting mark.

From the foregoing the reader will have very little difficulty in following through, step by step, the various

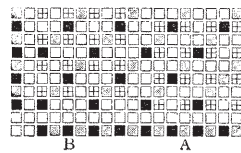


Fig. 241.

stages of double cloth figuring, and understanding easily the principles upon which they are worked. We will now suppose that instead of the stripes being transverse they are intended to be longitudinal; the same principle as to the lifting marks applies as in the last case; in fact, all throughout double cloth figuring this is the one system of working, and in whatever form it may be put the real work cannot be done in any other manner. The difference between this form of stripe and the last is, that in the last case the weft pick traversed the whole width of the piece on one side, whether face or back of the cloth, while the warp threads changed from face to back as required to form the stripe; in the present case the warp threads traverse the full length of the piece, on one or other side of

the cloth, while the weft pick passes from face to back as required. Fig. 241 is a design for a stripe of this kind. The portion of the design A, it will be observed, has the lifting marks upon the first pick and the second thread, thus bringing the white cloth to the face (supposing as in the previous case, that the first thread and first pick are black, the second thread and second pick are white, the principle which I shall observe throughout these examples; on B, the lifting marks are upon the first thread and second pick, bringing the black cloth to the face, consequently, as explained, the weft will work on the face in one portion of the cloth, and on the back in another portion, and this is repeated throughout the entire length of the cloth.

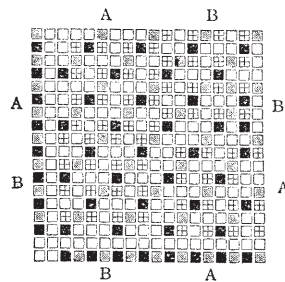


Fig. 242.

We will now suppose that instead of a stripe it is desired to make another pattern. Take, as an example, a chess board pattern, alternate squares of black and white. We have only to combine the two foregoing patterns and we have the thing at once. Fig. 242 is the design for this. The square A of the design is white, B is black, the result being obtained by the lifting marks being changed in the alternate squares from the white thread to the black, and *vice versa*, always carefully observing that when the white is intended to be brought to the face the lifting mark must be on the black pick, and when the black is to come to the face the lifting mark must be on the white pick.

It will be easily found out if it is on the wrong pick or thread by coming into immediate collision with the working dots or crosses, which it will never do otherwise.

We may now produce more elaborate and extensive figures. The readiest and surest way is to sketch the design upon squared design paper, colour it over with some transparent colour, put on the working dots for both cloths all over both the coloured and uncoloured portions, then, instead of having to go over the whole design with the lifting marks, the coloured portion answers for the lifting marks when cutting the cards for, say, the white

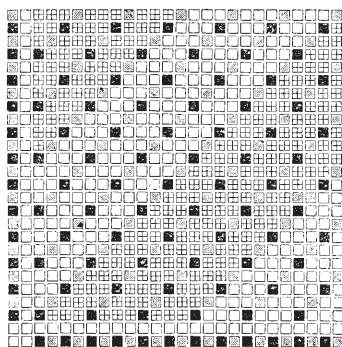


Fig. 243.

cloth, and the uncoloured portion for the black cloth, as shown in Fig. 243, where the coloured portion is represented by the small cross inside the square.

The reason I have dealt so fully with the lifting marks as I have named them in the examples just given, is, because I find it much more readily understood and followed up generally by students, than if the colouring was given first; because the colouring being painted over all the threads which form both cloths it is difficult in the extreme to separate in the mind of the student one cloth from the other, and to make him understand that every

alternate pick and every alternate thread represented on the design paper belong to separate cloths.

Fig. 244 is an example of a figure worked in this manner, and Fig. 245 is the same thing worked with the lifting marks, which shows the working clearly, but when the principle is thoroughly understood, the value and

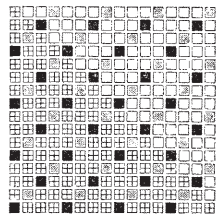


Fig. 244.

simplicity of the method shown at Fig. 244 will be obvious at a glance.

In all these examples I have kept to plain cloths; that is, the two cloths, although they form figures by passing to reverse sides of each other, are in themselves each quite plain; but, of course, it is not at all necessary to keep to plain cloths, they may be twilled or otherwise equally as

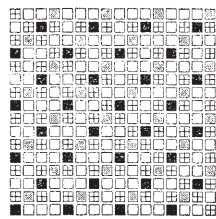


Fig. 245.

well. Fig. 246 is an example of a design upon twill ground. Other grounds may be worked equally as well on the same principle. Nor is it necessary that the two cloths should each be solid in colour. They may be varied in every conceivable form, one solid colour, and the other striped or checked, as fancy may dictate.

The way in which the figure is formed will perhaps be made more intelligible by reference to the section, Fig. 247, which shows the manner in which the face cloth passes to the back, and the back cloth to the face, for the purpose of forming the figure.

We must now return to what was said at the beginning of this chapter respecting casting out in harness. Assuming

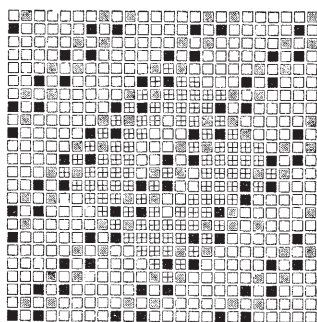


Fig. 246.

that we are working with a Jacquard having 304 hooks, the first three designs given, Nos. 226, 227, and 228, would not require any casting out; as has been already shown they occupy such a number of ends as will divide evenly in 304; but in Fig. 229 that is not the case. In this design the pattern occupies twenty ends, then $304 \div 20 = 15 + 4$,



Fig. 247.

consequently, there being a remainder of four, four hooks must be cast out, or allowed to remain idle, otherwise the pattern could not be made to meet and join properly at the sides. Again, in Fig 230 the pattern occupies thirty-two ends, then $304 \div 32 = 9 + 16$; consequently, there being a remainder of sixteen, that number of hooks would

require to be cast out, and so in all cases where the design will not divide evenly in the total number of hooks in the machine. After dividing the total number of hooks by the ends in the pattern the remainder must be cast out so as to make the pattern join properly at the sides.

Another reason for casting out in Jacquards is to change the sett, or number of threads per inch, from one number to another. In all cases the harnesses are tied up to what is termed a certain sett or degree of fineness, or with a certain number of threads per inch, and it frequently happens that some other sett is desired to be woven than that which the harness represents. This sett must of necessity be lower than that of the harness, because, although we may reduce the sett by casting out, we cannot add to it. Therefore, in any case where the harness is tied up to a given sett, and it is desired to weave some lower sett in the same harness, it becomes a question of simple proportion. Supposing the Jacquard to contain 304 hooks, and the harness tied up to sixty sett (Bradford or any other system), and it is desired to weave a fifty-four sett cloth, then as $63 : 304 :: 54 : 283$, consequently the number to be cast out is represented by the difference between 283 and 304, which would be twenty-one; but it is not usual to deal with odd ends, therefore twenty might be cast out, and so leave a number which would be a convenient dividend for patterns. Or suppose the machine to contain 400 hooks, and tied up with eighty threads per inch, and it is desired to reduce that to seventy per inch, then as $80 : 400 :: 70 : 350$, consequently the difference between 350 and 400 represents the number of hooks to cast out or remain idle.

These are the two principle reasons for casting out, and in any case by observing these two rules little difficulty will be experienced in adapting the harness to any design or sett.

PILE OR PLUSH.

All the varieties of cloth hitherto dealt with belong to, or are combinations of, two of the three primaries, which were pointed out in the early part of this work ; and before in any way dealing with the third of these primaries, it will be necessary to examine another, which apparently would belong to a quite different species, but in reality belongs to the two already dealt with, the different effect being produced partly in the process of weaving, and partly by another process after the cloth is woven.

Pile weaving is, like all other kinds, capable of producing great diversity of patterns, not only in itself but in conjunction with figures ; magnificent effects being produced by velvet forming figures upon silk grounds of various colours. Patterns of various colours in loop pile, as in Brussels carpet, imitations of skins of animals of almost every description, and in other ways, calling forth the ingenuity of the caterers for the public in the production of textile fabrics, which may deservedly take rank as works of art.

Loop pile is the first and simplest kind of pile made, and consists of a plain ground cloth woven in the ordinary manner, and having upon it a pile formed by a separate warp, which is bound into the ground cloth in the manner shown at Fig. 50, page 166, the loop being formed by wires being inserted under the warp which is to form the loop, in the process of weaving, and afterwards drawn out ; the size of the loop being regulated by the thickness of the wire used.

Cut pile is woven in precisely the same manner as the foregoing, the difference being that instead of the wire

being drawn out it is cut out, either by means of a knife run down a groove in the top of the wire, or the end of the wire being furnished with a knife which cuts its way as the wire is drawn out.

There are various ways of altering the quantity of pile upon the surface of a cloth, the manufacturer being guided by the purpose for which it is intended, as well as by the thickness and quality of the material being used. In the first place it may be very easily regulated by the number of threads of pile warp per inch, care of course being taken that the threads may not be so far apart that the pile will appear in rows, showing up the ground cloth between each. Again, the pile, instead of being bound in every pick of the ground cloth, may be bound in every alternate one, or otherwise as may be desired.

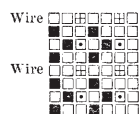


Fig. 248.

Another point to be observed is that the whole of the plush warp need not be brought over the wire at once, but every alternate thread brought over the first wire, then the other half over the next wire, the portion of the pile warp which is not being worked up being worked into the ground, as shown at Fig. 50; thus not only making the ground cloth a much finer and firmer one, but also binding the pile much more firmly into the cloth.

Before going further, it may be desirable now to show how the patterns for velvets or warp pile fabrics, are arranged upon the design paper; and then to examine how figures may be produced by forming velvet upon a plain or other fabric.

To turn first to the common velvet, or where all the pile warp is raised at once for the formation of the pile, the

design Fig. 248 shows the arrangement. In this the ground threads are represented by the solid squares, and the pile threads by the dots and crosses, the one indicating where it binds into the cloth, and the other where it passes over the wire. From this it will be seen that there are two ground threads to one pile thread, and three ground picks to one wire or row of loops. It will be further noticed that when the wire is inserted—as indicated by the word wire,



Fig. 249.

and the crosses—the pile warp issues from and returns to the cloth between two picks, which are exactly alike, as shown in the section Fig 249, by this means not only holding the pile firmly into the cloth, but forcing it to stand erect.

The arrangement for the working design for utrecht velvet is slightly different, as shown at Fig. 250. The wires are again shown by the crosses, and the pile thread always binds into the fabric along with its neighbouring

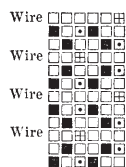


Fig. 250.

ground thread; a section of this is shown at Fig. 50, page 166.

Where figures are to be formed of velvet on a plain, or any other ground, the structure of the cloth, and the mode of binding the pile into the ground cloth remain exactly the same; the figure is formed by simply not bringing the pile warp over the wire, where the ground cloth

is to be visible, and lifting it over the wire where the figure is to be formed. The readiest method of making the design for figured velvets, is to paint the pattern on paper after the manner indicated with reference to double cloth, and as the ground picks remain the same throughout, and the figure is formed solely by the warp being drawn over the wire, in cutting the cards for the wire cut only for those threads which, as indicated by the colouring of the design, are required to be raised, and allow the rest to continue to form part of the ground cloth only.

For very strong heavy cloths, such, for instance, as Brussels carpets, the pile warp does not pass actually to the back of the cloth, as shown at page 166, but passes between two weft threads, as shown at Fig. 251, where two separately coloured pile threads are shown, each coming up at a different time to produce a figure. So far as the ground warp is concerned those two binding picks both go in the same shed, but one passes above and the other below the pile warp, so holding it firmly between them the weft being shown by the dots, and the ground warp by the thin black line. Upon this principle of working, figures may be produced by using various coloured yarns, or all with one colour, by bringing up the pile at intervals, the pile being either looped or cut.

It will be seen from a comparison of Fig. 251 and Fig. 50 what is the difference between an ordinary velvet and a carpet pile. And it will be also apparent what an advantage the latter possesses for use, because of the structure, and of necessity, the increased bulk of the ground, or body, of the cloth.

After what has been said it does not require much ingenuity to arrange designs for Brussels or other similar carpets. The one thing to regard, so far as the arrangement of the design upon paper as a working design, and apart from its artistic merits, &c., being to take care that the

proper thread is brought to the surface at the proper time. The ground working remaining the same throughout.

The length of pile is a very important matter, especially if the object is to imitate the skins of animals. The length of pile must be in accordance with the nature of the skin to be imitated. Take, for instance, the sealskin, which is very largely imitated, sometimes by the warp pile principle, and sometimes by the weft pile principle. The pile or nap of a sealskin is of the medium length, from a quarter-inch to about half-an-inch, somewhat longer than an ordinary velvet, while an imitation dogskin of the long curly or wavy kind has a very long pile or nap, ranging up to an inch in length. In both these kinds of skins there are important features to be observed, quite apart from the weaving. Sealskins are very often made with a sort of



Fig. 251.

tan-coloured ground, and the tips of the pile are coloured a very dark brown, which gradates down towards the ground, thus giving it an exceedingly rich appearance. This tipping, as it is termed, is done after the pile is woven and cut, and is really a part of the finishing process.

In the imitation dogskin the curl or waviness is produced by a preparation of the pile warp before weaving. The yarn is crimped, the length of crimp being regulated by the amount of waviness it is desired to give. The crimping is set in the yarn by a steaming process, the yarn is then made into a warp, and woven over wires and cut. The moment it is cut it falls into the crimps again, and thus produces that wavy shagginess.

No matter what the effect on the face may be, if the pile is a warp pile the principle of making is the same. If

the pile is of a material which is very likely to pull out easily it is more firmly bound into cloth by interweaving, and *vice versa*, but all other effects, such as curliness, waviness, colouring, &c., are produced in the preparation of the yarn before weaving, or in the finishing. Numbers of various effects in imitation skin might be given, all produced by different processes, but the object of this work is to deal with weaving only, and to lay down the principles so that they may be applied to all classes of trade, and not to detail the manner in which any particular cloth is made, otherwise there might be no limit to the work, and a vast amount of information might be contained in it which would be of no value except to those engaged in that special branch of trade.

Weft piles are produced by the material of which the pile or nap consists being thrown in as weft instead of warp. The appearance of a weft pile is usually totally different to that of a warp pile, inasmuch as the warp pile being woven over a wire and cut down, the pile is made all of a length, and unless in the case of a very long pile, or when the yarn has previously undergone a preparation for the purpose of producing some special effect, all warp piles present a smooth even surface, the tips of the pile only being presented to view. But in the weft piles this evenness cannot be well maintained, partly in consequence of the manner in which the pile must be bound into the ground cloth, and partly in consequence of the method of cutting making it almost a matter of impossibility for both sides of the loop to be cut of an equal length. There are one or two exceptions to this which will be mentioned, but they are only in special makes, and have each peculiar characteristics.

As an example of weft piles we will take an imitation lambskin upon a twilled cloth. The design, Fig. 252, shows the manner in which the weft, which is to form the pile,

may be bound into the ground cloth. Two ends are raised at a place, and at such distances apart as to allow for the length of pile required. These bindings, it will be observed, are not in exactly regular order, that is, they do not run in straight lines like velvet. The reason of this is that the material of the pile being of a thick and soft character—being usually of the finest and softest wool possessing the best felting qualities—it must not be so thickly bound in the ground cloth, consequently it is spread over the surface in the manner shown, so as to equally cover the surface without showing in rows, or leaving any bare patches. This, after the cloth is woven, is cut with a knife, as shown at page 167, the point of

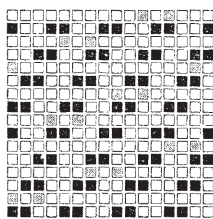


Fig. 252.

the knife being inserted under the weft, which is floating over the cloth, and pushed forward lengthwise of the cloth, the point of the guide always following the course of the pile, and raising it up to the knife which severs it. This process is repeated from one side of the cloth to the other, the cutter usually beginning at the right hand selvage of the cloth. The process of cutting is generally done after the cloth comes out of the loom, the cloth being stretched in a frame for the purpose.

Pile made upon this principle, as before remarked, is not even on the surface, as is the case with warp piles. This will be easily understood from the manner of cutting it, making it almost a matter of impossibility to run the guide under the courses of the pile in such a manner as to

ensure the cutting exactly in the centre of the weft float. This is remedied afterwards by the shearing machine, known as the cross cutting machine, and sometimes by the perpetual cutting machine.

After the pile of a lambskin is cut it presents something of the appearance of a very coarse velvet. To give it then the character of the skin of the animal it is intended to imitate, it is kept moving through a strong soap sud for some hours, until the pile on the face of the cloth becomes felted in patches, thus producing the semi-curly, semi-wavy appearance peculiar to the skin of the lamb.

With regard to "Velveteens" and such fabrics, where the pile is very short, the reader need only be referred to my work on "Design in Textile Fabrics" already mentioned, where he will find a considerable amount of information of what may be called a special character.

In the imitation of other skins the principle of weaving remains somewhat the same, the length of the pile being regulated to suit the character of the skin required to be imitated, and the firmness of the binding into the ground cloth being regulated by the nature of the material used for pile, and the subsequent processes it will have to undergo. To illustrate this we will now take as an example, a pile made of mohair yarn, where it is desired to have the pile firmly bound in the ground cloth. And here it may be observed, in the use of mohair which is of a very smooth and slippery character, it is necessary that it should be very firmly bound, otherwise it is very liable to pull out in wearing, and indeed even in the process of cutting. Fig. 253 is a design for this kind of pile. On examination of this design it will be found there are four picks of pile weft, which are represented by shaded squares, and one pick of ground weft, represented by black squares. These four pile picks are so arranged as to form one continuous pick,

passing over and under alternate threads, thus constituting one ground pick of plain cloth. The ground pick is also plain, taking the contrary thread of warp up to the pile pick, so forming a perfectly plain ground, with the mohair pile standing up out of it. Care should be taken that the succeeding series of pile picks do not leave the cloth at the same point, but are distributed over the surface in the same manner as the preceding example. Although but one ground pick is shown, or mentioned here it is better to insert two ground picks between the pile picks, so as to give firmness to the structure. One of the two would necessarily go into the same shed as the pile, but that would be no disadvantage, it would give more firmness to it. In the

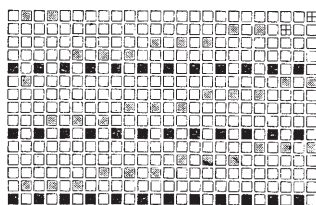


Fig. 253.

design here given the arrangement is not the best which could be devised, the order of changing being on the principle of a three-end twill. Had space permitted it would have been much better arranged on a satin principle, which would be the best plan to adopt in practice. Another advantage of this kind of pile weaving is that in addition to the firmness with which the pile is bound into the ground cloth—becoming, as it in fact does, a part of it—the manner in which the pile threads are nipped together at the point where they issue from the cloth, ensures them standing quite erect; indeed a good mohair pile made in this manner, with steam blown through it for several hours after being cut, will stand almost any amount of pressure, and yet spring back to its original erect position,

without being in any way deteriorated. In this kind of binding the length and quality of pile must be determined by the number of pile picks which go to form one complete pick, and the proportion of complete picks to ground picks. The greater the proportion of complete pile picks to ground picks, the fuller the pile will be, and the less the proportion of pile picks the thinner the pile. In this manner scope is given for the production of cloths of any quality, and at almost any price.

These are the distinct principles upon which pile cloths are made, of course being capable, like everything else, of a vast, indeed an almost endless variety of changes; for instance, a short silk or mohair pile may be made with a

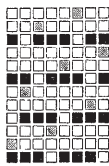


Fig. 254.

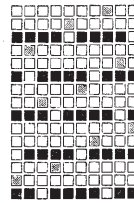


Fig. 255.

long pile scattered thinly over it, of some other material or of a different colour of the same material, as in the case of the chinchilla; or a short woollen pile ground, with thick worsted or mohair issuing at intervals from it. Or, we may take the case of piles of a shorter and more general character, such as the one represented by the design, Fig. 254, in which there are two plush picks to each ground pick, the plush being bound by one end only, and arranged after the order of an eight-thread satin, and the ground picks being worked as a four-thread satin. Or, take the design, Fig. 255, in which the plush is arranged as a ten thread satin and the ground as a five thread satin. Both of these are of the velveteen type, and fairly represent the principle upon which such cloths are made. In all

plush arrangements of this description the binding of the plush picks should be arranged in a regular order, so as to make regular courses for the knife to cut it. The length and quantity of plush may be varied at will, and the working of the ground may be regulated to suit any pattern, or in accordance with the quantity of material desired to be put in it.

Another method of making pile fabrics is to put pieces face to face, the pile warp passing from one cloth to the other, as shown in Fig. 256, and the two cloths being afterwards severed with a knife or by other means. One great difficulty to contend with in this method is to keep

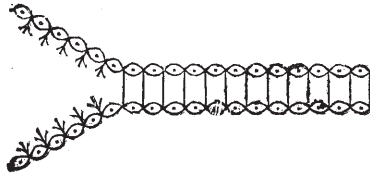


Fig. 256.

the pile of the two fabrics of an even length. To do this the pile warp must be let in very regularly, and the cutting knife or knives must be very carefully adjusted. Numerous inventions have been made by different parties to effect these two objects, with varying degrees of success.

DENSITY OF PILE.

In making pile fabrics it is often necessary to alter the length or density of the pile to meet some demand of fashion, or to suit the cloth to some specific purpose. A mere alteration in length is easily met. In weft pile it simply means an alteration in the number of ends over which the weft is allowed to float; and in warp pile the alteration is made by altering the size of the wire used. But it must necessarily follow that when the length of weft pile is altered, the density must also be altered at the same time,

unless some provision is made to meet it. For example, if the weft has been floating over the warp for half-an-inch, and then it is altered to an inch, and no corresponding alteration is made in the number of picks per inch, then the density of the pile is of necessity reduced by one-half, that is, there are only half the number of pile threads issuing from the cloth in a given space, consequently to counteract this there should be double the number of picks of pile weft per inch to obtain the same degree of density as exists in the first cloth.

At all times when such a question may arise, it may be treated simply as one of proportion, and the number of warp threads over which the pile floats taken as the unit of measurement.

Suppose, for instance, that a pile is made floating over 16 threads of warp, and it must be increased in length to 26 threads; the first cloth has say sixty picks per inch of ground weft, how many should the second have? Then as $16 : 26 :: 60 : 97\frac{1}{2}$, so that it would require $97\frac{1}{2}$ picks per inch of ground weft in the second cloth to give density equal to the first cloth. But in all probability this would be an unsatisfactory mode of obtaining the required degree of density, because either it would be difficult to introduce $97\frac{1}{2}$ picks when 60 had been used, or the cloth would be much heavier, and probably unsuited for its purpose. Then in such a case, the best plan is, in most cases, to introduce more plush picks between each ground pick, as for example, if the first cloth had two plush picks to one ground pick, the second would require three, and the slight difference in density could then be made up by a slight increase of ground picks per inch.

An alteration in the fineness of the ground cloth will have an effect in altering the density of the pile. If more warp threads per inch be introduced, and the pile weft allowed to float over the same number, then the length of

the pile is shortened, and the density increased in the same ratio, and of course any alteration of the cloth must have an effect upon the pile.

At all times this alteration can be determined by simple proportion, and a corresponding alteration made in the opposite direction to counteract it when desired, but it must always be borne in mind, or the results would be sometimes rather serious.

The alteration of density of warp pile is made either by introducing more wires, and consequently more picks per inch, by more warp and pile threads per inch, or by thicker yarn. It will not be a difficult matter, whichever method be adopted, to determine the exact amount of increase or decrease, because it will be in direct ratio to the alteration in either the quantity or thickness of the material employed.

GAUZE WEAVING.

Having in the foregoing chapters dealt with the two primaries, plain and figure weaving, their various combinations and applicability to the production of various kinds of cloth, which, although having on the face of them little to indicate that they belong to either one or the other of these two families, yet on a close examination of their constitution and character undoubtedly proclaim themselves the immediate descendants of them, and conclusively prove that no matter what name they assume, or under what guise they appear, they retain all the family characteristics, and indeed prove that only two principles can be involved, we may now come to the consideration of the third of the primaries, viz., gauze weaving, which in its principle is totally different from the two preceding ones. The two primaries, plain and figure, may be said to comprehend all varieties of cloth in which the threads of the warp lie parallel to each other, and are crossed at right

angles by the weft, while gauze may be said to consist of all varieties whose warp threads do not lie parallel to each other in the cloth, but are either twisted together, as shown

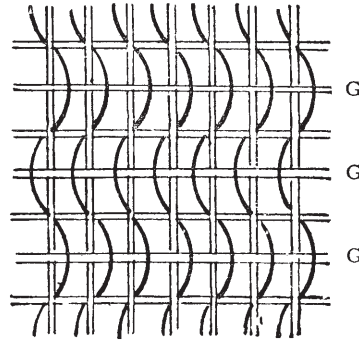


Fig. 257.

at page 168, or otherwise crossed in the cloth in the process of weaving.

The first step in the direction of combining gauze with other orders of weaving, is a species of cloth known

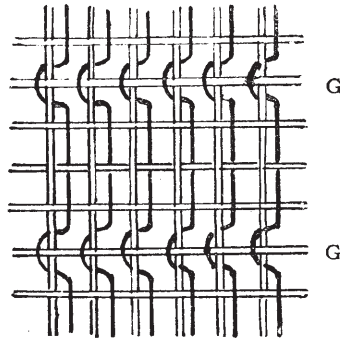


Fig. 258.

by the name of leno, and which is in fact a combination of gauze and plain cloth, but which has a decidedly gauze effect, as shown at Fig. 257. A close examination of this

plan will show that it is really a combination of gauze and plain cloth, the picks *G* if separated from the others would form a perfectly plain gauze with the warp as shown at Fig. 53, page 168.

Fig. 258 shows another combination of gauze and plain cloth, and is sometimes known as leno. In this it will be found that the warp threads are given a half turn round each other at every fourth pick, the intervening picks being perfectly plain, thus making it an intermediate between a plain cloth and a plain gauze. Perhaps a brief description



Fig. 259.

of the process of leno and gauze weaving will simplify and assist to a clear understanding of the principle.

For leno and gauze weaving, there is, in addition to a pair of plain healds, another of a different construction, which is known by the name of doup. This doup is a plain heald, with the addition of a loose half heald, which is shown at Fig. 259, and which passes through the eye of the lower half, and through the upper half. The warp threads are drawn through the two plain healds in the ordinary manner. The

doup heald is then placed in front of them, and every alternate thread is drawn through the loose half-heald of the doup crossing under the intermediate thread as shown in Fig. 260, where D is the doup, and 1 2 the plain healds. In the process of weaving, when it is desired that the open or plain pick shall be put in, the loose half of the doup heald is allowed to rise along with the plain heald through which the crossing thread is drawn, the intermediate pick being also plain by the simple process of raising the second plain heald; then for the purpose of crossing the threads all the doup heald is raised, and the plain heald through which the crossing thread is drawn is depressed along with the other plain heald, in this manner causing the crossing

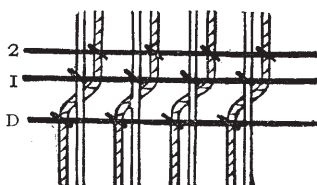


Fig. 260.

thread to take a half-turn round the other thread, as shown in Fig. 258.

It will be apparent that in this process one-half the warp at the moment of crossing must be drawn considerably tighter than the other half, and unless some provision is made to avoid this, the consequences to the warp must be somewhat disastrous. This may be provided for in two ways. The first and oldest-fashioned method is to have the warp on two beams, the beam carrying the crossing portion being furnished with spring weights, so as to give off warp when crossing and then spring back as the doup heald settles down. The second, and now generally adopted method, is by means of what is termed the slackener. This consists of a species of lever. The warp

is all wound upon one beam, the crossing warp is separated from the other and passed over the slackener, and then through a pair of lease rods placed between the slackener and healds, as in ordinary plain weaving. During the plain weaving the slackener remains stationary, but when the warp is crossed a cord attached to the arm of the slackener is connected so as to operate with the doup heald, and allow the warp to go in just sufficient to prevent it chafing the straight thread, and is then drawn back into its former position by means of a strong spring. This latter method would not apply in all cases, but only where very little crossing takes place, or where the take-up of the crossing warp is so slight that it does not become tighter than the rest of the warp, otherwise, not only would considerable breakage take place in the warp, but it would be a very difficult matter indeed to weave at all, and the appearance of the piece would be anything but satisfactory. Therefore in many cases it is absolutely necessary that the first method of having the crossing warp upon a separate beam or roller should be adhered to; the latter only being resorted to when circumstances will permit.

The order of raising the healds to weave the two patterns given would be as follows:—

For Fig. 257 No. 1 heald

 " 2 "

 Doup "

 No. 2 "

and so on. For Fig. 258 it would be

 No. 1 heald

 " 2 "

 " 1 "

 Doup "

To return to a plain gauze, pure and simple, that is, with the warp threads crossing between every pick. The same healds and doup are employed as in the former case,

but instead of the plain pick as in lenos, the warp threads cross each other every pick, as in Fig. 53, page 168, the method of crossing being in no way different from the

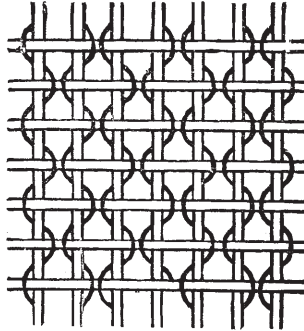


Fig. 261.

leno crossing. The crossing may of course be in either direction, from left to right, or right to left, in the doubling.

Some very excellent effects are produced in gauze by reversing the gauze twist, that is, by making every alternate

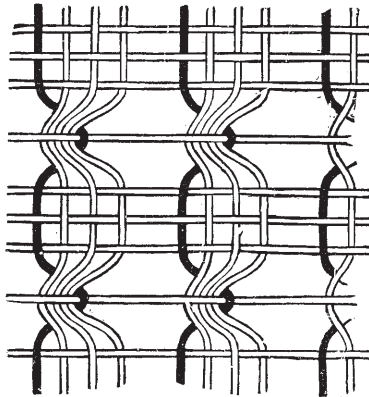


Fig. 262.

pair of threads twist round each other in opposite directions, as shown in Fig. 261. This effect is considerably heightened when the two threads are of different colours,

or a variety of patterns may be produced by arranging the reversing and the colouring in stripes, and if desired checking them to match. Patterns of a different character are also made by having a certain number of splits in the reed full of warp, and an interval of space in which there is no warp, the crossing of the warp threads preventing

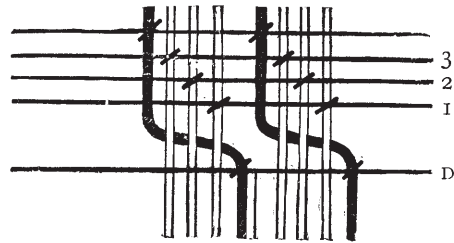


Fig. 263.

them slipping out of their place and producing a frayed appearance, as would be the case if an interval of space were left in a plain cloth ; or the crossing thread may be made to cross over more than one thread, and patterns formed by combinations of plain and gauze as shown at Fig. 262, the draught and douping of which is shown at Fig. 263.



Fig. 264.

The order of raising the healds is shown at Fig. 264, where the lifting of the doup is indicated by a \boxplus .

Again, this may be varied and a pattern of a check character produced by weaving a distance corresponding with the stripe in the warp quite plain, and a distance corresponding with the interval of space with gauze crossing.

or other effects produced by combination of plain gauze and plain cloth, as in Fig. 265.

The order of raising the healds can be readily found by following the individual warp threads, and bearing in mind

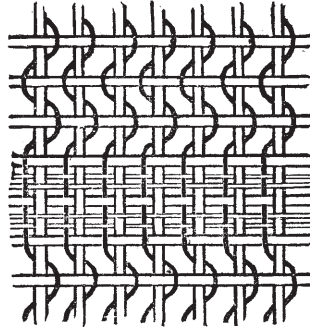


Fig. 265.

through which healds they are drawn, and when the crossing takes place taking care to raise the doup.

One rule must be carefully observed when a pure gauze crossing is required, always to raise the heald carrying the crossing thread *immediately before and after the doup*.

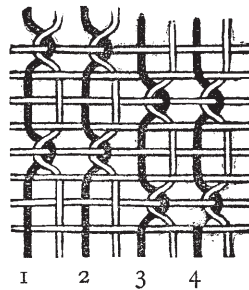


Fig. 266.

The reader having followed carefully the foregoing description of gauze weaving, and having made himself master of the various methods of arranging patterns for healds given in previous chapters, will have little difficulty

in making himself master also of pattern weaving in gauzes. Patterns in gauzes may be arranged on three principles,—the first, by making patterns *in* the gauze by introducing plain or other working, or varying the order of crossing of the several sets of threads; the second by arranging gauze and plain, or gauze and figure, in stripes, &c.; and the third by making patterns *on* the gauze with

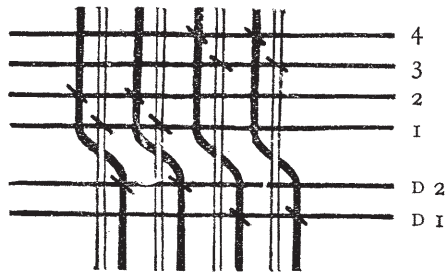


Fig. 267.

what may be termed figuring threads; this last is termed lappet figuring. Then as to the first kind, it has been shown on page 270 how the crossing thread is drawn through the doup and across the plain thread. In plain gauze only one doup is used, but it must be evident that if a pattern is made with the gauze, more than one doup must be used. Fig. 266 is an example of a small pattern made with two

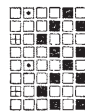


Fig. 268.

doups, the manner of drawing being shown at Fig. 267, and the order of raising the healds at Fig. 268. When the first doup is represented by a \boxplus and the second by a \boxminus .

Although this pattern is given as being woven with two doups, yet it may very well be woven with one. Suppose the ends are douped as shown in Fig. 260, then by lifting the healds as in Fig. 269, the same pattern will be produced,

There is this one objection to it, that the doup is lifting at every alternate pick, and consequently there will be more wear and tear, but as will be shown presently this mode of working may be well adopted for weaving figured patterns. The same rule may be observed here as in arranging patterns for ordinary healds, viz., that all threads which

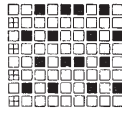


Fig. 269.

work the same may be drawn upon the same doup. In this pattern the threads 1, 2, would be repeated at the fifth and sixth pairs, and all working alike, may be drawn upon doup 2; threads 3 and 4, working alike, may be drawn upon doup 1, the crossing or plain weaving being effected as desired, in the same manner as explained in the leno weaving, due

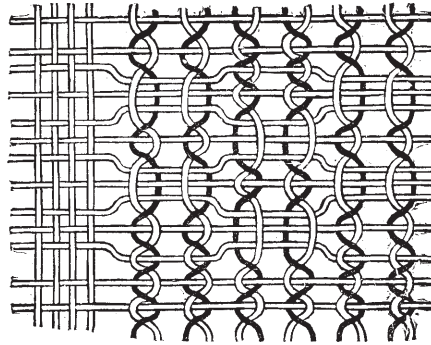


Fig. 270.

regard being paid to the pattern, which of course may be varied as far as the extent of the drafting will permit. Fig. 270 is another example upon a rather more extensive scale, the same rule being observed as in the last pattern. In this case at intervals in the pattern several picks are introduced into one shed, giving a totally different effect to

the pattern. The draught is shown at Fig. 271. In this pattern it will be observed that a few plain ends have been introduced up the side to form a stripe. In the same manner plain picks might be worked in so as to form a check effect.

With care in the arrangement of the doups a very great variety of patterns may be produced: more especially when more than one doup is employed; and even with one doup with skilful use very pretty effects may be made. Of course many of the more elaborate gauze patterns have been superseded by lace, or have gone out of existence for some other reason. Fig. 272 is a curious sample of gauze

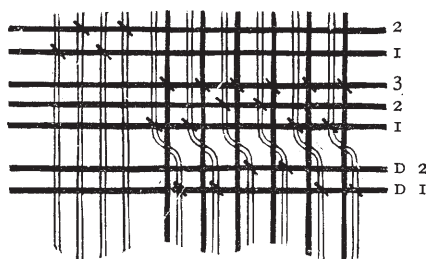


Fig. 271.

weaving. This has been reproduced by photography from a small piece of fabric which is in my possession, and engraved direct from the negative. The pattern as shown here represents only a small portion of the fabric, about $\frac{3}{8}$ in. by $\frac{1}{4}$ in., but is sufficient to disclose the different kinds of crossing employed. In the larger sample the large meshes—if they may be so termed—are made to form a pattern after the manner of lace. I have thought it worth while to reproduce this for the purpose of showing those who may not have had an opportunity of seeing some of the curious productions of the loom, what could be done by what is now looked upon as the primitive hand loom. This pattern must have been made in the early part of the present century.

Coming now to the use of the Jacquard we have an unlimited power for the production of patterns; whether an ordinary harness with one or more doups in front be employed, or a harness specially prepared for gauze weaving be employed. In the former case it is probable that very few really know what they can do with an ordinary harness for gauze weaving, and it would not be easy to

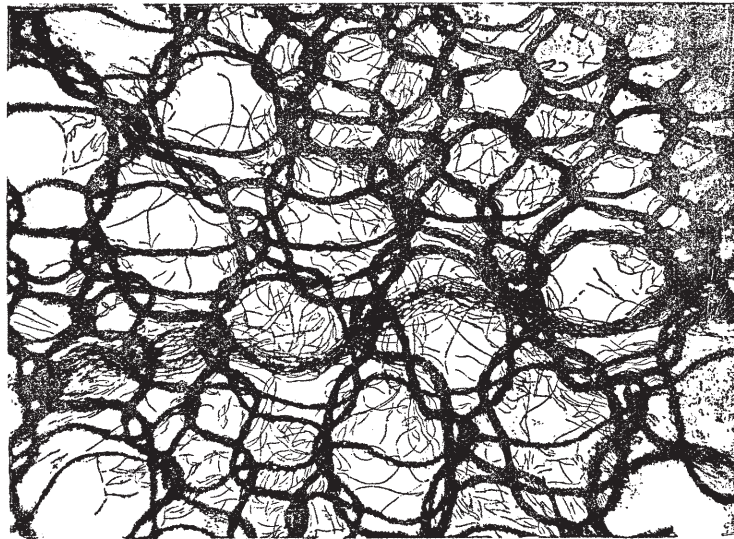


Fig. 272.

convey a knowledge by mere writing of what can be done, however the general principles may be conveyed, and the simplest mode of arranging designs for them explained.

Suppose we begin first of all by treating the matter as though we were employing a number of healds, for the harness is nothing more than a large number of healds arranged to occupy little space, and actuated by a particular mechanical arrangement. Take the draught and douping

plan shown at Fig. 273, there eight healds are represented and one doup. Now this would be a fair representation of each row of harness cords, so that a whole harness would be merely a repetition of those eight healds. In this small space even there is considerable room for making a large variety of patterns. To begin with, suppose it is required to make

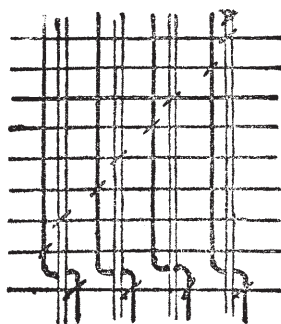


Fig. 273.

a diagonal pattern of plain cloth and plain gauze alternately, then we have only to proceed after the manner shown at Fig. 269 of producing the pattern Fig. 266. The plan shown at Fig. 274 explains how the doup and healds would have to be raised to produce such a pattern. Here it will be noticed that the doup is raised at every alternate pick, and that

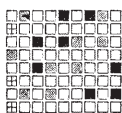


Fig. 274.

when it is raised none of the other healds are raised; then on the intermediate pick of weft, those healds which carry the crossing threads, viz., 1, 3, 5 or 7 are raised for the purpose of forming gauze, and when plain cloth is wanted the intermediate threads, or those carried by the healds No. 2, 4, 6, or 8, are raised. Again the great bulk of the cloth may be plain, and only here and there a perforation

made by the crossing taking place. Take for example Fig. 275, there as indicated by the shaded squares, only an occasional crossing takes place.

To follow this further, designs may now be made for the

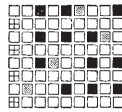


Fig. 275.

jacquard, and which will show how far figuring may be carried, when only one doup is employed.

Suppose the pattern given at Fig. 276 is desired to be made in gauze and plain cloth combined, say the black portion to be gauze, and the white portion plain, then the

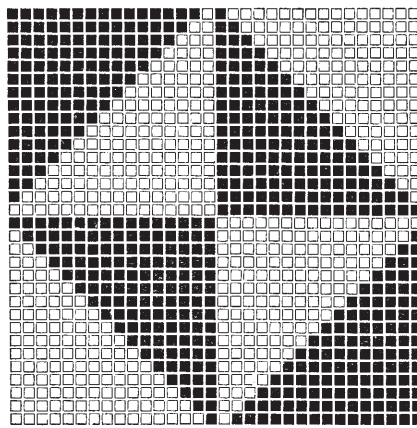


Fig. 276.

working design is given at Fig. 277. An examination of this will show that the arrangement is in strict conformity with that shown in Figs. 274 and 275. In making large designs it would be a tedious process to have to dot them all over as shown here, but that can be easily avoided by laying the design on paper in a wash of colour, and giving

instructions to the card cutter how to proceed. The procedure is, of course, uniform throughout. Wherever gauze is wanted, the heald or harness cord carrying the crossing thread is lifted, and in such a case as this it will always be the odd or always the even end of each row; and where plain cloth is wanted it will be exactly the reverse.

One thing must be made clear here, viz., that by this mode of working with the harness, when plain cloth is combined with gauze, only one pick can be inserted in

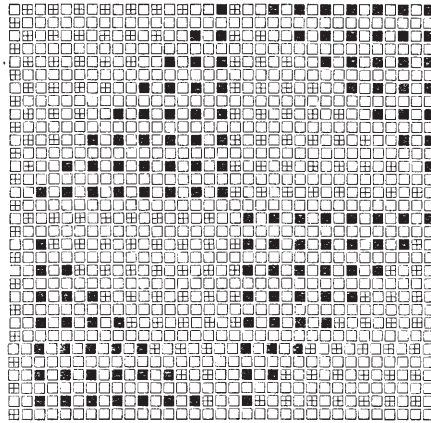


Fig. 277.

one shed of the gauze, simply because the plain cloth having to be formed by the doup and second heald, or that which carries the thread crossed by the doup thread, the doup must of necessity be raised at every alternate pick. Although only one pick can be inserted in each shed, yet it does not follow that the crossing thread can only be made to cross one warp thread; it may be made to cross any number, and the arrangement of the design will be practically the same, the difference being simply that the designer must remember that instead of every

alternate thread being a crossing thread, that it is every third, or fourth, as the case may be.

Attention may now be turned to figures of a rather more complex character. These given are simply a combination of plain gauze and plain cloth texture, but it may be desirable to form a figure with warp or weft, and surround it with gauze. Before going further one word of warning may be given to the beginner, that is, that it is never desirable to form a warp or weft figure upon gauze without separating it from the gauze by a few threads of plain cloth, because if not so separated, the crossing of the threads in the gauze will have a tendency to draw each

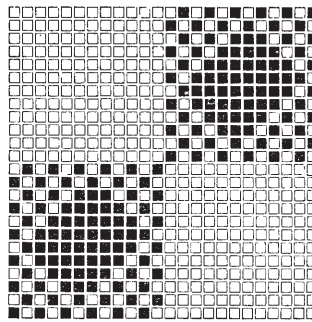


Fig. 278.

other out of their straight course, and so cause the figure to be distorted.

Suppose it is desired to form a figure of the character given at Fig. 278. Where a warp figure is made upon plain ground and the open square to be gauze. This may be produced by the working design given at Fig. 279. In this it will be seen that the plain cloth and gauze is produced in the manner already described, and the warp figure is produced by lifting such threads as are necessary for the formation of the figure, as shown by the dots □. It will be necessary to explain here one matter, which might

otherwise appear incomplete. It is well understood that when a warp figure is to be produced, the whole of the warp threads are raised, except perhaps some which may be left down for binding purposes; but in this case, on the pick when the doup is raised, the marking on the design paper appear to represent only every alternate thread as being raised. It has only to be borne in mind that the intermediate threads are raised by the doup, and the raising of the whole of the warp is provided for where the dots are placed.

It will generally be found that the best effects are produced in this class of gauze weaving, by keeping to

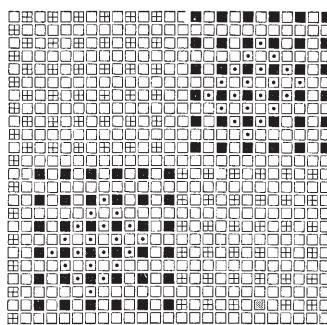


Fig. 279.

figures of a geometrical character; floral designs may be employed, but as a rule they are not so effective as geometrical arrangements, and again, as the crossing must take place at every pick, the cloths must of necessity be light, and as a consequence, if cloths of some substance are required, it is better to have a gauze figure upon a plain ground than a plain figure upon a gauze ground, that is, the plain cloth should predominate rather than the gauze. For gauze fabrics when it is desired to have more than one pick in each shed in the gauze, and at the same time to produce elaborate figures, harnesses with doups arranged within the harness

must be provided, that is, instead of the common form of doup being employed, a loose slip, or some other form of doup must pass through the eye of one of the harness threads, and so constitute each thread through which such loose slip passes a doup in itself, by this means each individual doup can be actuated at will, and consequently the figure may be made to assume any form desired.

The great majority of figured gauzes are arranged for two threads to cross two as shown at Fig. 280, and usually with three or more picks in each shed in the gauze. By this means a greater degree of openness in the gauze is obtained, and at the same time a close compactness in the plain cloth

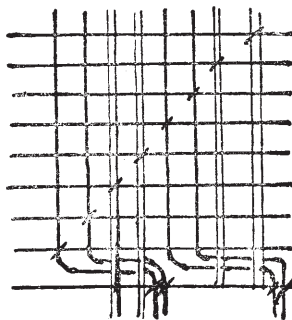


Fig. 280.

and figure, which by their contrast gives greater effect to the fabric.

The principle of arranging the designs for gauzes, whether in healds or jacquard harnesses, is precisely the same as for any ordinary fabric, only the doup must be borne in mind and raised at the proper time, and of course the working of the doup end will also affect the working of the end which accompanies it.

Patterns may again be varied so as to approach very nearly in some respects to the effect given by figuring threads, by drawing the crossing threads in the doup so as

to cross more than one thread, as shown in the pattern, Fig. 262. Of course in this case the crossing thread does not cross more threads than are drawn into one split of the reed; but this is a rule which is not always observed, otherwise this description of pattern would of a necessity be very limited, but the doups are sometimes placed in front of the reed, the lay being constructed so as to allow of their being placed between the reed and the shuttle race, and a series of needles or wires, which form a sort of false reed, being arranged for the shuttle to run against in such a manner as to leave the threads perfectly free to cross each other the moment the shuttle has passed through the shed, these needles rising and sinking at each pick.

This mode of working is not much in use now, but was necessary in such patterns as that shown at Fig. 272.

Fancy gauzes made upon the second principle, named in page 275, viz., by arranging gauze and plain, or gauze and figured stripes, produce splendid effects in some classes of goods. The principle upon which they are worked is very simple, being only a modification of the plain gauze. Fig. 265 shows a pattern of gauze and plain stripes. The gauze stripe may be worked just as a plain gauze in the ordinary manner, or in a variety of patterns, and the plain stripe being worked only upon the two plain healds; or this may be varied by twilling; or if a Jacquard be used the plain stripe may be converted into a figured one, and so produce an immense variety of effects.

Lappet figures are usually made upon a gauze ground, and consequently belong to the gauze class. Upon this system patterns are made by a number of what I have termed figuring threads. The manner in which the figures are formed is by the threads being passed through a series of needles set in a frame, which is placed between the reed and the shuttle race in a similar manner to the doups

for weaving the pattern mentioned on the last page. This frame is made to slide backwards and forwards from right to left, the needles being raised at the proper moment so as to allow the weft to pass under the figuring thread, and so

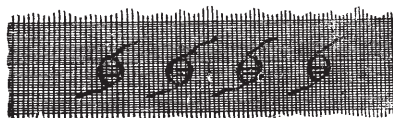


Fig. 281.

bind them into the cloth. For the purpose of producing this oscillating movement of the frame, a wheel is placed at the side of the loom, having grooves cut in it so as to carry

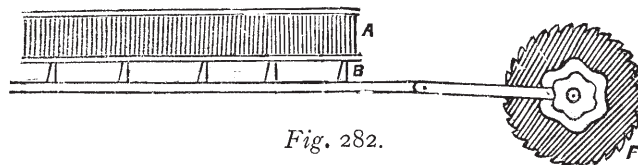


Fig. 282.

the frame the proper distance for the production of the desired pattern. Almost any pattern is capable of being produced in this manner, Fig. 281 being an example of

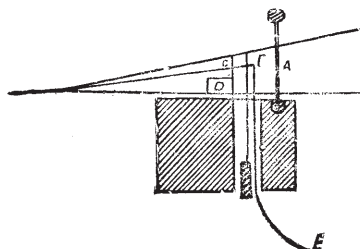


Fig. 283.

a pattern made on this principle, the arrangement of the apparatus being shown at Figs. 282 and 283, one being a front elevation, and the other a section. A is the reed, B the needles which carry the thread, C the needles which the shuttle D runs against, and E the figuring thread, the

motion being given to the figuring needles by the wheel F, which must be cut to the pattern. As the weaving goes on, this wheel moves one tooth for every pick, and by the cutting of the wheel moves the needles from side to side as desired for the production of the pattern.

In many respects this method of figuring resembles what is known as figuring with swivels, but there is not the same scope for the production of elaborate effects which there is in swivel weaving. In the latter system the figures are produced by a series of small shuttles, placed at intervals across the piece, and carrying the figuring material in the form of weft instead of warp, as is the case in lappet weaving. These shuttles form the figure only, taking no part whatever in the formation of the ground cloth, an ordinary shuttle forming the ground cloth, just as in plain weaving, the figuring shuttles being fixed at regular intervals across the loom or frame. Whenever a figure is to be formed, warp is raised at the proper places and the figuring shuttles are passed under it; this operation being repeated alternately with ground picks until the figure is formed. It will be evident that by this arrangement a number of shuttles may be made to take part in the formation of the same figure, and so enable the weaver to introduce a number of colours which, on the lappet principle would be very intricate and troublesome. The swivel method of figuring is used largely for producing patterns not only upon gauzes, but upon every kind of fabric.

GENERAL ARRANGEMENT OF PATTERNS.

Having in the preceding chapters gone through the three leading principles, and shown the nature of each, and their combinations for the production of an endless variety of patterns, it may not be amiss now to examine into one or two particular makes of cloth, and a general system of arranging patterns for various fabrics. Hitherto I have avoided as far as practicable making special reference to any particular cloth or pattern, except for the purpose of illustrating the general principle upon which all fancy weaving is founded, but there are some cloths which will require some little explanation as to their constitution, and other matters to which it is necessary to devote attention, quite apart from the general principles. First and foremost of these come velvets and plushes, or pile cloths of every description. This class of fabric, although appearing to differ in every essential point from all other fabrics, belongs to, or is at any rate composed of, the first two of the three primaries, laid down in this work; the difference as pointed out in the chapter devoted to pile fabrics, arising entirely from various processes in the preparation of the yarn, from the processes of finishing subsequent to the weaving, or from additional operations in the process of weaving, such as the insertion and withdrawal from the pile warp of wires so arranged as to leave the pile standing in loops, or with the loops severed so as to leave a surface of the fabric presenting to the eye the ends of fibres, instead of as in other cloths presenting the fibres or the threads composed of fibres, laid parallel in the warp, and crossed at right angles or otherwise in the weft.

Another cloth which may be mentioned is one known as the honeycomb cloth, which presents to the eye a series of ridges and cavities, resembling in appearance the production of that wonderful and industrious little insect, the bee. This cloth, although it presents this peculiar appearance, is nothing more or less than a figure of the simplest character, and running in a diamond form on the design paper. Fig. 284 is a design for a honeycomb cloth. It will be observed that at the corner of the diamond a certain number of threads work quite plain, and plain threads run from there in a diagonal form to the corner of the adjoining diamond, the sides of which they really form part; these plain threads really form the centre of a square and become the bottom of a cavity. From these plain

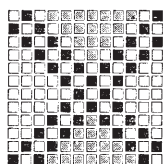


Fig. 284.

threads and at right angles to each other, the warp and weft begin to form figures by floating over a certain number of threads, beginning with one, the next thread floats over three, the next five, the next seven, and the next nine. Now, herein lies the secret of the formation of these ridges and cavities. This gradual increase in the number of threads which the warp and weft respectively float over, causes them to rise on the top of each other, and so form a ridge, while at the point where they work plain, although it is only for a few threads, the firmness with which they are bound keeps them together, and so forms the bottom of the cavity, by causing the others to rise from them as a foundation, the soft material of which honeycomb cloths are usually made tending in a great measure to facilitate this.

There are other kinds of cloth also which appear to belong to distinct classes, but which on analysis will be found to be composed of one or more of the three primaries.

Another instance may also be mentioned of a cloth which on the face of it bears no indication of the manner in which it is made, but presents an appearance which would be much more likely to mislead one as to the real nature and construction of the cloth. This is ribbed printed tapestry. This tapestry at a glance looks as if it were woven with an ordinary cotton warp, composed of thick and small threads alternately, the worsted passing over the thick and under the small threads, and a cotton pick passing *vice versa*, and so making an apparently thick worsted rib, running lengthwise of the piece, and with a pattern printed upon it. Yet the observer is somewhat puzzled to understand how the printer has managed to penetrate into the crevices between the ribs, which to say the least of it, would be no very easy task, when the immense variety and delicacy of shades which are introduced into many of the designs are taken into account. But this appearance of the cloth is entirely deceptive, as will be soon found out if the cloth be examined, and a small portion unravelled. So far from the worsted being thrown in as weft it is really as a warp that it is introduced into the fabric, in spite of the appearance of crossing the piece transversely. The warp consists of thick cotton cords, and accompanying each cotton cord in the warp there is a worsted thread already printed to the desired pattern, but in a very elongated form, so as to allow of the necessary take-up in weaving, which, owing to the peculiar construction of this cloth, is very great. The weft consists of nothing but fine cotton, and is woven straight forward, all of one colour; the worsted thread is made to cross over the cotton thread from one side to the other, after the

manner of a gauze cloth, as explained on page 168. A pick of the fine cotton is thrown in, and the worsted thread again passes over the cotton cord, another pick is thrown in, securing the worsted down again, in this way completely covering the cotton on the face of the fabric, and presenting on the back almost the appearance of a plain cloth.

Then this ribbed appearance is simply produced by the distance at which the thick cotton warp threads are placed apart, and the fineness of the cotton weft being so adapted to each other, and to the thickness of the worsted, as to cause the threads of the latter at each crossing to lie close together in such a compact form that they actually appear to be crossing the piece parallel to each other, while in reality each separate thread is laid parallel to itself over the cotton warp at each crossing of the weft.

There are numerous other fabrics to which attention might be called, but the object is not so much to call attention to special fabrics as to deal with the general principles.

Then, that being the case, it will be necessary in the first place to examine the principles upon which designs may be made, and what ought to guide us in the arrangement of a design for any fabric.

Designing for textile fabrics is unfortunately too frequently understood to be the merely mechanical work of arranging the patterns copied from some other material for practical use in the particular fabric desired; hence the majority of designers are mere copyists. But even taking the designer in this sense, his is perhaps the most important and delicate department in the whole establishment of a fancy manufacturer, for upon his judicious selection and arrangement, and extensive variety of patterns, combined with economy in the disposal and combination of colours, requiring a strict and careful watch being kept on

the changes of fashion and taste, as well as paying attention to the economical arrangement of his styles so as to cause no unnecessary expense in changing in the looms, and the arrangement and production of cloths not only novel and beautiful in style, but also giving the best value for the cost, the success of the manufacturer will ultimately depend in a great measure.

Then the qualifications of a designer are not of a superficial nature, taste, of course, being the first requisite. A facility for sketching or delineating any object that may present or suggest itself to him, whether natural, artificial, or imaginary, he should also be possessed of. He should have, too, strong and lively imaginative powers, combined with a thorough knowledge of weaving, particularly of the class of goods with which he is more immediately engaged. But a knowledge of the principles of weaving all classes of goods is extremely valuable, because very frequently ideas belonging to quite a separate branch of manufacture may with advantage be imported into his for the production of new effects.

Taste, then, is the first essential quality of a good designer, as well as of artists or others whose duty it is to produce works which may not only be pleasing to the eye as an adornment, but also may be serviceable in matters of every-day life. A very great diversity of opinion may exist as to what is good taste, every man measuring the taste of others by his own standard, yet there are principles upon which all might be agreed, at least to a considerable extent. "Taste," says Dr. Blair, "is the power of receiving pleasure from the beauties of nature and art. Nothing that belongs to human nature is more general than the relish of beauty of one kind or other, of what is orderly, proportionate, grand, harmonious, new, or sprightly. But although none be wholly devoid of this faculty, yet the degrees in which it is possessed are widely

different. In some men only the feeble glimmerings of taste appear ; the beauties which they relish are of the coarsest kind, and of those they have but a weak and confused impression, while in others taste rises to an acute discernment, and a lively enjoyment of the most refined beauties. In general we may observe that in the powers and pleasures of taste there is more remarkable inequality among men than is usually found in point of common sense, reason, and judgment." There are indeed some men who may be supposed to be possessed of a fair share of the latter qualities, but whose taste is remarkable only for one thing, a complete subservience to the expressed opinions of others, praising or condemning in accordance with the expressed or supposed preference of the individual present, and quite prepared to praise where he has before condemned, and condemn where he has before praised, should he consider that the circumstances of the case will permit it, without inquiring whether it can be justified or not.

"The characters of taste when brought to its most improved state, are all reducible to two, delicacy and correctness.

"Delicacy of taste respects principally the perfection of the natural sensibility on which taste is founded. It implies those finer organs or powers which enable us to discover beauties that lie hid from a vulgar eye. One may have a strong sensibility, and yet be deficient in delicate taste. He may be deeply impressed by such beauties as he perceives, but he perceives only what is in some degree coarse, what is bold and palpable, whilst chaster and simpler ornaments escape his notice.

"In this state taste generally exists among rude and unrefined nations. But a person of delicate taste both feels strongly and accurately. He sees distinctions and differences where others see none. The most latent beauty

does not escape him, and he is sensible of the smallest blemish. Delicacy of taste is judged of by the same marks that we use in judging of the delicacy of an external sense. As the goodness of the palate is not tried by strong flavours, but by the mixture of the ingredients, where, notwithstanding the confusion, we remain sensible of each : in like manner delicacy of taste appears by a quick, lively sensibility to its finest, most compounded, or most latent object.

“ Correctness of taste respects chiefly the improvement which that faculty receives through its connection with the understanding. A man of correct taste is one who is never imposed upon by counterfeit beauties ; who carries always in his mind the standard good sense, which he employs in judging of everything. He estimates with propriety the comparative merit of the several beauties which he meets with in any work of genius ; refers them to their proper classes ; assigns the principles, so far as they can be traced, whence their power of pleasing flows ; and is pleased himself precisely in that degree to which he ought, and no more.

“ It is true that these two qualities of taste, delicacy and correctness, mutually imply each other. No taste can be exquisitely delicate without being correct, nor can be thoroughly correct without being delicate. But still a predominancy of one or other quality in the mixture is often visible. The power of delicacy is chiefly seen in discerning the true merits of a work ; the power of correctness in rejecting false pretensions to merit. Delicacy leans more to feeling ; correctness more to reason and judgment. The former is the gift of nature ; the latter more the product of culture and art.”

The designer, then, possessing these qualifications may reasonably hope to attain to a position of some eminence in his business ; and for any one possessing a fair amount of

taste and common sense, it is not one of the most difficult tasks to acquire sufficient practical knowledge of the business to enable him to become a designer. Undoubtedly if he has had an early training in the departments of textile manufactures he possesses inestimable advantages over one who has not had such training, because there are in the manufacture of fancy textile fabrics, technical details, as in every other business, which can only be acquired by practice, and sometimes only by the aid or advice of those intimately acquainted with the business.

The learner having acquired a facility in sketching simple objects, if he intends to fit himself for designing patterns beyond the simplest kind, will derive much advantage in his early progress by making a collection of simple objects from nature, such as leaves, flowers, &c., which may be copied from drawings, or sketched from the originals; and after making himself thoroughly acquainted with their peculiarities of form and colour, begin to modify their forms and conventionalise them, arranging them in every conceivable form which his fancy may dictate, observing at the same time a definite system of arrangement, and paying due attention to symmetry and proportion. He will find that he will be able to give diversity to his designs, and produce rich and novel effects, which can be utilised for the purposes of his business with both advantage and credit to himself.

Patterns for textile fabrics are generally drawn first on plain paper to the size which they are intended to occupy in the cloth, and are also coloured, for the purpose of seeing what the effect will be. They are then transferred to the ruled design paper, and enlarged according to the number of threads per inch of the cloth in which they are intended to be woven. This can be easily ascertained. Suppose the pattern is desired to be drawn upon design paper, to appear in a cloth having sixty threads per inch, exactly of the same

size as in the sketch made. Enclose the figure in a square. This square measures, say, three-quarters of an inch in length, that is the weft way, by half an inch in width. That represents forty-five picks of weft, and thirty threads of warp upon which the entire pattern must be made. Then take a sheet of design paper, and mark off the requisite number of threads each way, and enlarge the sketch proportionately throughout. The sketch may then be coloured as desired. Care must always be taken in colouring designs to fill the small squares round the edges of the design with colour, otherwise, when cutting the cards, it is difficult to see which of the squares are comprised in the figure, and if not correctly read off, the edges of the figure are liable to be jagged, and far from satisfactory. For those who may not be very expert at drawing, it is no easy matter to enlarge an intricate figure, or one in which delicate lines occur, and to preserve perfect symmetry throughout, although it is of the utmost importance that it should be preserved. For such as are placed in this position, considerable advantage may be derived from adopting a method of lining the pattern in squares to correspond with the large squares of the design paper. This will serve as a most reliable guide to them, and enable them to enlarge their design with accuracy and despatch. If the pattern has to be copied from some drawing or fabric which may not be subjected to this operation, then take a tracing of the figure, by means of tracing paper, which place upon a sheet of white paper, and line as desired.

The system of lining or ruling sketches may be practised with advantage even by those who possess some ability as draughtsmen, because enlarging a drawing to the extent to which it must necessarily be enlarged upon design paper, for its reproduction in cloth, requires not only considerable skill as a draughtsman, but good judgment, and a quick and correct eye in discerning form and proportion

otherwise the figure, when reproduced on the fabric, may be very different in appearance to what is intended.

Then suppose the figure to be reproduced is of the proportion just mentioned, viz., three-quarters of an inch in length by half-an-inch in width, and that it is to occupy forty-five picks, and thirty threads. Then if the design paper upon which the design is to be made is ruled what is known as 8 by 8—that is, that each large square represents eight warp threads and eight picks of weft—the pattern will occupy five large squares and five picks, or $5\frac{5}{8}$ squares one way by three squares and six ends, or $3\frac{3}{4}$ squares the other way. Divide the small sketch exactly to those proportions, and rule lines across it both ways, which will divide the figure into the exact proportions it will occupy on the design paper, or, in other words, the large squares of the design must be made exact counterparts of the squares of the sketch. By this means the exact forms and proportions may be preserved without much difficulty, and large and elaborate figures may be reproduced with comparative ease, and the most satisfactory result.

In case one is dealing with a piece of fabric, or other material which cannot be lined, or which could not be traced without considerable difficulty, the material may be laid upon a piece of thick paper or card board, and white or coloured thread stitched across it, to represent the squares, instead of pencil or other lines. A very little experience will enable the student to judge at a glance which will be the readiest and best plan to adopt.

There are various kinds of design paper, each ruled to suit the quality of the fabrics for which it may be desired. The kind most generally in use is ruled 8×8 . In all paper intended for Jacquard designs the number of lines in the warp way must be made to correspond with the number of wires in a row of the machines. The majority of Jacquard's machines are made with eight hooks in a row,

but if the machines are made with twelve instead of eight in a row, as is frequently the case with those containing 600 wires, then the paper must be in twelves the warp way.

Then the variation in the number of lines per square must exist in the weft. For instance, if the relative number of threads of warp and weft is as 8 to 6, then the paper must be 8×6 ; if, on the other hand, the proportion is as 8 to 10, then the paper must be 8×10 , and so on. Any other number must be dealt with in the same way, always taking the number of wires in a row, as the basis of the warp, and the relative proportion of weft to warp on that basis will give the paper required.

It is quite as necessary that this matter of the paper should be attended to as the correct drawing of the pattern. Supposing the pattern were drawn upon paper 8×10 , and woven upon a cloth the warp and weft of which were as 8 to 6, the pattern would be elongated to nearly double its natural length, and would produce a far from pleasing effect.

Then these rules being duly attended to, the one thing which remains is for the designer to suit his design, whether it be in the form of a figure, stripe, or check, first to the nature of the material with which he is dealing, and secondly, to the purpose to which the fabric is to be applied. In putting the nature of the material as a subject to be considered before the object to which the article is to be applied, it may appear to some that I am placing the wrong consideration first, or giving too great prominence to it, but a little acquaintance with the manufacture of textile fabrics will soon convince one of the necessity of this arrangement. It may be a very easy matter to arrange a design which would meet all the requirements of the purpose to which the fabric is intended to be applied, but it might be found a very difficult matter to apply the design, or to produce it in a fabric of which the material is not

suitable. For instance, if we are dealing with strong firm threads, such as cotton or worsted, we may introduce a considerable amount of plain working, and at the same time have a considerable quantity of material in the fabric ; but if we apply the same design to woollen threads, which possess a totally different character, we may find that not only shall we have considerable difficulty in making the cloth, but if we succeed in making it the result will in all probability be most disappointing. Again we may have a design which produces a splendid effect upon a silk fabric, but in any other material the result is altogether disappointing, and this may arise either solely from the lustre of the silk imparting a liveliness to the design which no other material could give, or it may arise from the lustre and the fineness of the fabric combining to give character to the design.

This would apply in numerous cases, therefore it becomes necessary that the first consideration should be the nature of the material with which we are working, and in all cases we may be guided by this rule, that the firmer and stronger the thread (especially of the warp) the more firmly and closely it may be interwoven, the softer and more fibrous the thread and the more loosely it must be interwoven ; consequently if a firm cloth is desired, the absence of firmness in the interweaving will have to be compensated for by increased bulk in the thread.

After having determined by the nature of the material the character of working which may be introduced into the design, it may readily be adapted to the purpose for which it is intended to be used. In the selection of forms and objects for designs care should be taken not to violate the recognised rules of art. Wherever natural forms can be introduced they ought to be, but it is a very difficult matter in some classes of fabric to deal with natural forms ; but even when dealing with conventionalized forms due

attention should be paid to variety. Even in cases where form can scarcely be said to exist variety may be obtained. If, for example, we are making twills, which in reality are nothing more or less than straight diagonal lines, considerable diversity may be given to the pattern by varying the breadth and character of those lines ; and that variety may be further increased by the introduction of figuring between the lines, either for the purpose of concentrating or dispersing the light. In designs for textile fabrics, as in every other composition, there must be the proper play of light and shade, and a due regard to the proper grouping of the figure. If the design be scattered over the surface of the fabric in small, almost imperceptible patches, the appearance will be spotty and unpleasant, just as if the light and shade of a picture were scattered and unconcentrated ; but if the grouping of the figure be so arranged as to present to the eye masses of light and shade, with a due regard to detail, and if the masses of figure are properly interspersed with ground working, and the flat ground broken up with figuring, then the effect will be good, just in the degree in which they balance each other. And whether we are dealing with large elaborate designs, which not only embrace great variety of forms, but also variety of colours, or whether we are dealing with small simple spots or twills, or any other simple form of working, the same principles will apply. In like manner if we are dealing with stripes or checks, whether the stripes consist of a great variety of colours or simply of one or two, the same principles will apply ; and on the success in the application of these principles entirely depends the success of the designer or manufacturer.

I may now call attention to another subject, which is often a source of much embarrassment to beginners, viz., stripe patterns which contain more warp per inch on some portions of the cloth than others, being so fine in the

sett as almost to preclude the possibility of ascertaining the exact pattern which is worked upon it. We will take, for example, a class of stripes which is very much used for ladies' dress goods in various materials, also for stripes for borders of alpaca umbrellas. These stripes we will suppose to be made with a plain ground cloth, the striping being composed of fine material and very close in the sett. If the stripe be worked as a satin it will present a smooth flat surface, showing nothing but the warp on the face, the weft being entirely hid. In all probability the student would be entirely at a loss to ascertain how it was worked, and even if he suspected that it was a satin he would spend considerable time in trying to find out what satin it was, and unless he was endowed with considerable patience his endeavours might be given up in disgust, only to be renewed again after he had settled down and composed himself somewhat. In a case of this kind it is very easy to ascertain at a glance the exact working almost. If it is a satin the surface will be even and smooth, shewing no pattern, or if any pattern should be visible it will be in the form of a very fine twill, running not at an angle of forty-five degrees or thereabouts, as in an ordinary twill, but it will run nearly in a straight line with the warp threads, partly owing to the closeness of the warp threads, but mainly to the nature of the working. Then, to ascertain the particular satin, take the outermost thread and count how many picks of weft it passes over before it is interwoven with a pick. Supposing it passes over seven and is interwoven at the eighth pick then you may conclude at once that it is an eight-thread satin, and arrange your pattern as shown at page 183, Fig. 98. Suppose it passes over nine threads, and is interwoven at the tenth, then it is the ten-thread satin, and so forth.

So far as the actual working to produce this goes, if the reader has followed carefully the instruction given in the

foregoing chapters, he will have little difficulty in ascertaining this, the ground warp and the stripe being worked upon two separate sets of healds, a pair of plain ones for the ground, and whatever number is required for the striping. Fig. 285 is a design showing the arrangement, the plain healds being bracketed together and marked A, and the stripe healds bracketed and marked B, the drafting being shown; the threads bracketed together and the remark "twenty-four times" meaning that this portion of the draft must be repeated twenty-four times, making forty-eight threads, and the stripe being repeated nine times, the ground warp being two in a split and the stripe six in a

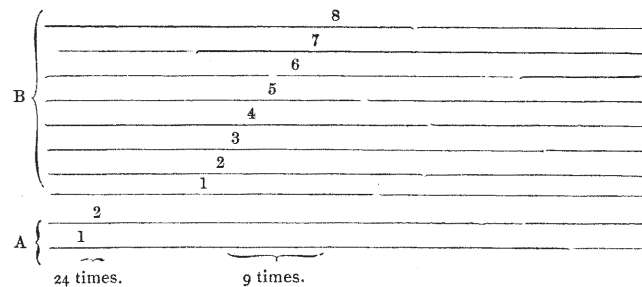


Fig. 285.

split of the reed. The design, Fig. 286, will be the working design for it. Another matter of detail which may be mentioned here, in connection with this particular kind of stripe, is the calculation for the quantity of warp that will be required for each portion. Suppose the reed has sixty splits per inch, the simplest and easiest manner is to take the number of reeds in the width of the piece, and divide that by the number of reeds in each pattern, which will give the number of patterns in the width of the piece. As an example we will take the above pattern, which occupies thirty-three reeds. Suppose the reed to have forty splits per inch, and the piece thirty-three inches wide, the number of splits is 1320, \div 33 splits gives 40 patterns in the

width of the piece. It is then easy to ascertain the number of threads in both the ground and the stripe warps. There are 48 threads per pattern of the ground warp ; 48 threads multiplied by 40 patterns gives 1920 threads for the ground warp ; then 72 threads by 40 patterns gives 2880 threads for the stripe warp. This system of calculation also applies to all patterns where one portion of the warp is more crowded in the reed than another portion.

To return to the question of patterns. If it is desired to copy patterns, I should advise a course of procedure here which is perhaps at all times the best, that is, not to attempt to dissect the pattern thread by thread, as is

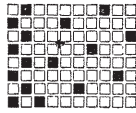


Fig. 286.

sometimes the practice, but to take the pattern off the face of the cloth. It might be said that by doing this it will be almost impossible to obtain an accurate copy, but I venture to say that if the student practices this method, after some little time he will be able to copy patterns with quite as much accuracy and very much quicker than if he attempts to dissect it. The first requisite is that he should make himself thorough master of twilling, both straight and broken, and all the various kind of working, and treat them as the alphabet of designing ; by doing this he will very seldom make a mistake in arranging a pattern.

SLAYING OR SETTING FABRICS.

The slaying or setting of warps are terms used to denote the proportioning of the counts of warp to the different sets of slay, so as to preserve a uniformity of fabric in similar species of cloth. In consequence of the different methods of indicating or calculating setts of reeds and counts of yarn in different localities it is a difficult matter to deal with this branch of the subject in a satisfactory manner. If a table of calculations were given suitable for the trade of one locality it would not be of the slightest value to those engaged in the staple trade of another locality, so that the subject can only be dealt with on general principles.

In order to explain more clearly what is meant by setting, suppose a piece of cloth is woven in any set of reed, say, for instance, with forty threads per inch, and that the diameter of the warp threads and the spaces between them are the same ; then, if we have another piece of cloth with sixty threads per inch, in this also the diameter of the warp threads corresponding with the intervening spaces, the texture of these two cloths is similar, and they are equally balanced, although the one is so much finer than the other, so that when the diameter of the thread is greater than the spaces, the fabric is proportionately stouter, and when the diameter is smaller it is proportionately thinner.

Then the method of determining the several thicknesses of yarn which will suit a given sett or the sett which will suit a given yarn, may be said to depend on the following theorem ; As the square of any given sett of reed is to

the thickness of yarn that suits that reed, so is the square of any other sett of reed to its respective reed for the same class of fabric.

The reason of this will appear evident if we consider the threads of warp when stretched in the loom as so many cylinders of equal length, and the reed as the scale which measures the space in which a given number of these threads are contained; therefore the solidities of the thread in one sett of reed will be to the solidities of the thread in any other sett of reed as the squares of their diameters.

But the weight of the threads, supposing them to be of the same density, will be as their solidities, and a determinate number of splits of any reed may be substituted for the diameter of the warp threads; therefore, by this analogy it will be as the square of the number of splits of any given reed is to the known weight or thickness of the yarn, so is the square of any other number of splits occupying the same space to the weight or thickness of the yarn that will produce the same fabric.

At first sight this may appear very intricate, and difficult of practical application, but on careful examination on the part of the reader it will be found to be strictly true, and exceedingly valuable in the manufactory.

There are numerous rules and formulæ in use in different districts for determining the setting of warps in the slay, but many of these are of an arbitrary nature. One will frequently meet with individuals who have rules of their own, drawn from their own experience, and which are perfectly applicable to certain classes of cloths, but which might be utterly inapplicable in other cloths. Indeed, what may produce in one class of cloth as near perfection as it is possible to arrive at may be seriously detrimental to another class of cloth. But the theorem just laid down will be found applicable under any circumstances,

and the manufacturer having found what reed and yarn are best adapted for a certain fabric, may with the greatest ease and utmost certainty vary his reed, and always be sure of having the proper yarn to suit it, or vary his yarn and be sure of having the proper reed for it.

Since this was written I have investigated the subject at length, the result of the investigations being given in my work on "Textile Calculations and the Structure of Fabrics."

In close connection with, in fact as a part of, this subject is what is commonly called the "balance of cloth." This is a term which is capable of a wide interpretation. The general interpretation which is put upon it is the proportion in which the warp and weft stand to each other. But if definite rules were laid down according to this interpretation one cloth might be perfection, and another cloth, according to the same rule, might be anything but perfection. Yet to all appearance, and for the different purposes to which they were to be applied, and according to the principles upon which the two cloths were constructed, one might be as perfect a sample of a cloth as the other. Again, the interpretation may be a wider one, and it may be said that a properly-balanced cloth is one in which the warp threads are set at a certain distance from each other, according to their diameter and weight, and the proportion of weft to warp which existed in the cloth. This interpretation would be a perfectly correct one, and might be carried out in its entirety, but the particular distance of the threads from each other, or the proportion of weft and warp, which might be taken as a basis, could only be taken for the one particular class of fabric to which it applied, because, although that proportion may be all that could be desired for one fabric, experience teaches us that it could not be so for all fabrics, therefore no fixed rule could possibly be laid down which would be applicable to all cases, but the rule being found for any one class of fabric

it would be applicable to all fabrics of that class. Suppose we are dealing with a plain cloth, in which the warp and weft are both of the same material, and that the warp is so set in the reed that the diameter of the thread, and the space between the threads are equal, the weft threads are equal in thickness or counts to the warp threads, and there are the same number per inch both ways. Then the cloth may be truly said to be equally balanced, and whether the material be woollen, cotton, or linen, the cloth will be perfect in construction, and will be made on the truest principle. As will be found pointed out in the work just referred to (page 150), some little allowance must be made for bending of the threads, but this is the theoretical starting point. But it frequently happens that to produce special effects this principle must be departed from. For instance, it may be desired to produce a corded effect, the cord to run either lengthwise or across the piece, then a different method of balancing must necessarily come into operation. We will suppose we wish to make a poplin, in which it is desired to have a decided cordy character, the cords running across the piece; instead of the warp threads having a space between them equal to the diameter of the threads, they must be set very closely together, and the weft threads must be some distance apart, otherwise the clear cord could not be preserved. But although it is necessary that the weft threads must be some distance apart, that distance must not be too great, or the cord will again be destroyed. Then from this it must be concluded that the warp threads must be set as closely as possible without being too crowded, and the weft thread must be driven as close together as the crossing of the warp thread will permit, and the more carefully this is observed the more perfect will the appearance of the cord be, and this will be materially increased if the weft be proportionately thicker than the warp. But it having been determined

what sett of reed for a given count of yarn will produce the best result, it is easy to determine what reed will suit any other count of yarn to produce the same result. Then suppose that the cord instead of running across the piece, is intended to run the length of the piece, the procedure will be the reverse of the previous one ; that is the warp threads must be further apart, and the weft as close together as possible, and if the bulk and distance apart of the warp threads be increased, and the bulk and distance apart of the weft threads diminished in a proportional degree, the clearness and boldness of the cord will be increased accordingly, so that in both cases the proposition laid down will hold good.

From those two examples another conclusion must be drawn. In the first the warp preponderates largely on the surface of the fabric, and in the second the weft preponderates ; and we have seen that as the warp or the weft preponderates it must be increased in quantity, (that is in the number of threads per inch), and it must be increased in fineness. This rule holds good not only for plain cloths but also for any other make of cloth. If we turn, for example, to twilled cloths, in which the same quantity of warp and weft are visible on the face, and in which the warp and weft are of the same material and thickness, then the same rule applies as in plain cloths, that there should be the same number of threads per inch one way as the other. But twilled cloths differ very materially from plain cloths in this respect, viz., that from the very construction of the cloth the threads must be closer together for the same thickness of thread than in a plain cloth, because in a plain cloth the warp and weft threads cross each other, and are interwoven at every pick, whereas in a twill cloth they may pass over a number of threads before they are interwoven ; therefore, the greater the number which are passed over between the interweaving

the closer or thicker the threads must be to produce an approximate firmness of texture. Hence it is that twilled cloths are so much better adapted for producing heavy, bulky fabrics.

In making twilled cloths the warp or the weft may be made to preponderate on the face of the fabric in two distinct ways. First, in the same manner as in plain cloths, by bringing the warp threads closer together and putting in fewer picks, at the same time decreasing the thickness of one thread and increasing the thickness of the other, or by increasing the distance apart of the warp threads, and putting more picks, again increasing the bulk of one and decreasing that of the other. Second, by bringing one or the other more to the surface in the order of working. In the latter case the rule must be invariable, that, whether the warp or weft preponderates on the face in the working, it must also preponderate in a like degree in the number of threads per inch, or in the actual quantity of material, and it is only when that is done that the cloth can be properly balanced. We can have no better illustration of this rule than in some of the best examples of satin cloths, in which the rule will be found to be observed to the last degree. In any cloth in which this is not done, not only will the cloth have an unpleasant appearance, but the effect of the pattern is marred considerably also.

These observations apply more especially to fabrics in which the warp and weft are of the same material, but they apply also to fabrics in which the warp and weft are of different materials, in the latter case, however, attention must be paid to the nature of the materials, their density, and their adaptability to blend or assimilate with each other, because the relative proportion of warp and weft, thickness, ends per inch, &c., in one material may be quite correct, if both warp and weft are the same, but if the warp be of one material and the weft of another, then a decided change

may take place in their combination. Not only will this be so if one of the threads be vegetable and the other animal substance, but it may be equally so if they are both either animal or vegetable. The combination of a woollen thread with a cotton thread would produce a very different effect from the combination of worsted with cotton, although in both cases it is a combination of animal and vegetable. Again, silk is an animal substance, yet it will require totally different treatment from any other animal fibre in this respect. Therefore absolute rules cannot be laid down, though the general principles may be clearly defined. Guided by these principles and careful observation, the designer or manufacturer will be able to obtain sufficiently reliable data to guide him with tolerable certainty to the best result in his own department, and it is only by observation and experience that these results can be arrived at ; but they are results which no one need despair of achieving.

CALCULATIONS OF MATERIALS, &c.

An important branch of the manufacture of textile fabrics is a knowledge of the system of calculating the material used in the production of a fabric, so as to estimate the cost of the article before offering it for sale.

This is a branch of the subject with which there is some difficulty in dealing satisfactorily, this difficulty arising from the numerous systems of calculation in use in the different manufacturing districts in this country. To some extent this difficulty is met in the little work referred to in the last chapter. It may almost be said that every manufacturing district in Great Britain has a different system of calculating. This diversity of system applies not only to the methods of counting or weighing yarns, but even in a greater degree to what are termed the setts of the reeds or slays. How these different systems have originated it would be difficult to tell, and in some cases it is not easy to find even upon what they are founded. Supposing we enquire first into the system of calculating the sett of reeds. The most intelligible system in use is that of counting by the number of dents per inch, or the number of threads per inch. The latter is preferable, though either system is sufficiently intelligible. If we reckon by the number of threads per inch, whatever that number is, that is termed the sett. For example, if a cloth contains sixty threads per inch, it would be said to be a sixty sett cloth. On the other hand, if we count by the dents or splits, each split is supposed to contain two threads, so that on this system a cloth containing sixty threads per inch, would be termed a thirty sett cloth. This latter system is used in some of the cotton manufacturing districts of Lancashire, and is

generally known as the Stockport count. It is also used in some of the woollen manufacturing districts. Then again another system which is in use in Lancashire is known as the Manchester and Bolton counts, and is based upon the number of beers in $24\frac{1}{4}$ inches. In other districts we shall find other systems at work. In some cases the number of ends in a beer are thirty-eight, in others forty, in others again they are fifty (the beer is also variously named, in some districts being called a porter or a portit). Then, in addition to the number of ends in the beer varying, the width upon which the calculation is based varies. In some districts it will be 30 inches, in some $24\frac{1}{4}$ as we have seen, in others it will be 36, 38, or 40 inches, according to the class of goods which are being made, and instead of the term sett being used, the cloths are termed so many porter (as say 40-porter) cloths. We shall find other districts calculating by the foot or by the yard. In the Scotch system the sett of the reed is based upon the number of dents or splits in 37 inches; 37 inches is the old Scotch ell, and this is taken as their standard. For instance, if the reed contains 1400 dents in 37 inches, then it is termed a fourteen hundred reed; if it contains 1200 dents in 37 inches it is termed a twelve hundred reed. In the Bradford worsted manufacturing district a different system prevails. The sett is based upon the number of times 40 ends are contained in a yard of 36 inches. It would be difficult to ascertain how this system has sprung in existence. At first sight it would appear as if it was based upon a similar principle to the Manchester and Bolton counts, 36 inches being taken as the basis instead of $24\frac{1}{4}$, but if so the beer of forty ends has completely dropped out of existence since the system was founded, as the beer or portie is now universally 50 ends in that district. Another conjecture is that the system may have arisen by the goods being ten per cent. narrower when finished than when they

come from the loom, and consequently the warp threads are proportionately closer, and that by degrees what was formerly the finished sett of the cloth became the sett of the unfinished cloth, which would be equivalent to adding one-ninth to the quantity of warp in the fabric. Then, by this system, whatever is the indicated sett, the fabric contains that number plus one-ninth of the number of ends per inch. For example, what is termed a 54 sett would contain $54 + 6$ ($\frac{1}{9}$ of 54) = 60 ends per inch. A 64 sett would contain $71\frac{1}{9}$ ends per inch. In making calculations for warps on this principle, to one not much accustomed to the use of figures these fractions sometimes become very troublesome. For instance, supposing the number of ends are required in a warp for a fabric 68 sett, 28 inches wide, if the ends per inch are first obtained, which would be $75\frac{5}{9}$, then there is the necessity of multiplying the fraction by 28. This may be obviated by multiplying 68 by 28, and then adding the one-ninth to the total, thus $68 \times 28 + \frac{1}{9} = 2115\frac{5}{9}$; or what would be still readier, multiply 68 by 28, add a cipher to the product and divide by 9, which will be exactly equivalent to adding one-ninth; thus

$$\begin{array}{r} 68 \\ 28 \\ \hline 9 \overline{) 19040} \\ 2115\frac{5}{9} \end{array}$$

so that the number of ends is obtained at once without the trouble of a fraction. This system of calculation is rather troublesome to the beginner, as indeed are many of the others also; and what adds to the trouble is the difficulty of obtaining information as to the basis upon which the system is founded. I should in all cases recommend any one engaged in the textile trades, on removing from one district to another, to ascertain at the earliest possible moment, as accurately as he possibly can, the system of calculation which is in use in the district, and as far as he

can, trace it to its source, and he will find that his work will be very materially facilitated, for not only will he know better how to work his calculations, but he will have some reason for what he is doing.

Having all these various methods of calculation before me, it becomes a somewhat difficult matter to deal with the question so as to make it intelligible to any one engaged in a district where the method may be different even from any of the above. The only safe way then is to deal with the matter on the basis of a given number of threads per inch, or a given number of reeds per inch. There is one portion of the calculation which is general, and only one, viz., that it is usual to reckon two threads per split, except where otherwise expressed.

Having now determined a basis of calculation for the reed, before we can proceed any further we must also determine a basis for calculating the weights of yarn. These again differ considerably in different localities, but not to such an extent as is the case with the reed scale. The greatest differences in the modes of calculating weight of yarns are in the woollen districts, the cotton, worsted, and linen calculations being very general.

The general method in the two first of the above-named three materials is by the hank, and in the last-named by the lea. The cotton hank contains 840 yards. This hank is determined as follows:—The cotton reel is generally 54 inches in circumference, 80 revolutions of the reel make one rap, or, as it is called in some places, skein, consequently each rap contains 120 yards. Seven raps make one hank, consequently $120 \times 7 = 840$ yards in one hank. The weight of the yarn is then determined by the number of hanks in one pound weight avoirdupois. For instance 20^s cotton means 20 hanks of 840 yards each per pound. If the cotton is twofold, which is very frequently the case, it is then denominated 2-20, and the number of hanks per pound

is only half the indicated number, that is, 2-20^s contains only 10 hanks per pound, being of course two threads of 20^s (the single yarn will be a trifle finer than 20^s to allow of the length which will be taken up in twisting bringing it to the proper weight) twisted together, and in this way making two hanks into one.

The worsted hank contains only 560 yards, which is made up as follows:—The reel for worsted is only one yard in circumference, instead of one and a-half yards, as in the cotton reel; the number of revolutions per rap is the same, as is also the number of raps per hank, thus 80 revolutions \times 7 raps = 560 yards, and the number of hanks per pound is termed the counts. Then worsted yarn is usually sold by the gross of 144 hanks.

Linen yarn as before mentioned, is reckoned by the lea. The linen reel is 90 inches in circumference, 120 revolutions of which make one lea, which consequently contains 300 yards, and the number of leas in one pound is what is spoken of as the counts, as 60 lea or 40 lea, which means that 60 and 40 leas respectively weigh one pound. Linen, like other yarn, is also made up into hanks, 10 leas making one hank and 20 hanks one bundle.

Woollen yarn is reckoned in a variety of ways. I will take in the first place the Yorkshire skein. This skein contains 1536 yards, which is equal to the number of drachms per wartern of six pounds, so that whatever number of yards there are per drachm there are so many skeins per wartern.

In one district of the West of England the skein is 320 yards, and one pound the standard weight, so that as many times 320 yards as there are in one pound the yarn is termed so many skein yarn, or as many times 20 yards as there are in one ounce will amount to the same thing. Now, to make a comparison of the two, in what is known

as the Yorkshire skein counts, 30 skein yarn will contain 46,080 yards per 6 pounds, while the West of England count 30 skein yarn will contain 57,600 yards per 6 pounds.

Woollen yarn is also sometimes reckoned by the hank, similar to the cotton and worsted yarns. When that is the case the reel is the one and a-half yard reel, the same as cotton, but it is reckoned one-third heavier, which is equal in effect to making it the same length as worsted, or to put it in another way, 8 hanks of woollen are equal in weight and length to 12 hanks of worsted, thus 24^s cotton contains 24 hanks per pound, 24^s woollen contains 16 hanks per pound; the 16 hanks of woollen are equal in length to 16 hanks of cotton and 24 hanks of worsted.

There are numerous other ways of reckoning the counts of woollen yarn, but to give the whole of them would be no easy task, and as the foregoing are sufficient to show the principle of calculation, it may be left to the student to adopt for himself the particular system which prevails in his district.

Spun silk yarns are reckoned on the same length and weight as cotton, viz., 840 yards, the number of hanks per pound indicating the counts, but in twofold yarns there is this difference between silk and cotton—when twofold cotton is used only half the number of hanks of the indicated counts are contained in one pound, in silk the full number of hanks are contained in the pound, thus 40^s silk twofold contains 40 hanks per pound, instead of as in cotton only 20 hanks, and is usually written 40-2.

Raw silk is generally calculated by hanks of 1000 yards, and the counts named by the number of deniers it weighs. In this, as in the woollen counts, there is some diversity in the customs of the different districts, and there appears to be some little difficulty about the weight of a denier. In the work on the silk manufacture, published in the "Cabinet Cyclopædia," by Messrs. Longman, in 1831,