

and the individuality of the stripe are more completely and effectively broken up. We give examples in Plate II. of two figured stripes, one of which has the figure running indiscriminately over the surface, and the other having the terminals of the sprays in the stripe. Sometimes small stripes are made running in thin, straight, lines, and broken either with figures similar to those shown in Plate II., or with small spot figures arranged so that they fall across the stripes and break the lines. Such spots are best arranged in satin order, so that they don't break in straight lines across the piece. In fact, the same reasons prevail as for the spiral scroll and other similar figures previously mentioned to prevent the too frequent repetition of the break in the stripe from being in the same straight line.

75. Figured Diagonals.—In addition to figured stripes there is another class of figures nearly akin to them—namely, figured diagonals, or stripes arranged diagonally across the fabric. These, of necessity, differ from stripes running the length of the piece, not only in appearance but in the order of arrangement; and while in figured stripes we may have the stripe different in both colour and fineness from the ground, we cannot have it so in diagonal patterns, from the fact that the diagonal stripe must be made of the same warp or weft as the ground. We might introduce extra material for producing the diagonal stripe, but as we shall show when dealing with the question of figuring with extra material, we should add to the weight of the cloth considerably; and at present we wish to deal with figures formed by the material composing the ground cloth only. It may be said that in dealing with stripes of a different colour from the ground, and, perhaps, in different material also, we are ornamenting with extra material. That is quite true, but it is not figuring with extra material in the general acceptation of the term. When we are making that stripe, it forms the *whole* fabric at that particular place; there is no ground cloth under it;

while what we usually mean by using extra material is that the ground cloth runs throughout, and the extra material figures *upon* it, and does not enter into the body of the fabric, *except to form figure*.

Then in figured diagonal patterns we are dependent upon form or variety of lines to produce variety of patterns; unless we do introduce extra material we cannot resort to variety of colour to assist us. But even when confined to single colours, we may produce great variety of patterns. In the first place, our pattern may consist more or less of scroll or sprays, running continuously diagonally, yet the variety of forms may break the rigid straightness of the line, or we may use straight lines with floral or other spots introduced at intervals between the lines. Again, we may use the straight lines combined with the scroll, and the scroll may be either confined strictly between the lines, or, like the stripes, it may break through it at intervals, regular or irregular. In fact, all that has been said of producing figured stripes so far as the design itself is concerned, apart from the use of colour and varying degrees of fineness, applies equally to figured diagonals. One remark which was made in a previous chapter in reference to small diagonals with spots running between them, also applies here—namely, that the number of ends occupied by the figure *counted in a diagonal direction*, must be a measure of the number occupied by the whole diagonal, or the pattern must be repeated to a number of which each is a measure. It is even more important that this rule should be borne in mind in commencing to make a large figured diagonal than in a small one, because any discrepancy between the number occupied by the diagonal and the figure respectively would lead to the necessity of carrying the design out to an immense length, and the increased number of ends employed makes it so much easier to arrange before the design is commenced that the two numbers shall coincide than is the case in smaller patterns. We might say that a little carelessness or

ignorance in the application of this rule will lead to a great waste both of labour and material which might quite easily be saved.

76. Combination of Figured Stripes and Diagonals.
—Not only may we make figured stripes and diagonals, but we may also combine them, running figured diagonals between the stripes. In the arrangement of such patterns the rule of determining the extent of the design will apply as to stripes, but it need not apply as to diagonals. The diagonal must be repeated so as to show no break throughout the length of the piece, but it is not necessary that it should be a true diagonal across the piece. It is broken up, as it were, into long narrow strips contained between two parallel lines; then it must be perfect as between these parallels, but it need not be arranged so that it would be a perfect diagonal if these parallel lines or stripes were removed. Perhaps if the stripe were a very narrow one it would have a much better appearance if it were so arranged, but if the stripe be sufficiently broad to prevent the eye detecting any break in the continuity of the diagonal, it would not matter whether a break occurred or not. True, the effect would, in most instances, be more pleasing could any break—whether actually visible or not—be prevented; but what we mean by calling attention to this is, that if any extension of the design were necessary to prevent this break, provided no actual fault would be visible, it would be more economical to allow the break to take place, because it would, in many cases, require—in order to avoid it—an extension of the Jacquard power, and probably also a greater number of picks in the pattern, which would mean the use of a greater number of Jacquard cards, and consequently entail more labour and expense in producing the design in the fabric; and whenever labour and expense can be saved it is certainly advisable to do so.

77. Figured Checks.—In addition to stripes and diagonals formed by figures, we may also make checks or

stripes crossing each other at right angles. These may be classed generally under three heads:—First, when a figured check encloses a plain, square space; second, when a plain check encloses a square figured space (in both cases the check lines being equal in texture and quality to the space enclosed); and third, when the check lines are different in quality and texture to the space enclosed.

In arranging designs for the first of these care must be taken that the figures running across the piece and those running the length of the piece join perfectly to each other. The two portions of the pattern must not have the appearance of having been made at different times, or by different hands, and put together by chance. They must combine to form one complete whole. They must be part and parcel of the same idea, otherwise there will be an incongruity about the pattern which will be most offensive to the eye. Patterns of this kind in the hands of a beginner are, perhaps, the most difficult to manage; the point of junction is often to him a source of much trouble. It may not, perhaps, be such a very difficult matter when making a design upon plain paper, but when he is applying it to the fabric, where he has to follow the warp and weft thread by thread, he often finds considerable difficulty. This difficulty is by far the greatest if the pattern has any stiff, rigid lines. These must fall in and join to each other perfectly. If the slightest break occur, it will be immediately visible. If the pattern run in flowing, graceful lines, the difficulty will be lessened, because a slight deviation will not be in any way detrimental, though it must never be attempted with stiff lines. The length of the lines must be measured with the most perfect accuracy, and the chief points carefully marked out upon the design-paper, so that nothing which will affect or be likely to affect their joining properly will be left to chance. We have thought it well to give this warning most explicitly, knowing the liability of the beginner to fall into error,

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which would result in spoiling his whole pattern, and compel him to begin the task again.

In the second class, where a figure is surrounded by a plain check, there is no necessity for this caution. Each square of figure is complete in itself, and, even more than in the striped diagonal, no regard need be paid to its continuity. It may be treated as we might treat a tile, or any square article with a figure in its centre and a border surrounding it. This border will prevent effectively the adjoining square from interfering with it. In fact, the different squares need not be all alike; different patterns may be alternated, and as much variety as the extent of figuring surface will permit may be introduced. There is no difficulty in arranging designs of this kind for the fabric.

In the third class, where the check surrounding the figure is of a different quality from the ground, what has been said of the second class applies exactly so far as regards the figure, but in respect to the check itself some knowledge of the structure of fabrics is required. We may say that it is a combination of two stripes placed at right angles to each other, both of which are finer than the ground fabric which they surround or upon which they are placed. Now, whatever may be the texture and degree of fineness of the longitudinal stripe, that of the transverse stripe should be exactly similar. If these two stripes or sets of stripes be much heavier or more compact in their structure than the ground cloth, they will exert a power over it, and cause it to "cockle" or curl. On the other hand, if the ground be firmer in texture than the stripe, it will exert a similar power over the stripe.

From the very fact that the stripes are finer, containing a greater number of threads per inch than the ground, they must be more loosely interwoven, so as to allow of this increased quantity of material being put in.

This being so, if the relative quantities or thickness of the materials of the ground and checking be

not properly proportioned to the order of interweaving of each respectively, trouble must of necessity ensue. Therefore, too much care and attention cannot be paid to the subject before actually attempting to make the pattern.

78. Diaper.—In all the patterns with which we have been dealing we have assumed that the figure is formed by the warp and weft ceasing to interweave with each other, or if not entirely ceasing, interweaving only very slightly—just sufficient to hold them together and prevent them from appearing as so much loose material, or to give some special effect to the design. We may now turn our attention to a class of figuring in which throughout, both in figure and ground, they are equally firm in texture. Such patterns are variously known as “diaper” and “damask.” The former is not so much used as it once was, the latter, which permits of much greater variety of form in the figures, having, since the great development of the Jacquard machine, almost entirely superseded it. However, both are alike in the principle of structure of the fabric, and it is probable that diaper preceded and was the original of damask, which, with improved machinery, has developed into a more perfect and pleasing class of designs.

In Fig. 82 we have a plan of a diaper pattern of the simplest kind, which will convey most readily an idea of the principle upon which the fabric is constructed. On the first eight ends and picks it will be seen that the weft comes to the surface, forming a four-end twill, and for the next eight ends exactly the reverse taking place. There is still a four-end twill formed, but running in the opposite direction, and with the *warp* brought to the surface. For the next eight picks the conditions are reversed, the ends which went

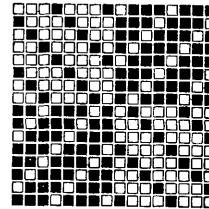


Fig. 82.

to the back at first now coming to the face, and those which were on the face going to the back, and the twills turning in the opposite direction at the same time. Throughout the whole system of diaper weaving this one principle is followed. The figures are formed by the warp and weft changing places from back to face and *vice versa*. In whatever direction the twill runs when the weft is on the surface, it runs in a contrary direction when the warp is on the surface; consequently both sides of the fabric are alike in pattern, and, what is quite as important, the fabric is equally firm in texture throughout. There is no loose material on face or back.

The pattern we have given in Fig. 82 would form a simple chequer pattern, but generally they are of a more elaborate character than this. The intervals of changing may be varied to any extent, and not only simple chequer patterns produced, but others which may almost be called figured goods. In all true diapers the chief characteristic of the pattern is that it runs in squares; the whole design is simply the changing of the order of working, as shown in Fig. 82, in various-sized squares or parallelograms. Fig. 83 is a plan of one in which there

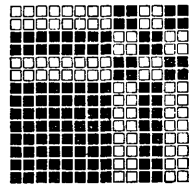


Fig. 83.

is greater variety than in Fig. 82. It is not carried out to the full extent, nor shows the twilling, but is simply made upon paper to explain the pattern. In arranging designs for diapers the plan adopted in Fig. 83 is a very general one—at least, when woven as diapers formerly were, with healds. The warp is divided into divisions of four or more ends, according to the pattern; each of these divisions is represented by one of the spaces on the paper, and all the divisions which correspond in their order of working have their warp threads drawn through the same set of healds, so there are as many divisions of healds as there are divisions of the pattern which are different from

each other in their order of working. So that, as will readily be seen, very large patterns may be produced with a very small number of healds; and if each of the spaces given on the paper represent a division of four ends, the whole pattern will be four times the size of that represented. Of course, what is said of ends applies also to picks.

There are many small patterns in both linen and cotton goods which are known as diapers but are not in reality such. They are simply small figures, many of them made on the principle we have before described—namely, a loose weft or warp figure upon a plain or other ground.

It may seem that if diapers are, as shown here, a mere combination of twills for the purpose of producing patterns, that the subject should have been treated under the head of figuring with twills in a previous chapter. Strictly speaking, that is so; because they are not only patterns which were always produced with healds in the days when they were most largely used, but the character of the pattern altogether would place it in the category of those with which we have already dealt. Our sole object in reserving it for this chapter has been to use it as an introduction to damask. In speaking of diaper patterns we have referred to them as being regular twills reversed to form patterns. This is a perfectly accurate description of the great majority of diapers, but sometimes instead of a regular twill a satin would be substituted, the pattern still being arranged in straight lines, squares, or parallelograms.

79. Damasks.—The structure of damask is precisely the same in principle as that of diaper. The figures are not arranged in straight lines or squares, but are generally more or less of a floral character.

It is supposed that the silk weavers of Asia invented diaper weaving. Damask, which was formerly made entirely of silk, though now both of worsted and linen, takes its name from the city of Damascus, whence it

is supposed to have come. So that it is probable that, as we have already said, the diaper is the original of the damask; and although we now apply the name exclusively to the class of patterns we have been describing, yet the two are practically the same thing so far as structure of the cloth is concerned, and the one is the outcome and development of the other so far as character of design goes.

In damask figuring we have, perhaps, more scope for producing large figures than in any other mode. Generally the ground is warp satin and the figures weft satin, or it may be the reverse. In either case the binding of the weft and warp together is the same in both ground and figure, so that the cloth is equally firm throughout. That being so, figures as large as we please may be introduced. It is not a question of having so much loose material on the face or the back, but merely the exchange of places of warp and weft, the two continuing to interweave in the same order whichever may be uppermost. One matter relating to the structure of the cloth requires notice here. We have said that to have a perfect structure of cloth the relative proportions of warp and weft must be regulated by the pattern of the fabric. In damask weaving what is termed the pattern of the fabric is that of the ground, or the general order of interweaving, which is usually a satin. To make a satin perfect with the warp predominating on the surface, we say that there should be a greater number of warp threads per inch than weft; and if the weft be on the surface, there should be a greater number of weft threads per inch than warp. Now, in damask we have the warp and weft on the surface alternately, and each weaving as a satin. Perhaps there may be nearly equal quantities of each, and at any rate both are on the surface at different parts of the cloth at the same time; then it is quite impossible to comply with the conditions required to produce a perfect satin. We cannot make either material

predominate just at the point where it comes to the surface, and nowhere else; if one predominate it will do so not only in the figure or ground, but in both. Then we are reduced to the necessity of making the fabric equal both ways, that is, warp and weft will be equal both in quantity and thickness. But that equality will not be the same as for a plain cloth. In plain cloth, we say, to make perfect structure, not only should warp and weft be equal in quantity and thickness, but the intervals between the threads should be equal, or nearly so, to the diameter of the threads, so that warp and weft threads may bend round each other equally. In satin cloth the threads do not interweave alternately, but at least once in every five. Then our threads must be closer together than for plain cloth; but as both sets of threads come to the surface neither must be set so closely as if only one were intended to come to the surface, but just so that both warp and weft will have to bend a little out of the straight line, without departing so much from it as in a satin of a perfect type.

The outcome of this must be, then, that in a damask we cannot have a perfect type of a satin. We certainly cannot, but we must come as near it as we can, consistently with the fact that *both* sides must be equally perfect, and not one side only. An examination of damask cloth, either in linen or worsted, will convince even the merest tyro of this, and more especially if he compare it with satins which are not figured after the style of damask. Instead of there being a fine unbroken surface, presenting only one set of threads to the eye, either in the ground or the figure, and all the points of interweaving of the warp with the weft being hid, he will see the weft come through to the warp surface, and the warp come through to the weft surface. The thicker the threads employed the more apparent will this be, and the thinner the threads the less will this be visible. The reason is not hard to find. Where the threads are thick the point of interweaving is

more difficult to cover, by reason of their bulk, even if the threads on each side spread out pretty well; but if the threads be thin, and those on each side of the point of interweaving spread out slightly, it will have a better chance of being covered; hence fine cloths present a more perfect appearance than coarser ones, although the diameters of the threads in both bear exactly the same ratio to the number in a given space. Although damask patterns are usually made upon fabrics with a satin ground, and the figure, as we have said, is produced by the warp and weft exchanging places on the surface, yet they are not necessarily confined to that only. As in other fancy cloths, variety of working may be introduced to give more effect to the figure. At points where some special effect is desired the satin may be exchanged for a twill, and the twill may be varied in its direction, or even in its order of weaving. Sometimes small spots of weft or warp are introduced to give additional variety and effect to the pattern, but in all cases care must be exercised not to make the fabric too loose at any point. The general practice is to make these goods all of one colour, as, for example, in linen table-cloths and similar articles, and again in worsted damasks for furniture purposes. So that the whole effect of the pattern is dependent upon the threads of which it is composed, and which are placed at right angles to each other, being brought to the surface alternately, according to the form of the figure, and thus, by the light falling upon them at different angles, relief is given. It will be easily understood that a little variety in the order of interweaving the threads in the pattern, instead of keeping strictly to the ground pattern as satin will give a pleasing effect of light and shade to the whole.

80. Combination of Damask and Repp.—Another type of fabric which is much used for furniture purposes is one which may be termed a combination of damask and repp, or a repp fabric with a damask figure upon it. The general body is constructed on the

principle mentioned in the first chapter, with a number of threads together as one, alternated with a single thread, and the ground of the cloth woven plain, so that all the thick or combined threads when passing over the pick form a distinct rib across the piece. For the purpose of figuring, those thick threads are allowed to "float" or pass over all the weft picks, so that they present a flat surface of loose warp upon the ribbed ground. This is all very well where the figures are small, and make stiff-looking objects, which run either across the piece or in diagonal lines; but if the figures are too large or too long in the direction of the warp there would be too much looseness, more especially for use in connection with articles of furniture, such as covering of chairs, &c. Then to prevent this looseness, and to enable the designer to employ large figures, the threads which combine to make a thick one are separated in the figuring, and woven into the ground weft in the order of a satin or twill. By this means not only the flat surface required is produced, but with the number of ends which they make when separated they cover the weft and the points of interweaving most effectively, and make a firm fabric; and in this, as in the damask proper, great variety may be obtained in the pattern by using a variety of twilling to give shaded effects. From the very boldness of the ribbed ground, the prominence of figures formed by the thick threads where they are not separated, and the flatness of the figure where they are separated, more effective and striking patterns may be made upon fabrics of this class than upon the ordinary damask. Quite as much extent of figuring can be produced, either floral or otherwise, and, of course, greater variety of effects. If proper regard be paid to the relative thickness and number of the threads according to the pattern, the cloth will be a most useful one also; but if this be neglected, in common with all repp goods, they will be liable to "fray," and be unserviceable for wear.

81. Figuring with Extra Material—Extra Warp.—

We have now examined pretty fully into the question of figuring with the material of which the fabric is composed. We must next enter into figuring with extra material, or the introduction of weft or warp, or both, for the purpose of forming pattern.

We shall now begin to find our knowledge of double cloths of value ; for the whole system of figuring with extra material may be said to be based upon double cloth, although two cloths are not actually formed. Even though we may not actually form two distinct cloths, yet we have one warp and weft making the fabric proper, and we have another weft, or warp, or both, forming figures upon it. In some instances, where we use both warp and weft extra, we may be said to actually form double cloth, at intervals, at any rate ; because if the extra materials interweave to make a figure, they will, as a matter of fact, at that point form a cloth of their own, separate and distinct from the ground cloth.

We will deal with this subject under the three distinct heads :—First, where extra warp only is used ; second, where extra weft only is used ; and third, where both extra weft and warp are used ; at the same time the combination of figures formed by extra material combined with those formed with ground material must be shown.

We will first take figures formed with extra warp, and deal with it in stripe form. Suppose we make a perfectly plain cloth for the ground, and we wish to make a stripe upon it either figured or otherwise ; we arrange the stripe ends in such a manner that they pass alternately to the face and back of the cloth, according to the pattern, but they take no part whatever in the formation of the cloth. When they come to the surface the ground cloth remains plain underneath them, and when they go to the back the ground cloth remains plain above them. Fig. 84 will represent a longitudinal section. In it

the ground cloth is shown as being quite plain throughout, and the thick thread, which represents the extra warp, is shown as passing from one side of the cloth to the other to form figure.

In the arrangement of fabrics



Fig. 84.

figured in this manner, the first condition, to ensure the figure being solid in appearance and effectually covering the ground, is that the extra threads should be set as closely together as ever they can be, and that they shall be of sufficient thickness to cover the interstices between them as nearly as possible. Those extra threads must, of necessity, be alternated with the threads of the ground warp; then, to ensure this solidity as far as may be, two conditions are requisite in the ground fabric: first, the ground threads must be set closely together, and second, these threads must be as thin as possible; and further, there should not be more than one ground thread between the extra ones. Suppose that the ground warp is set very openly, the extra threads have not only to fill the space between them, but it must spread out so as actually to cover them. If the diameter of those extra threads be less than the spaces, it cannot, of course, even cover these spaces; and if the diameter and space be equal, it of course can do no more than cover the space, so that there would be a space between each extra thread equal, at least, to the diameter of the ground thread, and that could not possibly show a solid compact figure on the surface. Again, if the space between the ground threads be small, but the threads themselves be thick, extra ones would undergo some compression at the point where they are passing from face to back or from back to face, but they will still be unable to spread out enough to cover the thick ground threads; then there is only one alternative: if the

figure must show a solid surface, the diameter of the extra threads must be equal to *both the diameter of the ground threads and the spaces between them*. It will then, at the point of changing from one side of the cloth to the other, undergo a compression equal to the diameter of the ground thread, or rather the two threads together—ground and extra—will undergo this compression; and as the extra one issues from the cloth it will spread out to its full diameter, and so cover the ground effectively. If the “floats” on the surface be very long there will be all the better opportunity of covering, but if they be short these opportunities will be decreased. Now with regard to the question of compression. If the ground threads be “soft spun”—that is, not having much twist in them, the fibres lying loosely together—they will be all the more subject to compression, and the extra ones will keep near their natural state. On the other hand, as is most commonly the case, if the extra threads be soft they will undergo the compression. Probably the latter alternative is the better, more especially if we look at it from a practical point of view. The ground threads have to bear all the strain of weaving; they form the wearing cloth; they really constitute the fabric. The extra thread simply ornaments; therefore, for the convenience of the weaver, and to obtain the strongest cloth, the ground threads should be tolerably firm in their structure, and we may have the figuring threads soft and loose, so as to cover the ground in the most effective manner. We have been speaking now on the assumption that the ground of the cloth has to be absolutely covered by the extra material. We have done so to illustrate more clearly the true basis upon which we must work. It is well known that a succession of sounds, if sufficiently rapid, conveys to the ear the impression of a continuous sound; or, in like manner, a succession of sparks will convey the impression of a continuous line of light; then, if the colours of

our extra warp be brighter than the ground, as they usually are, although they do not entirely cover the ground, the spaces between them may be so small that they will convey to the eye the impression of solidity, or continuity of colour.

If we wish the stripe to appear solid, like some of those of which we have already spoken where they are "crammed," or have double the number of ends in a given space of stripe to what there are in the ground, we cannot obtain it so perfectly by treating it as extra warp, and allowing the extra warp to form figure upon plain ground, as if we employ all, both ground and extra, of the same colour to form the stripe. Nor will it have the same fineness of appearance. This will be very easily understood; by bringing extra warp to the surface to figure upon the ground, only half the quantity is presented to the eye that there would be if both ground and extra combined to form the stripe; and whether the stripe be twilled or satin, it must appear finer in the latter case.

On the other hand, the ground cloth being quite plain under the stripe will give a firmer and stronger fabric, and there will be less tendency to "cockle," because of the texture being equal throughout. Again, from an economical point of view it may be advantageous. If the ground of the cloth be of cotton warp, and the stripe silk, it will be much cheaper to make it as an extra warp stripe, because only half the number of threads would be employed. Perhaps those would have to be somewhat thicker than if the whole were silk, but still there would be an economy, though we must again say not so good an appearance.

It is not often, however, that this system of working is resorted to for the making of solid coloured stripes; more generally it is employed for figured ones, and then it certainly does possess advantages. The figure may be approximately solid in appearance and well defined, and the stripe may be broken up as much or as little as may be desired by the figuring.

Perhaps it will be necessary to show the arrangement of the design upon paper for figured stripes of this description. Fig. 85 is a design for a small figure. It will be seen

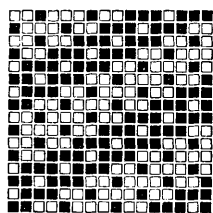


Fig. 85.

that every alternate end weaves quite plain, and the figuring ends form figure only, and consequently may be brought to the surface as much or as little as we please. The figure may be large or small, or the stripe may be broken up so that there is little semblance of a stripe left, or it may remain nearly solid.

Very frequently, although the warp is introduced in stripe form, no stripe is formed, but merely spots; the warp coming to the surface to form the figure, then passing to the back and remaining there until required to form another spot. If the spots are some distance apart, the loose material at the back must be dealt with. It must not be left loose for any length; it must either be bound at intervals into the cloth, or cut away. Sometimes difficulties arise with this loose material. If the cloth be a thin one, and more especially if it be woven quite plain in the ground, the loose material which is not figuring cannot be bound into it without showing through to the surface, and it would be most objectionable to have it showing through in dots at all the points of binding. Thus there is no alternative but to cut it away. Then, again, another difficulty arises. If after forming the figure on the surface it simply pass to the back, as shown in Fig. 84, and we cut away that which is at the back, there will be nothing to keep the figure on the cloth but the slight pressure of the ground threads upon the figuring threads at the point where they pass through the cloth. This would certainly not be sufficient, at any rate, if the cloth is to be applied to any useful purpose. The least rubbing on the figure would bring it away from the cloth as so much

loose yarn. Then we must bind it into the cloth round the edges of the figure. The best method of doing this is to let the extra ends weave plain into the ground cloth all round the figure for a sufficient number of picks to make it firm, then the loose yarn may be cut from the back, but it must not be cut quite close to the cloth. Fig. 86 is a plan of a small spot showing the binding around the

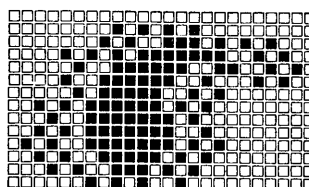


Fig. 86.

spot. If this binding can be introduced as part of the figure it will be all the better, and if some more can be introduced into the body of the figure better still. This may be done, not only as a species of shading to the figure, but also to give variety of effect to the colour. This subject of binding also brings another matter before us. We very frequently have to give variety and character to our figures by what might perhaps be called light and shade; that is, we wish the figure to vary in the degree of prominence given to its various parts. At some points the colour should appear in its full intensity, at others in a somewhat subdued form, and again at others be modified to the extent of being almost invisible. To obtain these effects we must bind the figuring material into the body of the cloth in a sufficient degree, and in such order as will reduce the colour to what we want. This binding we may vary as we please. We may twill in either a bold or a very firm twill, or we bind in plain or satin; our twill may throw a preponderance of the material to the face, or it may throw it to the back; in fact, we may bring as much or as little as we please to the surface, and so produce any effect we desire.

If the fabric upon which we are figuring with extra

warp be a heavy one, we can deal much more readily with the binding. Should the ground be twill or satin instead of plain, we can bind into it at will, without its showing through to the surface, upon the same principle as binding double cloths. In fact, where the extra warp comes, we treat it as a double warp cloth, except where it is forming figure. In such cases it is not often necessary to cut away loose material at the back. Having facilities for binding, it is better to do so, not only because of the saving of labour, but also because the figure will be less liable to pull out in wearing. Where cutting is resorted to we can never be quite sure that the binding round the edge of the figure is sufficient, more especially if cut too close; therefore it is not desirable to resort to it, except under circumstances which admit of no alternative.

In addition to spots or stripes formed with extra warp, we may figure all over the fabric with it, and by this means produce not only very pretty, but very elaborate designs; for we may use more colours than one, and even with the use of one colour we have excellent scope for making pretty patterns. We have two illustrations in Plate 3 of figures formed with extra warp, one with the use of one colour only, and one with two colours. With regard to the arrangement of these two colours, they must of necessity be arranged in stripes in the warp, that is, a given number of ends of one colour, and a given number of the other, and so on. The first object, however, must be to arrange the design so that these stripes are not too apparent on the surface; the figure must be broken up in such a manner that the existence of the stripe is not too plainly visible, at any rate to the untrained eye.

This breaking up of the figure may be very materially assisted by the use of figuring with the ground material along with the extra warp, and if judiciously done, very pleasing effects will be the result. Again, to assist the breaking up of the stripes, we may vary them



PLATE III.

as much as ever we please in size, and at the same time we shall be varying the sizes of the different figures formed by each colour respectively at various points.

In arranging designs for figures formed with extra warp upon the design paper, proper regard must be paid to the relative quantities of warp and weft. Suppose all over the piece the extra ends are alternate with the ground ends, and that the quantities of ground weft and warp are equal, then the total quantity of warp will be just double that of the weft. In that case if the Jacquard machine with which we are to weave the cloth has eight rows of hooks, our paper must have eight divisions in one direction and only four in the other—what is known as eight by four paper. If we were to use paper equal both ways, the figure would of course be distorted, the width on the paper being double that of the length, if it were to be correct in the cloth; and if correctly drawn on paper, it would be drawn to double the length on the cloth in weaving.

82. *Extra Weft Figures.*—We now come to the question of figuring with extra weft. This mode of figuring possesses decided advantages over the system with which we have just been dealing, and has but one disadvantage compared with it. When we figure with warp alone we weave as if we were weaving a plain, twill, or satin cloth only; the weft which forms the ground serves also to bind the figure. Consequently we can weave at a more rapid rate, having to pass the shuttle a sufficient number of times to make the ground cloth only, whereas in weaving with extra weft we have to form the ground cloth and pass the shuttle to form the figure also. On the other hand, in warp figuring we have the warp very crowded. This adds to the difficulty of weaving if carried too far, so that in most cases we are confined to the use of one colour only, or if we use more, they must be arranged in stripe form, as shown in Plate 3. Now, in figuring with extra weft we may use as many colours as we please; it simply means the

use of so many more shuttles, and so much additional weaving; that is, the shuttle has to be passed through the warp so many more times, though this is necessarily accompanied by slow production. Again, by the use of the "swivel" we may dispense with the loose material on the back, and use only just what is required to form the figure; and there is also an advantage in putting the pattern upon design paper, no distortion being necessary, as we shall show.

All that has been said respecting the relative thicknesses of the figuring and ground threads applies to weft figures equally with warp figures.

It is not often that continuous stripes are formed across the piece with extra weft, though it may perhaps occur sometimes. If it does, however, it will generally be in conjunction with warp stripes, so as to form a check pattern, though it frequently happens that the weft is thrown all across the piece to form spot figures. In such cases, what has been said of binding and of cutting off loose material in warp stripes will exactly apply also to weft, so that we need not enter further into the consideration of that question. Let us, then, turn to the discussion of figures formed with the "swivel," and see what are the advantages to be gained.

What is known as the "swivel" is an apparatus attached to the loom, and carrying a series of small shuttles, each being intended to form a separate spot; and in the process of weaving, after the shuttle carrying the ground weft has been passed through the warp, the "shed" is opened, or the warp threads are separated for the weft which is to form the figure, and instead of one shuttle being passed all the way across the loom, carrying weft which has only to form figure at intervals of two, three, or four inches, a small shuttle is passed through the warp at *each* figure, so that each one is formed by its own weft and with its own shuttle. The advantage of this is obvious at first sight; there is no loose material to deal with on the back, and conse-



PLATE IV.

sequently no need either to bind into the fabric or cut away. Again, as each figure is formed with a shuttle of its own, they may be of different colours; whereas, if one shuttle must serve them all, they will, of necessity, all be of the same colour.

The swivel, from the fact of its being a series of shuttles, is specially adapted for the production of spot figures; and the shuttles all being of a given size, and set a certain distance apart, necessitate the figures being set in like manner; in fact, the position of the figures is determined by the position of the shuttles, and the distribution of the figures is determined by the number of positions in which the shuttles can be placed. We have in Plate 4 a small figure formed by a swivel. An examination of the figures will show that the space occupied by the figure is much less than that between them. Generally the space actually occupied by the figure must not be more than half the space between each; that is, if the width of the spot be one inch, there must be an interval of two inches between that spot and the next. This is entirely dependent on the construction of the "swivel" apparatus. There are several forms in use, some of which occupy much less room than others, and consequently allow the spots to be placed much nearer together. With swivel figuring we are not necessarily confined to simple spots, but may make figured stripes, after the character of those we have spoken of as being produced by warp. The shuttle being placed in one position, if we keep constantly weaving without changing it, a continuous stripe would be the result.

83. Combining Extra Weft Figures with Figures formed by Ground Weft.—Again, we may combine the extra figure with figuring produced by the ground weft. Suppose, for instance, we are wishing to weave a representation of a rose-bud. The leaves, stem, &c., may be formed by the ground weft, or we may use both weft and warp, and the bud itself may be formed by the extra

weft. By this system of combining figures some very pretty effects may be produced economically, but great care is required in the arrangement of the designs. We have already shown that the spots formed with the swivel must occupy certain positions, according to the arrangement for moving the shuttle from one position to another. If the figures so formed are to be combined with others, all must be arranged so that they fall properly into the places assigned to them.

Sometimes figures of this description are made with the extra material introduced as warp. In such cases the distortion of which we spoke with reference to warp figures occurs on the design paper; the extra ends coming in alternately with the ground ends only at intervals, the whole figure must occupy at those places double the space upon paper. The paper will be ruled alike throughout. As the conditions of the pattern alter, so also must the form alter upon the paper. In extra weft figure this need not be the case. The figure may be painted upon the paper in the various colours, and the rest will be arranged in cutting the cards for the Jacquard machine. When cutting the ground cards, simply treat the extra colouring as if it were ground, and when cutting the cards for the extra figuring deal with it *only*.

Swivel figures may assume a great variety of forms. They may be simple spots, or may introduce additional colour or colours into figures formed with the ground; or the spots may be surrounded by checks. They may form continuous stripes, or, by the judicious movement of the shuttles and corresponding arrangement of the figure, waved lines; or a series of figures broken in a greater or less degree may be obtained. In fact, there is scarcely a limit to the varieties; the only limit is the width of figuring which may be produced at once.

Although swivels may be used to give us these varieties of figures, with economy of material, yet we have often to step beyond their range. If our figuring occur too frequently, or occupy a greater area than



PLATE IV.

the swivel can give, then we must resort to the ordinary shuttle, and throw the weft all across the piece.

If we throw the weft across the piece for the purpose of forming spot figures only, it will often be desirable to arrange the figures so that they shall not too strongly suggest a stripe. This may sometimes be the result of the arrangement of the figure formed by the ground material accompanying the extra figure; for instance, if the ground figure run in a diagonal direction, as in the designs in Plate 5, although the spots are really in straight lines across the piece, the general arrangement altogether neutralises it. In the first of these two figures the spots are so far apart that they might be easily woven with the swivel. It would only require to be so that it could be moved the requisite distance to suit each spot.

In the second design the spots are so arranged that the weft forming the large spots is at the same time forming also the small ones, yet there is nothing that will suggest to the eye a straight line of colour across the fabric. If the figures be large and rather close together it will not be easy to prevent the tendency to show stripes; but if they be small and well distributed it may be prevented without much trouble. If we use more than one colour in the same spot, as will often be necessary, it will be desirable as far as possible to arrange the colours so that one colour is ended before the other begins; or if that would make the division too harsh, let both colours run simultaneously for a short period. But in using two colours one of two things must be done—either the two colours must continue simultaneously throughout the fabric, or for a very short period only. As can be easily understood, if two extra colours come in together for a time, and then either one or both cease, or if one cease and the other shortly after, there will be great variation in the bulk of the cloth, and that variation will detract from its value as an useful article. We may introduce one colour at intervals and not materially affect the structure. If the cloth be a heavy one

we may, perhaps, introduce two, but if the cloth be a light one two will be dangerous. But if our colours be judiciously treated, and arranged in such a manner that one commences when the other has finished figuring, whether it be to take part in the formation of the same spot or another, then we may use them with freedom.

In Plate 6 we have two examples, one showing the use of two colours, or rather two shades of the same colour, which would necessitate the use of two shuttles, as though they were two colours. In one case both colours take part in the formation of the same figure, and in the other they form separate figures.

In the pattern when both colours go to form one figure, there is a tendency to show a stripe across the piece. Even if this occur only in a slight degree it will offend the eye; possibly it would be less offensive if the stripe were more decided: it can neither be called a figure free from stripe, nor can it be called a stripe. The latter is suggested without actually having an existence. This might be neutralised to some extent by the introduction of other small spots between, so as to break the line a little, or rather to show the colour more distributed over the surface of the cloth.

When we are figuring with extra weft we do not necessarily confine ourselves to its use for spot figures or stripes, but figure all over the surface of the cloth, and we figure not only with one colour but with many colours. In the common speech of the trade, when we figure with a number of colours all over the fabric, each colour is termed a "cover;" thus, it is no uncommon thing to hear the terms, "three cover," "four cover," &c. This means that three, four, or any number of shuttles indicated by the number of "covers" follow each other in regular succession in the order of weaving, or that every time a ground pick is inserted so many picks of extra weft, or that which takes no part in the formation of the cloth, only in figuring, follow it in regular succession. Sometimes



PLATE VI.

it may be spoken of as "three covers," or "ground pick and two covers," which would mean that there is a ground weft and two extra wefts. Again, in some instances we have a number of "covers" and "extras;" that is, a number of colours running throughout as figuring material, and an extra colour coming in occasionally to form some particular part of the figure.

Now, when we are making a cloth with a number of "covers," it does not necessarily follow that we are confined to that number of colours; though such is generally the case, one of the "covers" may be a "changing" one. Instead of always remaining the same it may consist of two or more, but always keeping the same relation to the others. When one colour has completed its portion of the figure another takes its place, and so on; so that if it is called a "three cover," there may be four, five, or even six colours, but there are never more than three wefts being inserted at once. Either one or two of the covers may be "changing" ones.

When we are making cloths of a number of colours, we cannot make them very light fabrics in weight, so that we have an opportunity of binding the loose material into the back. In some cases the extra materials instead of being bound into the face cloth, have a binding warp at the back with which they interweave, and form a separate cloth or "lining." This has two advantages: first, it enables us to deal readily with the extra material, and leaves none loose on the back, as well as forms a good support to the face cloth, giving additional strength; and second, it saves any risk of the binding showing through to the face. Again, sometimes there is a separate back put upon the cloth, so that all loose material which could not be conveniently bound to the face, and which might not be sufficient to form a separate cloth on the back, might be held between two cloths, and so give the cloth a "smart" appearance, as well as additional strength.

When we are figuring with extra wefts in this manner we have also the ground material which we may use for the same purpose, and thus give more variety to the pattern; and in order to retain the full strength and compactness of cloth, when the ground weft comes to the face, one of the extra wefts takes its place, weaving into the warp as the ground weft; thus forming, in addition to keeping the cloth strong and perfect, a more stable background for the figure, and throwing it more prominently to the surface. To such an extent is this carried sometimes, that it would be difficult to say which is the ground and which is the figuring weft. In figures of this description the same resource is open as in making spot figures by interweaving the extra or figuring material into the ground for the purpose of giving variety of shade to the pattern. If we are weaving, for instance, with black figuring weft upon a white ground, by allowing the black to enter into the structure of the ground fabric we may produce as much variety and as much delicacy of light and shade as in fine engravings.

Suppose we are weaving a small picture, a landscape, a portrait, or designs in which foliage or great variety of light and shade is required, and our ground cloth is a plain one. To obtain the deepest shadows, we should bring the black weft to the surface, and if it had to cover a large area, or such that if allowed to float for a considerable distance the weft would be too loose on the face, we should bind it in satin order just enough to attach it to the cloth with sufficient firmness, without at the same time allowing the white to show through it. Then for a medium between black and white, let the black weft enter into the ground and form plain cloth, passing the white weft to the back out of the way. For the lighter shades, or where it approaches white, simply let the black enter into the ground in some twill form, more or less of it entering into the structure of the cloth, according to the depth or lightness of the shade required, and



PLATE VII.

by this means we may obtain any degree of light and shade that may be needed.

Some splendid examples of this kind of weaving are exhibited in the well known book-marks of Mr. Stevens of Coventry, not only as illustrating the best methods of figuring with coloured yarns, but really as works of art. The use of coloured silks as well as of black and white is shown in many of these productions in the most perfect manner. Again, in the Paisley shawls, which were so extensively worn some years ago, we have some beautiful examples of weaving. In the fancy waistcoats of a by-gone day, and in some of the ladies' dress goods of the present time, excellent work is also displayed.

In Plate 7 we have a small portion of a pattern copied from a Paisley shawl, not by any means one of the most intricate designs, nor showing the greatest variety of colour, but sufficient to show clearly the principle. This is what would be called a "three cover," or "two cover and ground." There are two colours employed for figuring upon a white ground, the white itself taking some part in the formation of the figure. One striking feature of this design, as indeed of many of the patterns for this class of shawl, is that there is not at any point a great quantity of one colour either on the face or back of the cloth at once. This arrangement prevents the necessity for binding the loose material, although with the amount of figuring on the face the binding might be done without there being much probability of its being seen on the face; yet in light fabrics, such as the one from which this design is copied, it is better not to have to resort to it, but to bind by figuring. Although we may not bring any of the colours to the surface in large quantities at once, yet there is no difficulty in making predominate sufficiently at any part of the design to give character to it, as will be seen from the example before us. We have only to bear in mind the illustration we have previously made use of, of the succession of sounds conveying the idea of a con-

tinuous sound. A close examination of this pattern shows that the colour is in small patches, but at a short distance it has the appearance of being solid in colour. This is one of the most simple of patterns of this description, but it will probably be sufficient to convey to the student an idea of the manner in which they are formed. Very frequently a great many colours are employed, sometimes each colour being continuous throughout, at other times some of them "changing," and so giving greater variety. It would be an easy matter to multiply the illustrations infinitely, but probably most students of weaving will have opportunities of examining real fabrics of this description, which would convey more to their minds than any amount of writing.

In Plate 8 we have an illustration of a design for ladies' dress goods. It is a species of lace pattern upon the surface of the fabric, and was awarded the gold medal offered by the Worshipful Company of Clothworkers of the City of London at the Fine Art and Industrial Exhibition at Bradford in 1882. The designer of it, Mr. James T. Lishman, has kindly given permission for its use in this work. The pattern is formed by one extra weft and the ground weft combined; but though we speak of them as a ground and an extra weft, it would be difficult to say which we should have to call the ground, for both take an equal part in the formation of the cloth. The ground fabric is a satin with the warp on the surface and very closely set in the threads; this gives an opportunity for binding both wefts into the warp, and so imparting additional firmness to the cloth. Both wefts are lighter in colour than the warp, and thus the pattern is shown to the best advantage.

This pattern is an illustration of the fact that all our figuring material need not be the same; one is of silk and the other of worsted. Patterns are frequently made where the yarns are different in the materials of which they are made, and of the same or different colours. In some instances, as in the use of soft wool and silk to-

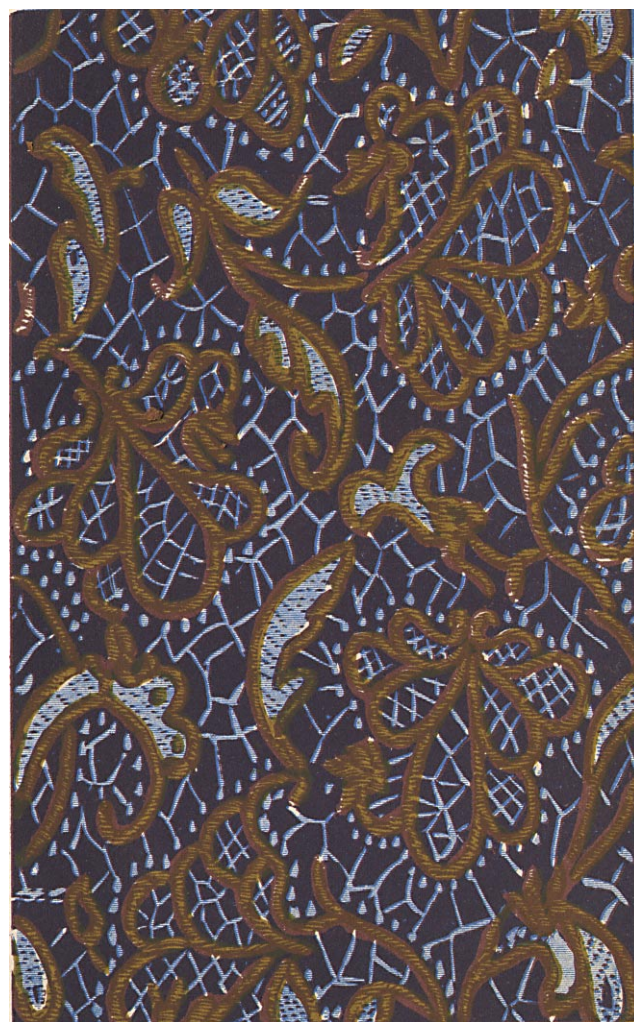


PLATE VIII.

gether, we may obtain very pretty effects, simply from the difference in the brightness of the material. If one be dull and the other very bright, the pattern will be distinctly visible, though both are of the same colour. Other instances might also be mentioned, such as the use of mohair, or alpaca and cotton in combination, and in all cases the effect of the pattern is dependent upon the brightness of one material and the dulness of the other.

84. Combination of Extra Warp and Weft.—We must now turn our attention to the production of patterns in which extra warp and weft are both employed, and a consideration of the reasons for using both.

One of the commonest forms of using both extra warp and weft is for the production of stripes with figures running between. Thus, for instance, if we were to take the pattern on Plate 4 where we have spots set some distance apart, and we wished to insert a stripe either between every figure or at alternate figures, that stripe would in all probability be of a different colour from the figures, and even if it were the same, it would be better and easier to make the stripe with extra warp than with weft. Then we have here not only one of the commonest forms of the use of both materials, but one which commends itself at once as being both a ready and economical mode of making such patterns. Of course this class of pattern is capable of an endless variety of arrangements; the stripes may be varied, and the figures also, and figure may be formed upon the stripe as well as upon the ground of the cloth by the extra material; and again in this, as in other cases, we may call in the aid of the ground material to give further variety to our figures. Another form of using both warp and weft is where we are figuring all over the fabric with extra weft, as in Plate 8, and we desire to introduce a small spot of a different colour, this spot to come in only at intervals. More force is given to this mode of working when our looms are capable of working with only a limited number of shuttles, and we wish to

use more colours than we have shuttles. In addition to that, where the spot *can* be as readily made with the warp, as we have previously pointed out, it saves time and expense in weaving, so that the designer will find numbers of instances where he can introduce a spot with extra warp, and add very materially to the effect of his pattern, without in a great degree increasing the cost. In such cases due care must be taken in arranging the pattern upon paper because of the distortion at the point where the extra warp comes in, caused by that warp being alternate with the ground.

Not only may we use extra warp for spots when we are figuring all over the fabric with weft, but we may also use both for figuring all over. Patterns made in this manner will have practically the same appearance as if two wefts had been employed; but there is this great advantage—that when they are not forming figure on the face, they may interweave with each other so as to form a cloth on the back, and prevent any loose material either from being cut off or bound into the face cloth, with the risk of showing through to the face.

Both warp and weft are used for the purpose of forming figures perfectly solid in colour, and of a texture quite different from the ground cloth, perhaps quite as frequently as for the purposes already named; and in such cases it is no uncommon thing for several kinds of figuring material to be employed upon the same fabric. We may use silk and worsted, or cotton and linen, or any combination, according to the nature of the cloth we are making, or the purposes for which it is intended. Whenever we figure upon this principle, we deal with the extra material as belonging to a second cloth; in fact, the principle of double cloth making is employed in its entirety. At the point where the extra materials interweave with each other, they form a cloth quite separate and distinct from the ground cloth; and if both are passing to the back at the same time—that is, if at any one point any of the extra warp is passing to the back,

and at the same time extra weft, which may be forming figure elsewhere, is passing to the back also—they interweave with each other, and so form cloth at the back of the fabric.

It will be easy to understand that by this system of working not only may we make the figures of any form, but we may introduce any number of colours also. If we make our warp in stripe form, and arrange the colours of the weft to correspond, taking care that any colour of weft always interweaves with the same colour of warp, and that the spaces occupied by each colour are equal to the spaces occupied by the figures they are to form, we shall have a series of figures, all different in colour but each solid in its own colour. Again, we may so arrange the colours of either weft or warp, or both, that each figure has more than one colour in it, and the colours may be mixed as we please; so that this mode of figuring gives us more scope for producing pretty effects, especially where we must have the figure displaying solidity of colour, than any other mode of working.

It is really an application of double cloth pure and simple in one sense. It is double cloth wherever figure is formed, but not necessarily all over the piece. If the two cloths were separated the ground would be one complete fabric, but not necessarily so of the figuring cloth—it would only appear in patches; and if the figures are formed from different materials, as silk and worsted, each material interweaving with its own warp only, we may be said to be using portions of three fabrics, but not more than two of them occurring at the same place.

But when we are figuring with extra warp and weft in this manner, we are not bound to confine them to interweaving with each other, but either or both may figure independently, and they may enter more or less into the ground cloth. In fact, we can combine in this one method of figuring *all* that we can do by *each* of

the other methods with which we have dealt, so that of all methods of figuring this one is the most comprehensive.

We have but one other mode of figuring to deal with at present, and that is what is known as lappet weaving. We shall subsequently have to point to other modes of ornamentation, but they will refer chiefly to special forms of structure in the fabric, and ornamenting by varying those forms of structure.

85. Lappet weaving is really figuring with warp threads, but presents to the eye the appearance of figuring with weft, very similar to swivel figuring. To convey an accurate idea to the reader of the true nature of this class of figures, it will be necessary to describe the mechanical method of producing the figure. From the warp beam the threads are brought forward towards the cloth; but instead of being passed through healds, in the usual manner, they are passed each through a needle in front of the reed or slay. These needles are carried in a vertical position on a horizontal movable bar. As a weft pick is being inserted the bar is raised, still keeping its horizontal position. The eye of the needle is near its upper extremity, so that as it is pushed through the warp which forms the lower half of the "shed," the threads which it carries are raised to the position occupied by the upper half of the shed, so giving room for the shuttle to pass under them. The moment the shuttle has passed through the warp the bar is lowered until the needles are quite clear of the warp; it is then moved horizontally to the right or left, and such distance as is required to form the intended figure; it is again raised, the weft inserted, lowered again, and the same operation repeated as before. By this method of moving the threads, a figure is formed on the *under* side of the cloth. This will really have to be the face; the cloth is woven wrong side up. The figuring material is bound into the fabric by being passed round a weft thread, always entering and issuing from the cloth

between the same warp threads, but not between the same weft threads. Figures of this description are easily distinguished from "swivel" figures, or any figures formed by weft. In forming weft figures the thread does not necessarily "float" on the surface the entire width of the figure, but may be bound into the cloth at any point, or any number of points, either for the purpose of preventing looseness or for producing given effects, such as the veins or stems of leaves or flowers. But lappet figures cannot be so bound; they must "float" the entire length of the figure, consequently the figure must be of a simple character, and present an appearance of solidity. An appearance somewhat approaching that of a "swivel" figure may certainly be produced by letting the thread forming the figure enter the cloth at some point in the middle of the figure, but a pick of weft must be inserted before it again issues from the cloth, so that it will present the appearance of two threads, not of one thread having simply been bound into the cloth by passing under warp.

Lappet figures are not usually made very large or in masses; they generally are of a scroll character, showing only thin lines, such as would be produced by a thread stitched into the cloth at intervals, so as to form some simple pattern, similar to that shown in Plate 9, Fig. 16, and referred to at page 188. Of course it must be understood that the threads for figuring are not set so closely as the ground warp, but at intervals of an inch or so, according to the size and arrangement of the figure.

This method of figuring has peculiar advantages, and some disadvantages. As compared with "swivel" weaving, it uses just the quantity of material required to form the figure as the swivel does; but the figure cannot be bound into the cloth in the same way, and consequently cannot give the same effects. On the other hand, the figures can be set nearer together, in fact, as near as we please; we need not consider the size of the shuttles. And

again, we have not to pass a shuttle through the warp for the sole purpose of forming the figure ; the ground weft binds in the figuring thread, just as in ordinary warp figuring, so there is economy of time and labour.

86. The allotment of Area to Figures.—We have now dwelt generally with all the ordinary methods of figuring on fabrics, and also to some extent with the effects upon their structure, but we must take into consideration the areas to be occupied by figures of different descriptions, not so much in reference to the ornamental or decorative effect intended to be produced, as to the effect upon the texture of the cloth and its application to useful purposes. If we are making figures by allowing the material which forms the ground of the cloth to cease to interweave and simply lie loosely one upon the other, it is very obvious that we cannot carry the figuring to any great extent without very materially impairing the structure of the fabric and affecting its utility. We have already shown the necessity for perfect distribution, and the question of the proportional area which the figure must occupy in relation to the ground ought always to accompany that of equal distribution. To lay down hard and fast lines, definite rules, would be impossible ; we must be guided in the first instance by the uses to which the fabric is to be applied, and in the second place by the order of interweaving of the ground cloth.

No matter what may be the structure of the ground cloth, if the figuring occupy a considerable portion of the surface we must alter the quantities of warp or weft, or both, because the want of structure at the points where the figure is formed will very materially affect the whole fabric, so that we cannot separate one consideration from the other. In fact, we must treat it somewhat as we treat twills, whether plain or fancy. As we have made the fabric loose in its texture by the order of interweaving, we must compensate for it by the increase of material, so that one set of threads can give the proper amount of support to the other.

As we have seen, when figuring on the principles of diaper or damasks, we need not take the areas into account as when the figures are loose, for the texture of the cloth is not altered; it remains the same throughout, and our figures may occupy any space, or come as closely together as we please. The same may be said of figuring with extra material, provided sufficient precautions have been taken to bind the figure on the face, so that the "floats" are not too long, or so that they do not appear as so much loose material on the face of the cloth. In figuring with double cloths we are much in the same position as with diapers and damasks; no matter what extent of figuring we have, each weft continues to interweave with its own warp; there is no loose material, but always a solid fabric. If the figures be very large, however, it may be necessary to bind them together in the middle of the figure, if formed of two separate cloths, else they would separate from each other, and give the cloth a flabby character; but if it is simply a double faced cloth the binding goes on the same throughout. These considerations of allotment of area and the effects upon the fabric are such as must be dealt with as they arise, and as the circumstances of the case may necessitate, and not by any arbitrary rules, which could not apply in every case alike. The designer having made himself thoroughly familiar with all the various structures of cloth, with the relative quantities of warp and weft necessary to give a perfect fabric, and with the conditions and circumstances which will tend to destroy this perfection, will find little difficulty in counteracting these conditions as they arise.

CHAPTER VII.

GAUZE FABRICS.

87. The Structure of Gauze.—We may now turn our attention to fabrics of a totally different character from those with which we have been dealing, and consider not only their structure or their decoration, but the decoration by variation in the structure. We have yet several classes of fabric to examine, all of which present certain inherent peculiarities in their structure, and these forms of structure we may combine with those we have already considered for the purpose of ornamentation.

We will first deal with gauze and its varieties, and examine into the structure and methods of ornamenting. The whole structure of gauze cloth is quite different from any other and most nearly approaches lace. The fabrics of which we have been treating up to now, whether plain or figured, have all the warp threads parallel to each other, and the patterns are produced by the order of interweaving. In gauze the warp threads are not parallel, but twist round each other more or less, and the pattern may be formed either by a variation of the order of twisting, or by their ceasing altogether to twist, and forming figure after the manner of cloths with which we have dealt. We will endeavour to discuss this subject in the most exhaustive manner possible, and show the combinations with other orders of weaving, but it will be a difficult matter to put the subject before the student in such a way as to elucidate all the uses and applications of gauze weaving. We can only hope to give the general principles, and show very briefly how we may combine with other orders of weaving for the production of patterns.

Since the introduction of the Jacquard machine, gauze, like other classes of goods, has been very much improved, at least so far as its combination with other orders of weaving is concerned. On the other hand, the introduction of the lace frame, and the consequent cheap production of lace, have caused some of the most elaborate forms of gauze weaving to become obsolete. Murphy's excellent work on the "Art of Weaving," shows some most beautiful patterns of fabrics which have been quite superseded by lace, and which are probably not made, or anything approaching them, at the present time. Perhaps the introduction of power loom weaving—upon which, so far as they are perfected at present, such fabrics cannot be woven—may have had something to do with this, but cheap lace has probably had more. On the other hand, the combination of gauze with other orders of weaving, as it has been developed within recent years, gives much more beautiful patterns than the most elaborate gauzes of former days, though, perhaps, not so ingenious in the structure of the cloths.

We will first deal with gauze in its simplest forms, and show the various methods of producing patterns, and then proceed to the more elaborate combinations.

Plain gauze has all the warp threads divided into pairs, the threads of each pair half twisting round each other between each weft thread. The plan in Plate 9, Fig. 1, is one of plain gauze. An examination of this plan will show that one half the warp is always under the weft, and the other half always over it; the thread which comes uppermost always passing under the other between each weft pick, and consequently coming up on one side and then the other alternately, so that the fabric is held together solely by this crossing of the warp threads. If the straight thread were drawn out of the cloth, the crossing thread, or that which comes to the surface, would simply lie perfectly loose upon the weft, no interweaving whatever taking place. In fabrics made

upon this principle there must of necessity be very great firmness of structure; the twisting of the threads round each other, and holding of the weft in their coils, as it were, must give a very strong texture. At the same time, the crossing of the threads between the weft picks will not permit these picks to come close together. Suppose we hold what we for convenience call the straight thread—that which never comes to the surface—perfectly tight, and allow the crossing thread to go comparatively slack during the operation of weaving, so that the crossing thread has not only to bend round the weft but also round the straight warp thread, each weft pick will be kept apart for a space just equal to the diameter of the warp thread; but if both threads are held equally tight, then, as each successive weft pick is driven up to the cloth, both are equally bent out of their course and the twist occurs exactly between the picks, thus keeping them a distance apart equal to at least the diameter of both threads.

In the event of the threads being held at an equal tension in this manner we have a more open texture and, at the same time, a firmer one. When one thread is quite straight and the other bends round both it and the weft, the weft cannot be so firmly held between them as when the crossing thread is so tight as to draw the other out of its straight line.

Of all fabrics there is none so firm in texture or so light in the quantity of material it contains as plain gauze. It cannot be made into a very bulky cloth, and the order of interweaving prevents it from being made a close, compact cloth. It will always present a perforated appearance, and increased thickness of threads, more especially of warp, will increase the size of the perforations.

88. Figuring with Plain Gauze.—We must now proceed to deal with the ornamentation of gauze fabrics; and so as to deal most effectively with the subject, we will first examine the various methods of crossing and

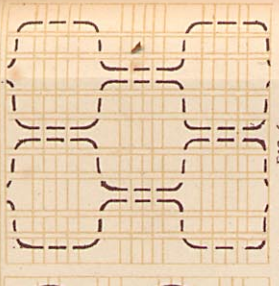


FIG. 1

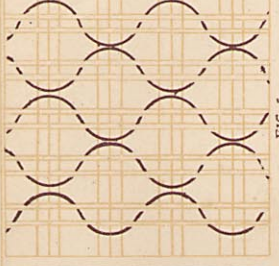


FIG. 2

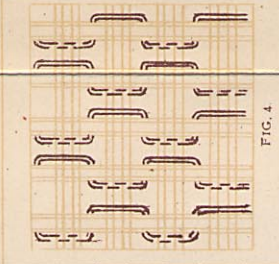


FIG. 3

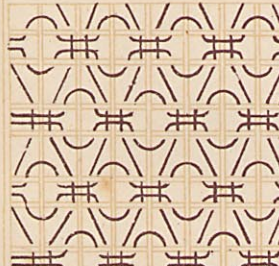


FIG. 4

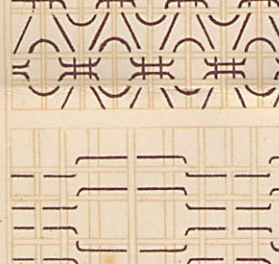


FIG. 5

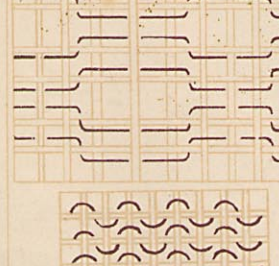


FIG. 6

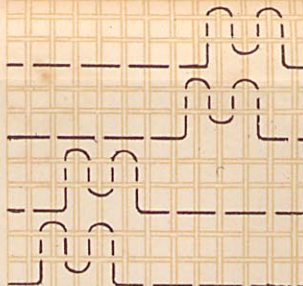


FIG. 7

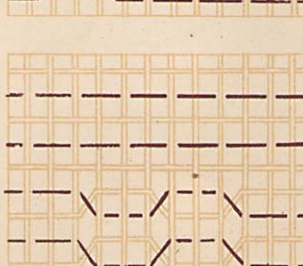


FIG. 8

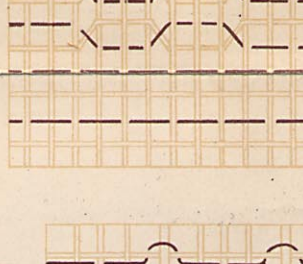


FIG. 9

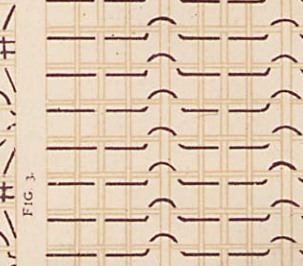


FIG. 10

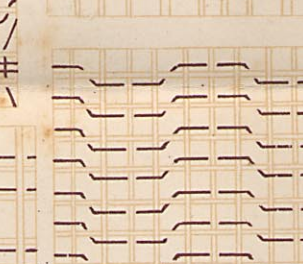


FIG. 11

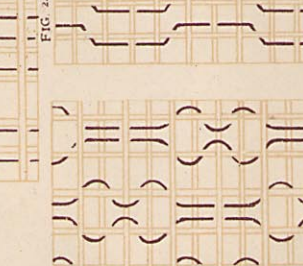


FIG. 12

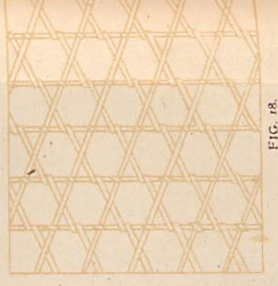


FIG. 13

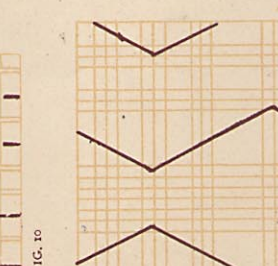


FIG. 14

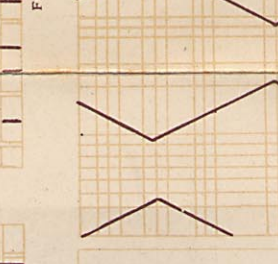


FIG. 15

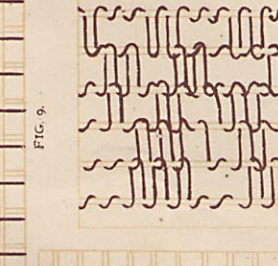


FIG. 16

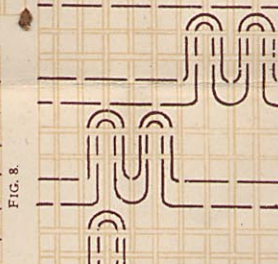


FIG. 17

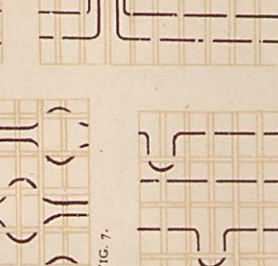


FIG. 18

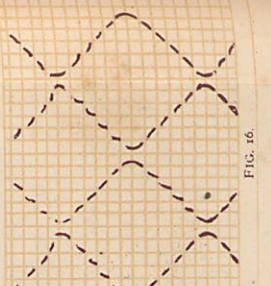


FIG. 19



FIG. 20

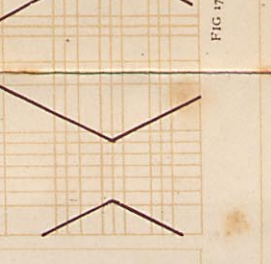


FIG. 21

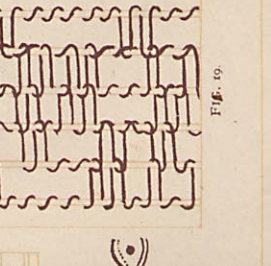


FIG. 22

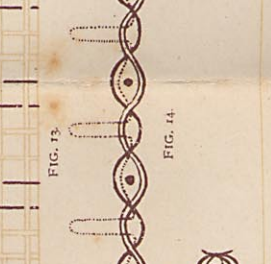


FIG. 23

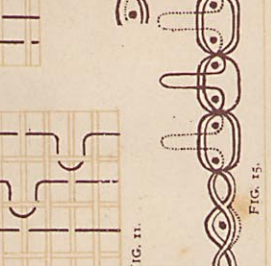


FIG. 24

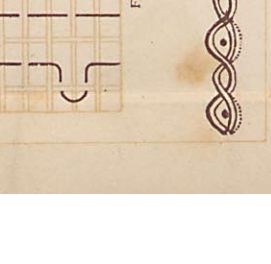


FIG. 25

interweaving, and the reasons which may induce us to adopt them. We have shown in Plate 9, Fig. 1, a plan of plain gauze; of this we may produce some varieties. If, for instance, we have every alternate pair of threads crossing in opposite directions, that will give a slight variation, but it will be more effective if the weft thread be very thick; it will throw it up as though it were a series of small spots. Again, further variety may be given to it by using thick and thin weft alternately, or by using a given number of picks of one thickness and a number of another; or other similar means may be resorted to for the production of special effects. Again, a further variety of plain gauze may be made by having two pairs of threads crossing in one direction, say, from right to left, and at the same time two pairs crossing in the opposite direction. It may seem absurd to speak of forming patterns with plain gauze, but what we mean by plain gauze is where one end crosses one, and that at every pick, the mere reversal of the direction of crossing, or the use of threads of various thickness, although it produces pattern, still leaves the structure of the cloth equal to that of a plain gauze, so that we speak of it as such, but when we vary the order of crossing, then it may become a *fancy* gauze.

A very pretty example of figuring with plain gauze, by reversing the crossing, and in which weft threads of different thickness are used, is shown in Plate 9, Fig. 2. Although in the order of crossing, with the exception that they are reversed, the cloth is quite plain, yet the combination of this reversal with the different thickness of the weft threads produces quite the effect of a figure.

89. Figuring by various orders of Crossing.—In a great many instances of the production of patterns by varying the order of crossing, a number of weft threads are allowed to come together so as to form one; they then separate, some of them after separation continuing single for some time, then rejoining the group, others leaving one group to form part of another, and so by

varying the division and bringing them together at different points forming a distinct pattern. An example of this mode of working is shown in Plate 9, Fig. 3.

This method of figuring, as may be seen, is capable of great variation, and, as compared with plain gauze weaving, will give more weight of fabric; for while in plain gauze every pick is kept quite distinct, whether we reverse the crossing or otherwise, in this mode of figuring more picks run together to form one; and although they may separate and form part of other groups, yet the fact of a number of picks running together, even at different points of the fabric, will permit of a greater number of picks per inch being inserted, and so give more weight to the cloth.

In addition to the mere formation of patterns in the gauze in this manner, we may combine any two or more of these orders of working for the production of stripe check or distinct figured effects. For instance, we may take the patterns shown in Figs. 1 and 3 (Plate 9) and form a stripe with them, or in like manner any two workings or patterns; but there is one thing we must very carefully observe in doing so. We say that Fig. 3 will permit of a greater number of picks per inch of the same yarn than would Fig. 1. If that be so, and we combine them together in stripe form, we cannot put as many picks per inch into the cloth as will make the stripe formed of Fig. 3 pattern perfect without at the same time forcing too many into that formed with Fig. 1. Indeed, what will most likely happen will be that the plain gauze stripe will not permit the number of picks being inserted which can make the other perfect; and even if it did, the warp forming the plain stripe would become very tight as compared with the other, and the gauze would not have a sufficiently open and perforated appearance as compared with the fancy one. Then we must adopt some means of counteracting this; we must have both stripes equally perfect in their structure. We may easily do this by allowing two or more picks—ac-

ording to the pattern of the fancy stripe—go to form one of the plain gauze. By doing so we can bring both to the same density of structure very readily, and also give more openness to the plain gauze.

It would be an easy matter to give a great many patterns of gauze made upon this principle, and some of them very nearly approaching the appearance of lace, and if we were writing a history of gauze we might show some most excellent and elaborate patterns produced in the days before the lace frame made such progress; but at the present time their manufacture could not be carried on profitably.

90. Combination of Gauze with other Orders of Weaving.—It is not so much in producing pattern by variety of crossing as by combining gauze with other forms of structure that such fabrics are made at the present time, and in this we may manufacture fabrics which do not come at all in competition with the lace or net goods.

We will endeavour to deal with all the most general combinations, and show both the method of forming patterns and the chief characteristics of each kind of combinations.

We will begin by taking those combinations which most nearly approach pure gauze, and which are, in fact, intended to convey to the mind the idea of pure gauze, and at the same time produce a heavier fabric, with more marked perforations, without making them actually coarse by using thick yarn.

If we refer to Plate 9, Fig. 4, we have a pattern which is a combination of gauze and plain cloth, but which presents to the eye the appearance of pure gauze. The warp is divided into sets of four threads, and in the crossing two of those threads cross the other two; at the same time there are four picks of weft which appear to go in as one. But those four picks are effectually separated by one pair of ends out of each alternate set interweaving with them as plain cloth, and the next

set of four picks weaving plain with two ends of the next set of warp ends; the result of this plain weaving being that, instead of the four picks which go into the cloth apparently as one, forming a thick rope, as it were, they are spread out and laid side by side, and form more of a ribbon-like structure. The effect of this, both in the appearance and in the structure of the cloth, is much better than if the four picks had gone in absolutely as one. The gauze effect is quite as good, the perforations being clearly marked, and the cloth is somewhat stronger, without appearing quite so bulky. In some instances, where it is desired to spread the weft even a little more than is done in the pattern before us, two of the four threads would weave plain with one set of four picks, and the other two with the next four. This would make the cloth a little firmer again, and prevent any possibility of any of the picks getting too close together or one on the top of another. A very simple and effective method of combining gauze with plain is shown in Plate 9, Fig. 5, where two or more threads are weaving plain with the weft all through the piece, and a thick figuring end, as we might term it, is forming gauze by crossing and recrossing round the ground ends. In this pattern the effect is somewhat similar to that of the previous pattern, but the thick gauze thread gives it a good effect. Again, sometimes the gauze thread weaves plain into the ground along with the other ends, and then crosses round them, as shown in Plate 9, Fig. 6.

In all the patterns we have shown so far all the crossing threads are crossing at the same time, so that the division between the picks is all across the piece. Certainly some of the threads are crossing in opposite directions at the same time. Even by this method of working we may produce some very pretty effects.

The patterns shown in Figs. 2, 3, 5, and 6 (Plate 9) would have somewhat the appearance of net. The perforation would all run in straight lines, but the threads would be drawn out of the straight line, and by some being

drawn to the right and others to the left, a distinct net pattern would be formed.

Although such patterns may be very pretty, much better effects may be produced by varying the crossing; that is, by not letting all the threads cross at the same place. Take, for example, Plate 9, Fig. 7, in which the crossing threads form a distinct pattern. Another very good specimen is given in Fig. 239, p. 250, of my "Treatise on Weaving and Designing," 2nd Edition; and did our space permit we might give numbers of illustrations all showing patterns of gauzes crossed in different manners, and producing some of the most beautiful effects in the fabric.

When we have obtained all the patterns we can in the gauze, though they make pretty fabrics in themselves, we may treat them as the basis for further ornament. We may combine any two of the different orders of working, and produce stripe or other patterns, or we may figure upon the gauze grounds, or form figures of gauze upon plain or other grounds.

We have already shown the combination of plain with gauze in one simple form. Before entering too fully into the question of figuring with gauze, we may examine a few more simple combinations of a different character. Sometimes the introduction of gauze into a fabric is not so much for the purpose of ornament as to obtain lightness of cloth or openness of texture, and, as we have already shown, there is no better means of obtaining light open texture combined with strength than the use of gauze, and by combination of gauze with plain or other orders of working we may regulate the weight and bulk of the fabric. Take the example shown in Plate 9, Fig. 8. We have three picks of weft weaving quite plain, then a crossing takes place in the warp; there are three more picks of plain, and another crossing takes place. Now this cloth is as nearly as possible a plain one, the crossing which takes place is not what is termed a full gauze, but only a "half-cross;" that is, after the

crossing thread has changed from one side to the other of the straight thread it remains there for some time before crossing back again, all the time weaving plain with the weft. That being the case a division takes place, or the weft threads are held apart by the crossing of the warp threads at every three picks. This division will be equal to at least the diameter of the crossing thread of warp, and it will certainly be greater than that between two picks of the plain portion of the piece, and will therefore show an opening or "crack" all across the piece; consequently there will not be as many picks per inch as if this crack did not exist, and as a matter of course the more frequently these cracks occur the less weft the piece will contain. Sometimes what is termed a full gauze pick is introduced; that is, the warp crosses on both sides of one pick of weft, as shown in Plate 9, Fig. 9, the distances between the gauze picks being varied according to the weight of cloth required, or the effect desired to be produced.

If we wish to combine plain cloth and gauze in stripe form, we must consider the relative structure of the two cloths. We will suppose in the first instance that we wish to have a stripe running the length of the piece plain cloth and gauze alternately, and we have the same number of threads per inch in both. The plain portion will be a very loose fabric and the threads would slip upon each other and fray; that being the case we must either have a greater number of ends per inch in the plain stripe, or adopt some modification in the gauze. If we increase the number of ends in the plain stripe, or the diameter of the threads of which it is composed, or, what would be better, combine the two alterations, we may make it sufficiently firm, but we shall have increased the weight very considerably, and it is not desirable that there should be such a great difference in the weight of two portions of the same fabric as would necessarily accompany this arrangement; then we must resort to the expedient of altering the

gauze so as to enable us to put more weft in. This may be done by simply letting a number of picks go into the gauze as one. Suppose, for instance, it should require sixty picks per inch in the plain cloth to make it such a cloth as we require, we could not possibly put sixty of such picks into the gauze portion, with the warp threads crossing between each one; but if we allow two, three, or four of these picks to go into one shed between each crossing, then we can get them in quite easily. If two picks go in between each crossing, it reduces the number of crossings to one half, and the two go together to make one pick, and consequently occupy much less room. The most common practice is to put three or four picks together, but this will be regulated by the quality and weight of cloth required.

If the stripes are to be across the piece, then a different mode of working must be resorted to. We may, perhaps, put more than one pick together in the gauze, so as to give more decision to the perforations, but we must alter the warp threads. We have up to now been speaking of the gauze ends as single in the warp, but we may put any number together. Suppose we want our plain stripe to be finer than the gauze in the proportion of two threads to one; then when we are weaving the gauze, two threads go together as one, and the gauze shows two threads crossing two, but the moment we begin to form plain cloth they separate and work independently of each other. This method of altering the gauze, putting a number of threads together either in the warp or in the weft, or both, is the most ready and efficient for forming either stripes or figures. If in making patterns which are combinations of gauze and plain cloth we do not desire to have quite so much or so striking a difference as is shown between gauze and plain, the gauze having a number of threads together, both in warp and weft, we may obtain a medium between the two.

We have in Plate 9, Fig. 10, an illustration of one mode of dividing the threads of weft after they have

combined to form gauze, and also of intermixing plain in the gauze, and making that which is so intermixed different from the ordinary plain cloth in appearance. For the purpose of illustrating this most clearly, we have shown it as really forming part of a check pattern instead of a stripe; that is, with plain cloth all round the gauze.

The system of forming pattern in stripes or checks, by the combination of gauze and plain cloth, such as we have been dealing with, may strike the reader as being extremely simple. So it is. There is no more simple method of forming patterns upon light fabrics, or of ensuring the lightness of the fabric, and at the same time producing very pretty effects; but in the decoration of gauze fabrics, or using gauze for the decoration of fabrics of other structures, the stripes or checks are the most simple, though even they are capable of giving very great variety, especially if threads of different thicknesses be employed, or if there be a variation in the number of ends and picks which are put together.

91. Figures formed by Combination of Gauze and Plain Cloth.—Though we can produce great variety by combination of gauze and plain in these two forms, we have far more scope when we begin to form figures with them. There may be said to be two distinct methods of combining these two orders of working to form figures: first, figures formed by plain cloth upon gauze ground; and second, figures formed by gauze upon plain ground. We will examine both in detail, so that we may see to what class of fabric each is applicable. If we are making a plain cloth, and we wish to form patterns upon it by giving it the appearance of being perforated, we may introduce gauze working to form the perforations, and by doing so give lightness to the cloth without detracting from the firmness of structure, but rather adding to it. Take, for example, the small pattern, Plate 9, Fig. 11, where we have every alternate pick of weft forming gauze at some point, and the gauze being distributed regularly over the surface of the fabric. As it appears

on the diagram, each of the weft threads forms straight lines, the warp bending round them at the point of crossing. This is shown so for the purpose of giving a clear view of the structure of the cloth; but in the actual fabric the weft threads would not form straight lines, but on each side of the gauze crossing would curve round, disclosing a distinct perforation on each side of the pick, and the thicker the warp threads the wider will the perforations be. The pattern we have here is one which in the cloth would convey the impression of the gauze and plain being in about equal quantities, although really only one-fourth of the interweaving is gauze, but the plain picks are so much bent out of their straight line, and jammed together by the crossing of the warp, that they occupy less space than they otherwise would. This will prove, then, that greater firmness is obtained in the cloth by the introduction of the crossing than if it were all plain. If the weft threads can be so much bent out of their straight line, and, as it were, pushed closer together by the gauze, they cannot be so firmly interwoven with the warp; the relative quantities or thicknesses of warp and weft threads cannot be such as to make a satisfactory cloth, were it not for the presence of the gauze. These remarks will apply all the more if the weft threads are soft; that is, loosely twisted together or made of soft materials.

We have in this pattern a medium between pure gauze and plain cloth. It contains more material, is closer in texture, and heavier than if it were pure gauze, but not so close, compact, or heavy as a plain cloth. It presents the chief characteristics of the gauze, with some of the qualities of a plain cloth, or, in other words, it has the decorative features of gauze with the wearing properties of plain cloth. If we wish to make the perforations more marked, we can easily do so by letting the crossing take place with more than two ends; that is, let two ends cross over two, or more; or, let a number of picks go together to form one in the gauze.

By resorting to either expedient we may have the plain portion both closer and heavier, and the gauze portion quite as open, or even more open, than in the combination of simple plain gauze with plain cloth.

We must, however, consider the character of figure most suited to this class of fabric, and the effect upon the cloth. An examination of a figured gauze will immediately reveal the fact that where the crossing of the threads takes place, a greater length of warp yarn is taken up than where there is no crossing, even in a small simple pattern like that shown in Fig. 11 (Plate 9), but if the gauze be further extended it will be even greater. In fabrics consisting of a combination of plain and gauze, for the most economical production, the whole of the warp should come from one warp beam. Such being the case the gauze must be distributed as equally as possible, so that one portion of the warp, by reason of a greater amount of gauze being formed with it, shall not become tighter than the rest. Then, if we are forming spots, they must be very equally distributed, so that every thread has its equal share in the formation of gauze. Again, the figures must not be too large, or occupy too much space at once, and the gauze must be considerably less in quantity than the plain, otherwise the plain portion of the cloth will be too thin, and the threads will be too loose upon each other.

92. Distribution of Gauze Figures on Plain Ground.

—We have already pointed out in reference to spot figures what is the best method of arranging the spots so as to secure equal distribution, and what was said there will also apply equally to gauze spots, and it is even more imperative that the rule should be observed than in ordinary warp or weft spots, so as to secure uniformity of texture. But we may not always desire to produce spot figures; it may be that we wish to have figure or gauze working running all over the fabric, in fact, to imitate to some extent lace; then we may adopt scroll patterns, or any other which will give such effects as we

wish to produce. If we do adopt such figures we must be extremely careful in their arrangement, so as to ensure equal distribution. We shall generally find that geometrical designs are best adapted to this class of figuring, not necessarily of the stiffest character. We may introduce some freedom of design, but if we have a geometrical basis we shall be more certain of obtaining equal distribution. Of course, we are speaking now of the combination of pure gauze; that is, one end crossing one, and only one pick between each crossing, with ordinary plain cloth, and the gauze forming the figure.

93. Plain Figures upon Gauze Ground.—When the figure is formed by plain cloth upon gauze ground, the conditions of the structure are different. We obtain only a very light cloth if the warp threads are one crossing one and at every pick. The mere fact of so much crossing taking place—the greater part of the fabric being gauze—will necessarily make it a light open fabric; that being the case, any figure formed by plain cloth will be very loose. No matter whether the figure be large or small this will apply; but it would of course be more apparent in large than in small figures. If extremely light fabrics are desired, this mode of figuring may be resorted to, and some very pretty effects obtained; but as in the case of gauze figure upon plain ground, there must be very perfect distribution, and if the figures are so small that the pressure of the warp in the crossing can push the weft picks a little closer together in the plain, the appearance may be very much improved, for not only will it make the plain look finer, but the curvature given to the weft threads will give a more novel effect than if they were quite straight and parallel to each other.

It may be observed of gauze cloths, as differing from all other woven fabrics, that instead of keeping the threads of either warp or weft parallel to each other, the object very frequently is to draw them out of their parallelism as far as possible.

94. Warp or Weft Figures upon Gauze.—This com-

combination of gauze and plain is the most simple form of ornamenting gauze fabrics, no matter which of the two predominates or forms the ground. In addition to this system of figuring we may also resort to warp or weft figures, as in ordinary fabrics, but we must not be under the impression that when we do so we can figure as readily and with the same results as figuring on ordinary fabrics.

In the first place, if our ground cloth be an ordinary plain gauze, of the type of which we have been speaking, and we suddenly cease to form gauze, and leave the weft and warp quite free of each other, neither of them would be present in sufficient quantity to cover the other. And as it is usually one of the first conditions in figures that the material which comes to the face shall quite cover that which goes to the back, so as to present a solid appearance, it could not give a satisfactory effect if the warp and weft were both visible, one through the other, in the figure. Again, the sudden transition from gauze—the firmest possible structure of fabric—to absolute looseness, the warp and weft not interweaving at all, would be too great. If we wish to have either warp or weft figure upon gauze ground, we must separate the figure from the gauze by plain cloth. This will to some extent modify the looseness of the figure, and, what is quite as important, it will give it most clear definition. If we were to change direct from gauze to figure, the figure could not be clearly defined, especially if it were large, and its outline at all indented; but by bringing in the plain all round it, it is formed just as upon an ordinary plain fabric. Another question arises also; the figure must in all probability be bound down more or less. This binding will be more in harmony with the ground surrounding the figure if it be plain than it would be if gauze. We still, however, have the difficulty of want of fineness, not only in the plain which surrounds the figure, but more especially in the figure itself. If the figure is to be formed with the weft, we may resort to

the expedient we have before mentioned — namely, putting more than one pick of weft in one shed; and this we may vary according to the size of the figure or quality of the cloth. By doing so we shall not only make the figure “cover” better, but we shall add to the fineness and firmness of the plain portion without detracting from the openness of the gauze. If the figure is to be formed with warp, we may make a number of ends work together in the gauze, and then separate them in the plain, so making sufficient fineness, and making the warp figure cover the weft. We may also combine the two methods, a number of ends going together as one, and a number of picks going together as one in the gauze, thus increasing the fineness of the plain and the weight of the cloth to any degree, without interfering with the openness of the gauze, unless it be to make it more open. To begin with, suppose that we only want to increase the fineness in a slight degree in the warp, and to obtain the requisite increase of ends we let them work in groups of three, one crossing two—that is, one end working by itself, and two working as one along with it when forming gauze, but separating for plain, as shown in Plate 9, Fig. 12.

When the crossing is of this description, the crossing threads may go all in one direction, or they may cross alternately in opposite directions, as shown in the figure; but in either case when they separate they must form perfect plain cloth. In arranging designs upon the squared paper for this kind of crossing, perhaps more care is required than for any other kind, because the gauze threads being arranged in threes, and the plain having alternate ends alike, or, as it were, working in pairs, each end must be properly arranged, or a fault will occur in the plain. Now, if we form warp figures with the ends arranged in groups of three in this manner, and we do not separate the figure from the gauze by the introduction of plain, our warp threads will be laid in groups of three, which will look like one thick thread.

Our object must be to distribute the threads; then we have no alternative but to introduce some plain so as to effect this separation and distribution. The more general practice in figured gauzes is to arrange the threads in groups of four, two threads together as one throughout, and crossing each other in pairs, as shown in Plate 9, Fig. 13, and separating to form plain as before. This has the double advantage over working with three threads of making the cloth still finer, and giving us even numbers of ends to deal with at once. In such cloths, however, the mere increase in the warp threads is not enough usually, we must also increase the weft threads by putting two, three, or four together in the gauze and separating them in the plain. Now, in many instances we may desire that our figures should be not merely loose warp or weft on the surface, but, perhaps, bound in satin order, after the manner of damask or such figures, so that it is absolutely necessary to obtain fineness in the figuring portion; but no matter how the figure may be formed, the almost invariable rule is to surround it with plain, so as to ensure the proper separation of the threads before the figure is formed. This plain need not be more than a few ends, but it must be there. Another feature of gauze figures is that a true even outline cannot be formed as in patterns upon plain or satin ground, the threads running together in groups of, say, four; all these four will cease to form gauze at the same time. One portion cannot be making gauze while the other portion is making plain or figure, therefore the outline will form a series of steps, not a steady, free line. This difficulty is even more apparent in flowing curves, the steps interfering very much, in some instances, with the beauty of the curve, and requiring the utmost care in reducing the interference to a minimum.

Perhaps it will not be out of place here to say a few words upon the mechanical operations required in gauze weaving. Our excuse for doing so must be that existing treatises on weaving do not deal in a sufficiently

complete manner with the subject, as applied to the looms of the present day.

The general principle of gauze weaving is fully treated in the "Treatise on Weaving and Designing" before referred to, so far as the formation of gauze in small patterns and stripes is concerned; and more fully in the excellent treatise on the "Art of Weaving," by John Murphy. But Murphy's book was written before figured gauzes of the class now mostly used were developed by the Jacquard machine, which was at that time quite in its infancy; and, again, most of the fancy gauzes of which he treats are such as could only be woven in the hand loom by careful weavers, because of the complication of cordage, and the delicacy of manipulation required; and besides, such goods have been entirely superseded by the lace frame.

In the "Treatise on Weaving and Designing," the use and construction of the doup heald are fully explained, as also the use of several doups along with healds for forming patterns in the gauze, but nothing is said of Jacquard harnesses for weaving figured gauze. If all the doup healds are attached to one heald shaft it will be obvious that they will all rise together whenever that shaft is raised; and if we use two or even three heald shafts for the doups, it is evident that our orders of crossing will still be limited. But even limited though it be, under certain conditions we may make great variety of patterns; for instance, such patterns as that shown in Plate 9, Fig. 11, can be woven quite easily, either with healds, or a common Jacquard harness and one doup. Although all the ends are not crossing at the same time, the crossing end is drawn through the doup and through one of the ordinary healds at the same time, but is carried under the thread with which it works *between* the common heald and the doup, so that as the common heald rises, it will take it to one side of its companion thread, and when the doup rises it will take it to the other side. Now, if we have half the threads drawn

through the doup heald, and each through a separate common heald, so far as the pattern goes—as, for instance, in the pattern before us, there are eight separate threads—we shall require eight common healds, each thread drawn through one of them, and the first of each pair also through the doup. If the ends are crossed from the common heald to the doup, from left to right, whenever we raise the doup all those ends will rise on the right of the threads they cross; then if the pattern is to be a combination of gauze and plain, as in this case, we lift the doup at every alternate pick of weft; and if we wish to form gauze at the next pick we raise the common heald carrying the crossing thread, so bringing that thread up on the left of its companion, as shown in the figure; and if we wish to form plain we raise at the second pick the thread which *does not* go through the doup. If we now substitute for the eight common healds, a Jacquard machine, where we can actuate each thread separately, and we place in conjunction with that a doup heald, and draw the ends through the doup in the manner described, it is very evident we can produce any variety of figure which is a combination of plain cloth and plain gauze, or we may make warp figures upon the plain, or further, we can combine plain gauze with twill, or make one end cross three or any number; but if gauze is forming at some point throughout the piece we are necessarily confined to one pick in a shed, and to one end crossing at once, and all ends which do cross must cross at the same time and in the same direction. True, we may give some variety by using more than one doup, but still we should be confined to certain classes of figure; then if we wish to figure freely, and at will, we must resort to what is known as a gauze harness—that is, with douns formed in the harness of the Jacquard machine; this provides that each set of threads has its own separate doup, which may be brought into use at will, so enabling us either to vary the direction of our crossing, or the number between each crossing as we please.

95. Combination with other Orders of Working than Plain.—We may now proceed to examine a little more in detail the combination of gauze with other orders of weaving. We have shown pretty fully how it may be combined with plain, and how the fineness of the cloth may be increased to almost any degree, and also, to some extent, how figures may be formed with warp or weft, or both. When we are figuring upon a gauze ground, we may vary both the form of the figure and the order of interweaving of the weft with the warp as we please, provided, as we have already said, we surround the figure with plain, so as to prevent the gauze from interfering with the outline, and the ends from running together in groups. Having done that, we are as free to figure or introduce twill, satin, or any other order of working, for the purpose of obtaining special effects, as if our cloth were an ordinary one with no gauze in it. Not only that, but we may vary our gauze; we need not necessarily keep to the plain form of gauze working, either with single threads or a number thrown together, but we may adopt any of the forms of gauze such as those shown in Plate 9, to make the ground-work. It is not necessary that we confine ourselves to the gauze forming the ground of the cloth. Very frequently we may desire to produce a somewhat heavy cloth with a simple twill or satin ground, and in order to give a light appearance to it, we may introduce a gauze figure. Or the ground may be a figured one, such as a rich damask, in which case a small portion of gauze introduced into certain parts of it will give lightness; by this means some of the richest and most beautiful fabrics are produced. We often see in silk goods that some of the choicest fabrics are combinations of this character; in fact, there is no limit.

Quite apart from the combination of gauze with plain or warp or weft figure, we may also produce excellent effects by combining two orders of gauze working, one forming the figure upon the other, but, of

course, in such cases the cloth must necessarily be a light one ; and if one portion of the gauze be much firmer than the other, the remarks which we applied to the combination of gauze with other orders of weaving respecting the proper distribution will apply to it also.

Having examined the combination of gauze with plain to form figures, we may now examine the combinations with other orders of weaving, for the production of effects of different characters. We have already referred to the formation of plain stripes upon gauze ground, and pointed out the necessity of either putting a number of picks together in the gauze, and separating them for the plain, or having a greatly increased number of ends in the plain stripe. In many instances the latter arrangement is preferable ; by increasing the number of ends we may, by using these ends of a different colour from the ground ends, show a distinctly coloured stripe. The closeness of the warp threads will so completely hide the weft that the colour of the warp only will be seen ; consequently, the weft and the gauze warp may be of the same colour, and so show a difference between ground and stripe. We may also form checks on the same principle ; let the stripe in the warp be formed exactly as above described, and to form the cross stripe use thick weft, and instead of weaving gauze into the ground let it weave plain, so that the gauze warp will be hid in the thick weft in the same manner as the gauze weft is hid in the thick warp. This mode of working has also another advantage apart from the question of colour ; the contrast between the compactness of the stripe and the openness of the ground makes the pattern most striking.

In some cloths more substantiality is required. Instead of forming plain stripes upon gauze ground, gauze stripes upon plain ground are formed, and with very pretty effect. We give one illustration upon Plate 10, where we have a drab ground and a pure white stripe ; of course we use white weft only throughout, and white warp in the gauze stripe, the ground warp being drab,

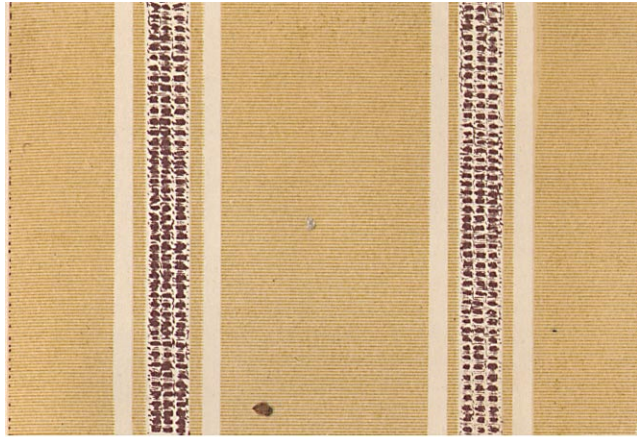


PLATE X.

and so closely set as to completely cover the white weft.

Perhaps a more effective method of forming stripes upon gauze is to work the stripe as a satin. We can then give any degree of fineness to it, and present a perfectly smooth surface. Some of the most beautiful examples of striped gauze have the stripe worked in satin. This class of stripe also gives some pretty effects when a little figuring is introduced into the gauze ground, and nothing is lost if the figure be run over ground and stripe indiscriminately, and more especially if the figure be formed with weft satin. In such case it becomes necessary to put a number of picks together in the gauze, and also sometimes a number of ends also, so as to give sufficient fineness to the figure, and make it cover well enough.

96. Combination of Gauze Figures and Figuring with extra Warp.—From what we have said, it will be clear that a great variety of effects may be obtained by combining various orders of weaving with gauze, and using only the material which takes part in the formation of the ground fabric; but, as in other classes of cloths, this variety may be very much increased by the introduction of extra material, warp or weft. It must, however, be borne in mind that we have not the same freedom for the use of extra material upon gauze cloths that we have upon simple plain or figured fabrics.

In these cloths we may use extra warp or weft, or both, forming figure on the face, and then passing to the back, and being bound to the back of the cloth, instead of being cut away. We cannot do the same upon gauze—the open texture of the cloth would show it; we must either use only what will form the figure, or we must cut the waste away from the back. Again, for reasons we have pointed out in reference to ordinary warp or weft figures, we cannot very well figure upon the gauze itself, but must form a plain ground upon which to do so, in order that when we

introduce extra materials to form figures, we must also figure to some extent with the ground material also. In speaking of figuring with extra material, at present we are speaking of it as an extra colour; in fact, as a means of giving more variety of colour to the pattern, but we shall shortly have to speak of the use of extra material for a different class of figuring; however, in the meantime we must confine ourselves to the use of it as an additional colour. Figures made with extra warp, whether upon gauze or other grounds, must either be arranged stripewise, or the whole surface of the cloth must be figured. It does not necessarily follow that in all fabrics the figures appear to the eye as being in stripe form, even though they are so arranged, whether the loose material be cut away from the back or not; but in gauze cloth unless the material be cut away from the back they *must* appear in stripe form. The figure, as we have shown, must be formed upon plain ground. If when it is completed we change the structure from plain to gauze, and leave the material on the back, it will be clearly visible through the gauze, and being visible as so much loose material it would not add to the appearance of the fabric; then it must be cut away. Before being removed the same rule must be observed as in figuring upon ordinary fabrics, of binding it round the edges of the figure, so as to prevent it slipping out. Then if we wish to avoid the cutting off at the back, we must make the plain continuous throughout. Although this is a disadvantage, as to some extent crippling us in our power of producing patterns, yet we may obtain some very pretty effects in stripes; one simple example is shown in Plate 10. In this we give coloured and white stripes alternately, but we may have other colours at will, and not only each stripe of a different colour, but several colours in each stripe. One ready means of introducing more colour, without adding much to the weight, is to let the extra warp take the place of the ground warp in forming plain cloth under the figure. For instance, if

we wish to have two colours in the stripe, whilst one of them is forming pattern on the face, the other is forming plain cloth under it, and they are constantly changing places according to the pattern, each forming figure and plain alternately.

97. Figuring with extra Weft upon Gauze.—Figuring with extra weft upon gauze frees us from the necessity of making the figures in stripe form. If the weft be thrown all across the piece, we shall, of course, form stripes in that direction, but we may use the swivel shuttle, and so place our spots as we please, exactly as if we were figuring upon a compact cloth as shown in Plate 4, instead of upon a perforated fabric; the same rule will, however, apply to these as to extra warp figures, of the cloth being plain under the figure. Indeed, no matter how we figure upon gauze, we must have plain cloth somewhere about the figure. We have no other means of distributing the warp and weft threads, or of securing the proper form of the design. When we are using extra weft, we have all the advantages and opportunities of ornamentation which can possibly be obtained, for we may not only combine figures with gauze, but we may combine all the forms of figuring—plain figure upon gauze ground, gauze figures upon plain ground, loose weft or warp figure, figures formed after the character of damask, or with extra material in any colour or any number of colours. We may make extremely light fabrics, or we may give to heavy fabrics the appearance of lightness by the introduction of gauze figuring. Sometimes very pretty effects are produced by figuring with extra weft of the same colour as the ground, but in different material, or in thicker yarn of the same material, so giving prominence to it merely by the thickness of the yarn.

98. Combination of Gauze and Plush.—We have not yet, however, quite exhausted the means of ornamentation of gauze cloths. In addition to the methods we have already described, we may introduce pile or

plush figures. There are two distinct methods of doing this: first, when the pile is formed upon gauze, and second, when the pile is formed upon plain surrounded by gauze. Now as to the figures formed by pile upon gauze ground, we have the means of obtaining pretty and novel effects. The ends of warp which are to form the pile assist also in forming the gauze. Plate 9, Fig. 14, shows a longitudinal section, indicating the manner in which the threads twist round each other, and how the loop of the pile is formed. In this it will be seen that one of the three threads is constantly twisting round the other two, and at intervals one of these issues from the cloth and forms a loop. The manner in which the loop is made will be fully explained in the next chapter; we merely wish to call attention here to the fact of its being formed. On each side of the loop formation a weft thread is inserted, represented by the dot, and the crossing thread passes from one side to the other of both the loop thread and its companion. This constant twisting taking place, the loop thread is held firmly between the straight thread accompanying it and the crossing thread, so that whatever loop is formed it is held rigidly just as it is made. Sometimes it is cut, so forming velvet pile; and even though there is really no solid cloth under it, it will be so firmly bound between the ground threads that there will be no fear of its slipping out or being easily pulled out.

In the second class, as it may be termed, of plush figures on gauze, instead of the pile being formed actually upon the gauze, plain cloth is formed by a portion of the threads and the pile by the other portion, as shown in the section, Plate 9, Fig. 15. By this system, all the threads share in the formation of the gauze, as in the other, but when we come to the figuring they are separated into two portions—one for the ground cloth and the other for the pile—so that a solid cloth is formed in the ground. The pile is not held so firmly as

in the previous case, but still sufficiently so to make a serviceable article, and it has the advantage of making a more solid structure. There is necessarily more warp employed, more threads running together in the gauze, and consequently a heavier cloth. The principle of the formation of the pile is the same in every respect, but it issues from the plain cloth instead of from the gauze cloth. The pile may be cut or uncut, exactly as in the previous case.

Beautiful effects are produced by this combination of gauze and pile weaving; but of course the pile is of the same colour as the ground, when the figuring is distributed over the whole surface. Sometimes, however, the plush is made to form stripes; then different colours may be introduced, or, indeed, we may have coloured figures all over. But as the pile threads have to take part in the formation of the gauze ground, if we have two colours of warp the ground will necessarily partake somewhat of the colour of the figure, though modified by the presence of the second colour; but where the figure runs in stripe form it may be totally different from the ground. To give variety to figured goods of this description, we may combine with the pile or plush figuring any or all of the other modes of figuring we have referred to. If the figure run in stripe form, we may combine with it figures formed by extra warp, or plain, satin, or other figures in the ground. If they are distributed all over the surface, we may introduce extra weft and any other forms of ornamentation, and so make our patterns as elaborate as we please; and again, instead of the gauze being an ordinary plain one, with any number of threads running together, we may use any of the fancy gauzes—such as are shown in Plate 9—so that by the contrasts of colour, or such as are produced by the variety of structure in the fabric, we may ornament to an unlimited degree, and in all cases produce pleasing effects.

99. Lappet and Whip—net Figures on Gauze. We

have now but two forms of ornamenting gauze cloths to refer to, both of which have to some extent been anticipated—first by lappet threads, and second by threads crossing over wide open spaces. We give an illustration of lappet figuring in Plate 9, Fig. 16, and of the crossing threads over open spaces in Fig. 17. In the first we have an ordinary plain gauze ground, with single threads forming figures by being stitched as it were over the surface; this stitching is done in the manner described at Art. 85. By this mode of figuring considerable variety may be produced, but all by a series of single threads. An appearance of solidity might be given to the figure by crossing and recrossing in quick succession, say at every pick, but generally such effects as shown here are more aimed at. This mode of figuring is seldom combined with others, being usually applied to fabrics of very light texture. The same remark will apply to the class of figuring shown in Fig. 17, but the designs are of a stiffer character. This arises from the fact that each thread is arranged to be brought into the cloth only at two certain points in relation to the warp threads, though their positions in relation to the weft may be varied—that is, the number of picks inserted between each point of interweaving may be varied, but the number of ends cannot, in the same piece of cloth; therefore the figures must partake of a stiff character, this stiffness only being modified by a varied arrangement of the order in which the ends are drawn through the doup, and consequently the manner in which they are manipulated. However, both lappet and this form of figuring will partake more or less of the stripe character, though the stripe may be almost hid by the variety of lines introduced.

100. The Materials from which to make Gauze.—One necessary part of the design of gauze fabrics is a proper consideration of the structure of the threads from which the cloth is made. From the nature of the

cloth, its open perforations, and the necessity for the pattern being very clear, threads of a smooth even structure, with little or no loose fibre on their surface, are best adapted. Silk being a long continuous smooth filament is best suited of any class of yarns. Next come cotton and linen, for although they may have a little loose fibre on the surface of the thread, yet it will be very little, and not likely to interfere much with the clearness of the pattern. We may also use worsted yarns, but they will not give the same clearness of pattern as the other three, especially if not made from the finest wools. Woollen yarns are quite unsuited for making gauze cloths, as are also the coarser cottons and tow yarns; though, if well twisted, they may be employed in making the heavier goods when gauze is combined with twill or other forms of working, and where clearly defined patterns are not needed. It is not only so as to obtain clearness of pattern that smooth even yarns are required in making gauze, but it is necessary to have a strong thread in the warp at any rate. When the crossing takes place considerable strain is thrown upon the threads, and also great friction; probably the latter is most likely to do harm. If the thread is not strong and well twisted, it will soon give way under the friction, and if it has much loose fibre on its surface, there will be a great amount of friction in the threads passing each other, and also in passing and repassing through the eye of the heald, so that the smooth thread is as necessary to the successful operation of weaving as to the clearness and definition of the pattern. In fine woollen yarns with the thread sufficiently twisted as to give strength to the yarn to bear the work it has to do in the process of weaving, some excellent effects are produced by the combination of gauze with other orders of working, chiefly with twill in stripe form, but the texture must be very open, the threads being set a sufficient distance apart to reduce friction to the lowest point, so

as to obtain all the ease possible in weaving, and even then the pattern of gauze will not be well defined, but will be partly hid by the loose fibre on the thread. Perhaps it is this want of definition which gives the charm to this class of fabric; the perforations are not clearly marked, there is a kind of hazy mystery about the pattern which probably renders it more attractive than if it were well made out, and what adds to the attractiveness is that the character of the gauze is quite in keeping with the body of the cloth. At any rate, some really charming fabrics are made in this manner, but they require great skill in the use of the material, because of its soft fibrous character and the amount of friction thrown upon it in the process of weaving.

101. Madras Muslin.—It may be necessary to refer to and point out the chief characteristics of some fabrics which bear a strong resemblance to gauze. In the first place, there are several varieties of extremely light texture, which at first sight, from their very lightness, would lead one to suppose they were gauze, but which are not necessarily of that material. The term gauze is often applied indiscriminately to all cloths of a light open texture, without regard to the mode of interweaving of warp and weft; but this habit is very misleading to the technical student. One class of fabrics, which gives pretty effects upon a light cloth, is known as Madras muslin. This is a very light texture indeed, with a figure formed by the introduction of a thick thread of weft into the ground and then cut away where no figure is formed, so that it is really an alternation of thick, or moderately thick, and very thin, light cloth. Similar effects are also produced in fancy coloured goods, two or even three colours of weft being employed to form figures, sometimes one weaving plain into the ground cloth, and the other figuring upon it, and sometimes both entering partly into the ground cloth, and figuring alternately; and, as in the previous case, when no figure is being

formed the extra material, which would otherwise go to the back, is cut away. In the arrangement of patterns for such fabrics we should be guided by the same rules as for figures upon ordinary fabrics; the only difference being that the ground cloth is of a much lighter texture, and the figuring weft in a great measure goes in when the figure is formed, as an ordinary ground pick, or partly as a ground and partly as a figuring pick. There must be proper care as to the distribution of figures, and all the other precautions which usually accompany the arrangement of them. We must not omit net and lace in our comparison of fabrics, often confounded with gauze.

102. Net.—Whip net, a class of fabric formerly made, but now almost entirely superseded by lace, was really an extension of gauze weaving of a very complicated character. The pattern given in Plate 9, Fig. 17, may, perhaps, be called a species of whip net, though of the simplest kind. What is termed the whip or crossing thread, is made to pass over a greater distance than in ordinary gauze weaving, and frequently they not only cross what might be termed straight threads, but also cross each other, the crossing of the weft threads between them at the point or points of intersection keeping them in their places. Sometimes these weft threads would be so thin as to be scarcely visible to the naked eye without careful examination; and the whip threads being thick, all the appearance of lace would be obtained by the variety of crossing and interweaving. Although whip net produced some beautiful fabrics, it has been superseded by bobbin net and lace, partly because of the superior figured effects which can be secured, but mostly on the ground of economy.

Bobbin net, as its name implies, is formed by having a series of bobbins, which are made to travel to and fro in a pair of "combs," or bars. A series of threads are placed vertically, and the bobbins, which are extremely

thin, are passed through between them from one comb to the other; they are then returned, *but not through, between the same threads*. A lateral motion is given to the combs, or bars, termed "shogging," so as to move the threads to a different position in relation to the bobbins, thus causing them to pass through between different threads at each movement. The effect of this is to cause the bobbin thread to twist round the straight, or what may be termed the warp thread; and as bobbin and thread are moved at each passage of the bobbin, the bobbin thread is passed round each warp thread in succession, as shown in Plate 9, Fig. 18. Sometimes small spots are formed upon net by one thread traversing a number of times across the "mesh," but these are not large or elaborate, and call for no special skill, except so far as applies to regulating the movements of the machine.

Net very nearly approaches lace in its structure, but in the latter more elaborate designs can be produced.

103. Lace.—It is not our intention to deal at length with designing lace for two reasons: firstly, lace is not strictly speaking a woven fabric, and secondly, because to do justice to the subject it would require a complete work in itself. We shall, therefore, only refer to the general character of the structure of the fabric, and the manner in which patterns are formed, so that we may be able to compare with other fabrics.

If we examine the cheaper kinds of lace curtains, we shall see readily how the fabric and design are formed; and we can then understand more easily the formation of other kinds of lace. In the curtains referred to there is first a straight warp thread; along with this is another, which when no figure is being formed remains with the straight thread; these two have constantly a third thread twisting round them. When figure is to be formed, the figuring warp thread passes from one straight thread to the next, is made fast to it by the twisting thread, then returns to its former position as shown in Plate 9, Fig. 19.

This passing and repassing of the figuring thread is carried on with each one all over the fabric, according to the pattern to be produced.

This is, perhaps, the commonest kind of lace, but it will serve to convey an idea of how lace is made. In other kinds of lace those threads which we have spoken of as straight, and which in the common laces remain straight, are drawn out of their course by the varying strain put upon them. A similar kind of twisting action takes place with the bobbin thread, but the warp threads are varied in their thickness. They are made to traverse varying distances, and are bound to different ends by the twisting of the weft or bobbin threads; this, coupled with the varying tension, causes them to be drawn, and to make any pattern that may be desired.

It will be apparent that lace gives by far the greatest scope for producing ornamental open texture. The whole fabric is formed of such texture; the shape of the openings, the lines made by the thick or the twisted threads are capable of infinite variation, so that the texture may be as light, as open, and as varied as ever the designer may please.

In net we cannot have the same variety; the "mesh" will be of the same form throughout, most generally hexagonal, and any figuring will be limited, usually to small spots; while in gauze weaving we have something which may be said to come in between the two, and is capable of producing effects which cannot be obtained in either net or lace, whilst, of course it cannot give the effects which lace can. In gauze cloths, as we have shown, we may vary the weight and texture in any degree, and at the same time ornament by the texture. We may combine gauze weaving with any or all of the other forms of weaving, and form such patterns as we like. In fact, the combination of gauze with other textures affords more scope for the production of ornamental fabrics than any other class of fabric or

texture. In lace there is not this power of combination, and we are therefore limited to the production of light, open textures.

CHAPTER VIII.

PILE OR PLUSH FABRICS.

104. The Classification of Pile Fabrics.—We have now but one kind of fabric to deal with, so far as the ornamentation in the structure is concerned, and that is the class known as plush or pile fabrics. This class differs in appearance from all others, having on its surface a series of short threads which issue from the cloth, and present the ends of the fibre to the eye, or the threads issuing from the cloth in the same way form a series of loops. We will examine each section in detail, so as to see to what extent the principle of ornamentation can be carried in it, and also its combination with other orders of weaving.

It may be said sometimes that pile fabrics are divisible into two classes, cut and uncut, or cut and loop pile, but that is not a sufficient division. They are separable into two kinds more distinct than cut and uncut—namely, weft and warp pile; that is, when the pile is formed by weft, or when it is formed by warp.

105. Weft Pile.—Let us deal first with weft pile, and examine it in all its forms. It consists in the first instance of a series of weft threads bound into the ground cloth at intervals, and floating over the surface loosely after the manner of a figure. This loose material is then cut by using a long bar of steel made into a knife at the end. This knife is extremely sharp, and is provided with a guide, which is simply a narrow piece of thin sheet-iron doubled so as to form a groove which fits on the knife. As it leaves the point of

the knife, the iron is welded into one piece, and is tapered off to a point, more or less sharp according to the length of the plush to be cut. This point is inserted under the weft floats, and as the knife is pushed forward it raises the weft up to the knife, which severs it, so forming the cut pile on the surface of the cloth. Take, for example, the section of a velveteen in Fig. 87, where two picks of weft are shown, one of ground and



Fig. 87.

one of pile. The ground weft forms with the warp quite a plain fabric, while the pile weft passes under one end only and over seven. By inserting the point of the guide of the cutting knife under this pile thread and pushing it forward the tapering form of the guide will raise it up until the guide just holds it tight, when the knife coming in contact with it severs it, as shown at *b*, *a* being an uncut loop, just as it comes from the loom. Thus the pile is formed.

106. The Structure of the Cloth, and Binding Weft Pile.—We must consider the structure of the cloth most carefully in order to determine the best mode of binding the pile into the cloth, so as to make it serve the most useful purposes, and also the best distribution of the pile over the surface of the fabric. The ornamentation of the fabric may be left for after consideration, or we may deal with it as we refer to the different modes of structure, as well as the uses to which pile-surfaced fabrics may be applied.

The binding of weft plushes into the fabric to secure firmness is one of the most important questions in connection with their manufacture; for if it is not firmly bound it will not, in the first place, permit of its being cut—the knife will pull it away from the cloth; and in the second place, even if it were cut, it would constantly

be coming out in wearing. There would be no power to resist friction, and these are matters which must not be neglected. The firmness of the binding is in some degree dependent upon the compactness of the fabric, the firmness with which the threads forming the ground texture are bound and beat together, and perhaps more especially the closeness of the weft threads, so that the pile weft which is introduced between them shall be gripped, as it were, in a vice. It is also in a measure dependent upon the manner in which the pile weft is interwoven into the ground.

Very frequently the pile weft passes round only one end of the warp, as shown in Fig. 87. Then it may be said of such that it can make no difference how this binding point is distributed, because it will have to depend entirely upon the pressure of the ground picks on each side of it to secure it firmly in the fabric. The fact, however, that numbers of patents have been taken out for different modes of binding so as to make the pile more firm, and even when only passing under one end, proves that there must be something more than the mere pressure of the weft threads, or that this pressure may be increased by the mere arrangement or distribution of the pile. Let us take the case of a pattern of velveteen we have now before us, examine the manner in which it is made, and how it might be made, and see what the effect would be in each case. Fig. 88 is the plan of the cloth.

It will be seen that there are four picks of pile weft, each floating over seven ends and binding under one only. Then there is a plain pick, the four pile picks are repeated, and there is another plain pick. Those two plain picks will form a perfectly plain ground. Now, with regard to the pile picks, an examination of them will show

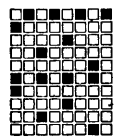


Fig. 88.

that the four taken together would be equal to one plain pick—that is, every alternate end is occupied by them, and the *same four ends* are passed under by

the plain pick immediately following. Then the four pile picks are exactly repeated, and the next ground pick passes under the ends which have been passed over, and over those which have been passed under. Thus the first four plush picks would constitute as it were one complete plain pick, the ground pick a second, and the next four plush picks a third; so that we have an exact equivalent to three picks of weft in one shed, or under and over the same ends, and one in the contrary shed, or under those which have been passed over before, and over those which have been passed under. Now those three picks coming together as one, or, more correctly speaking, the nine picks coming together as three in one, will form one very solid mass when pressed together by the crossing of the warp for the next pick, and the driving of the latter up to the cloth, and each will help to bind the other into the fabric. The nine also becoming one, will allow a considerable number of picks per inch to be put into the cloth, so that we shall have weight, closeness of the pile, a solid compact cloth at the back, and the pile bound firmly into it. But there are other ways of looking at the subject. We may obtain too much weight of cloth if we beat the pick up close enough to make the pile firm. We have been speaking as if we were beating the weft as close as possible in the process of weaving, but if the cloth we have produced is too heavy, and we simply reduce the number of picks per inch, and retain the same arrangement of binding, we shall loosen the pile just in proportion as we reduce the picks.

That will not answer our purpose. However much we reduce the weight we must keep the pile firmly bound. Then suppose we adopt the arrangement shown in Fig. 89; this would have the effect of making each set of four plush picks and the ground pick following it go together as one, so that instead of being practically three picks together as one, and then a single one as in the previous case, they would be

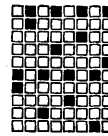


Fig. 89.

double picks throughout. This would possess two advantages: first, the plush would be even more firmly bound, because each set of plush picks is followed by a plain pick passing over the ends they have passed under, and two picks going together as one would make the whole order of interweaving firmer for the same weight, or equally firm for less weight; and secondly, the pile would be binding with *all* the warp, instead of only with every alternate end, as in the previous case, so giving more even distribution of tension upon the ends than before, and consequently a better constructed fabric.

Suppose, again, that the plush picks are arranged in their order of binding, that one portion of them goes into the same shed as the ground pick which precedes them, and the other portion into the same shed as that which follows them, they would require to be arranged so that equal quantities went into each. And even then they could not be held with the same degree of firmness as if they all went into one shed, because the pressure upon them by the ground picks would not be so evenly distributed, there would be a slight degree of waviness given to the ground weft picks which would make them hold one portion of the plush more firmly than another.

Binding the plush with one end of warp is sufficient only when the weft is so closely beaten into the cloth as to exert great pressure upon the pile, and hold it by pressure only; and in a large number of instances there is not enough of this pressure; in fact, it may be said that in the majority of plushes there is not. Then when such is the case we must resort to other means or methods of binding; we must let the plush weft interweave with more of the warp threads. We have a plan in Fig. 90 of

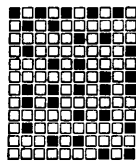


Fig. 90.

a velveteen similar in its arrangement to that shown in Fig. 88, but having the plush pick interweaving

with three warp ends, instead of one only. There are five plush picks to each ground pick; the pattern occupies ten ends instead of eight, but as the plush weft interweaves with three ends instead of one, the length of pile is just the same, floating over seven. The first five plush picks go under the same ends as the second ground pick, so do the second five, so that five complete picks go under every alternate end, and only one—the first ground pick—over them; thus it is equivalent to having five picks together in one shed, and only one in the other. Now this plan will possess all the advantages pointed out in reference to Fig. 88, with the additional one of the plush being even more firmly bound by interweaving with more warp ends. The back of the cloth will present less of the appearance of a plain fabric than even will that of Fig. 88, but it will form decided ribs, and there will be more strain thrown upon that half of the warp under which each plush pick passes. Certainly this strain will be somewhat neutralised by the thread having to pass *over* one only, but it will still be greater than the other portion of the warp. If we arrange the plan as shown in Fig. 91 we shall neutralise this, and give more plainness to the back cloth, and more firmness to the binding. There is, perhaps, one advantage, or so-called advantage, in the arrangements shown in Figs. 88 and 90 over those shown in Figs. 89 and 91—namely, in imitating warp pile. In the latter the pile runs distinctly in rows across the piece, because of its being formed with wires, as we shall show; and the arrangement of Figs. 88 and 90 will give more of the same appearance than Figs. 89 and 91. In each of the examples we have given there are four plush picks to one ground pick, and these four are distributed over the whole surface; but it must not be taken either that there are always four plush picks to one ground pick, or that

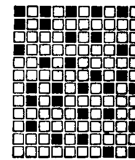


Fig. 91.

the plush picks between each pair of ground picks are distributed over the whole surface; the number of plush picks will be regulated to some extent by the density of the pile required, and the distribution which takes place between each pair of ground picks will be dependent partly upon the number of plush picks to one ground pick and partly upon the length of the pile. For instance, if we were only having two plush picks to one ground pick in such a pattern as shown in Fig. 88, we should only occupy two ends out of the eight, while with the same proportion of picks in Fig. 90 we might occupy every alternate end, so that the order of binding will also interfere with it.

The patterns we have given in Figs. 79 to 82 are what are commonly known as "tabby" velvets, or velveteens; the term "tabby," as used in the trade, being synonymous with "plain." And in such patterns it appears to be a general practice to occupy only every alternate end, and in most cases also

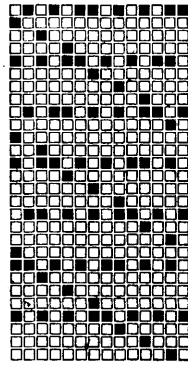


Fig. 92.

to preserve the arrangement shown in Figs. 88 and 90, of having one of the ground picks to go into the same shed as the plush on each side of it. There are some exceptions, and some of these are amongst the patented patterns. One feature of the perfect binding of plush into the ground, which has been made much of by practical designers of fabrics, is that the ground pick succeeding the plush picks shall be contrary to those plush picks in the order of interweaving at the point where they bind into the fabric. This is shown in Fig. 92, where the ground is not quite plain, but nearly so, and the departure from plain is evidently due more to a regard for the proper binding of the plush than from any desire to produce a pattern on the

ground fabric. This is a most ingenious arrangement, and effectually secures the perfect binding of the plush into the cloth. The same principle of arrangement is applicable to pushes of any length, or with any number of picks of plush between the ground picks, or with the plush binding into any number of warp threads.

“Tabby” velveteens, or velvets, are only suitable for the production of light fabrics. The pile may be tolerably dense, but the ground cloth cannot be very heavy, because of the order of interweaving preventing the threads coming very close together; and as the pile cannot well occupy more than every alternate warp thread between the ground picks, the number of them issuing from the cloth in a given space cannot be so large as if there were more ground picks per inch. Then if we wish to increase the bulk or thickness of the cloth we must substitute twill or satin for the “tabby.” If we do that our binding of the plush cannot be so firm or perfect if it only passes under one end, but if interweaving with more than one end it may be equally perfect.

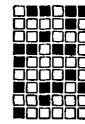


Fig. 93.

We have in Fig. 93 a plan of a velveteen with a three-end twill ground, and two picks of plush to each ground pick. In this it will be seen that again the principle of occupying every alternate warp end in binding the plush is employed, and also that every alternate plush pick falls in a different position

in relation to the ground twill, and consequently that one half the plush will be more firmly bound than the other. Again, in Fig. 94 we have another pattern upon a three-end twill ground, but with three plush picks to one ground pick. In this, only one-third of the pile will be imperfectly bound. Now all

these are patterns which have been regularly used, yet they are not free from defects in their binding. They have probably depended more upon the mere quantity of the material which the fabric con-

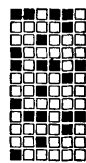


Fig. 94.

tained for the firm binding of the plush than upon anything else, but this is not satisfactory; each pick should be equally perfect in its binding to ensure a good cloth, but with a twill ground, and more than one plush pick to one ground pick, this is difficult to attain when the plush passes under one end only, but if the plush interweaves with more than one end, then it can be bound perfectly. We showed in Fig. 91 the method of binding into more than one end upon plain ground, and also the best mode of making the pile firm. Precisely the same rule will apply to twill grounds, only that instead of interweaving with three ends it would be



Fig. 95.

probably with four, or even perhaps more, after the manner shown in Fig. 95.

In this section it will be seen that the pile issues from the cloth between two ends, which are passed over by the succeeding pick, and which are in consequence pressed close together at that point, and so tend to cause the pile not only to be firmly bound, but also to stand more erect on the surface after it is cut. In most pile fabrics the systems of binding shown would be quite sufficient to hold the pile quite firmly in the fabric; but sometimes the nature of the material, such, for instance, as mohair, renders it desirable to bind it more firmly into the cloth. Then, if the ground be plain, the pile may bind into as many ends as is desired, and a number of picks going to form one, always being arranged so that the point where the first pick, say, issues from the cloth, the next pick enters it so that the pick formed by the succession of plush picks shall be one complete plain pick, just as the five picks in Fig. 90 form two complete picks.

107. Distribution of Pile.—We now come to the question of the distribution of the pile, and here there are two distinct features to consider—first, equal distribution, so that the whole surface of the fabric shall be equally covered; and second, the arrangement, so that

what are termed courses for the knife shall be regular. Although, as we say, these are two distinct features, and both often exercise the mind of the designer, yet if the first condition be properly complied with, the second must be. Let us see what this distribution means. In the patterns Figs. 88 and 89 the four plush picks are arranged in what is commonly known as four-end satin, or satinette order. Each alternate end is occupied by a plush pick, but not in consecutive order. In this particular case they might have been arranged in consecutive order, as what may be termed the pattern is complete between each ground pick, but if there had been only two plush picks and one ground pick, then there would have been a tendency to show a twill, and this would not only have been apparent at the back of the cloth, but also on the face of the plush. Again, in Fig. 90, the plush is arranged in almost what may be termed a twill order, though not following on consecutive ends, yet from the manner in which they issue from the cloth, and the "pattern" again being complete between the ground pick, no twill will be visible. Generally, the best arrangement of plushes is that of a satin order, the number of changes being regulated by the length of the plush, and the number of plush picks required to complete "one round of the pattern." If we keep our plush distributed equally in this manner, we at the same time also insure regular courses for the cutting knife; the pattern being in regular order, the distribution perfect, we are of necessity bound to have perfectly straight courses. But if this regularity is not preserved, if the binding is distributed irregularly over the fabric, then the courses will be irregular, and the cuts will be "heavy and light"—that is, in one course there will be more material to cut through than in another, and so irregularity in the quantity of pile on the surface and difficulty of cutting properly will be produced.

108. The Effects of Cutting Plush.—Cutting the plush has quite as much to do with the ultimate appear-

ance as the regularity and perfection of the binding, though in the short plushes of which we have been speaking not so much difference can be made, perhaps, as in longer plushes. We have already explained how the plush is cut by the knife and guide. Now, this guide plays a most important part; its first function is to raise the thread up to the knife, but it must also determine exactly where the knife shall cut that thread, in the middle of the float or elsewhere. This is governed by the size of the guide itself; if the pile is all to be of equal length—that is, the float of weft to be cut exactly in

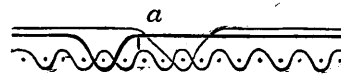


Fig. 96

the centre—then the guide must be just of such size that it will fill the space between the weft and the cloth

of *one float only*. Take, for instance, Fig. 96, where two weft floats are shown binding at two different places, as would be the case of any two picks in a plush pattern. If the knife-guide is of the proper size, it will pass under only one of these at once, but if it be not large enough, it will pass under two or more, as at the point *a*. In that case, instead of the thread being severed into two equal parts, one will be much longer than the other. Instead of being cut between the two binding points of one thread, it will be cut between a binding point of each thread, and so produce long and short plush intermixed.

109. Imitating Skins of Animals with Plush.—In such fabrics as velveteen, and others where the pile is very short, this would be a fatal objection; the surface of the pile would present a most irregular appearance, but where the pile is of considerable length it may be an advantage. Very frequently plushes, more especially weft plushes, are made to imitate the skins of animals. Most people are aware that a great many animals have next the skin a short close fur, covered with a longer hair, the hair lying over the fur and serving to turn off the wet, while the fur serves to keep

the animal warm. In imitating such furs two lengths of plush must be formed. Sometimes this may be got sufficiently well merely by the cutting, using a guide so small as to catch two or even more picks, after the manner shown in Fig. 96, and so producing long and short. If three picks at different points of the pattern are caught by the guide, there will of course be three different lengths of plush, and so on. Sometimes, however, this does not give sufficient difference in the length of the plush, and the floats of the weft are varied—in fact, two distinct plushes are combined upon one ground; say, for example, one having a float of an inch in length, or even more, to form the long hair, and the other having a float of only a quarter of an inch. In cutting these, one of two courses must be adopted: either the long plush must be cut first, with a guide which cannot enter the short plush, or both must be cut together with the short plush guide. In the first case the long hairs may be equal in length, or unequal, according to the size of the guide used; in the second case the long plush will be all equal, and very nearly of the full length of the float, from one binding place to another, because the guide for the short plush will be so thin, and the cuts so frequent, that the long floats will always be cut nearly close to the binding point, the short end of it being just of the same length as the short or under plush. If two different materials be used, as fine wool for the short, and silk or bright mohair for the long plush, some pretty effects may be obtained, and very correct imitations of the skins of some animals made. Sometimes even three materials, each forming a different length of plush, may be employed, and more variety given to the fabric. In making imitations of skins, the nature of the material employed to form the pile must of necessity be properly considered; for instance, in making imitation sealskin, smoothness and brightness of the fibre are essential conditions. Again, if the pile is required to stand erect upon the surface of the cloth, unless it is very short pile, the hair or fibre of which it

is made must be very strong, so that it can retain its erect position.

110. Density of Pile.—Another question now arises—namely, the density of the pile. If it must stand erect it must be tolerably dense; that is, there must be a great many pile threads issuing from the cloth in a given space, so that they can support each other. To obtain this density of pile the number of plush picks to one ground pick must be properly proportioned to the length of the pile and to the number of ground picks per inch. It may to some extent be obtained by the use of thick pile weft, but this must not be carried too far, else it will appear rough and coarse. In obtaining density by an increased number of plush to one ground pick, we must not carry the proportion too far. Fig. 90 will represent what should be the limit; in fact, it goes almost too far. The ground picks must be sufficient to form a fabric of such weight and strength as will carry easily the pile to be put upon it. Perhaps the pile weft may take part in the actual formation of the ground fabric. Sometimes it does; then, of course, more strength is given to the structure. These are all matters in which the designer can only be guided by the circumstances of the case immediately before him. Empirical rules cannot be laid down, and if an attempt were made to lay such rules down they would only be misleading.

111. Special Effects produced by Yarns.—The same remark will apply also to the preparation of yarns for forming pile to produce special effects. For instance, in the imitation lambskin the yarns must be made from soft fine wool, with good felting properties; the softer it is spun into the thread—so that it will hold together to be cut—the better. Then after it is cut it must undergo a teasing process to separate the fibres as effectually as possible; then they are felted until they form little “cots” all over the surface of the cloth. Again, in the imitation of dog and other skins, the yarns must undergo a preparation which will give them the proper amount of

wave or curliness ; and in some cases the subsequent processes of finishing assist or intensify these effects ; however, all such must be left to the ingenuity and skill of the designer, and a due consideration of the effect he desires to produce.

112. Corduroys.—Plushes, in addition to being distributed equally over the surface, are often made to produce patterns upon the ground cloth, such, for instance, as stripes, which when they occupy a small space are commonly called cords, or, when they run the length of the piece, corduroys. They may also run across the piece, or in diagonal form. Figures are also formed.

In the small cords or corduroys the principle of binding referred to in velveteens is usually employed, only that the binding of the plush is not distributed over the whole surface, but confined to a few ends. We have in Fig. 97 a simple cord on a plain ground cloth, which is known as a "velveret on tabby back." In this the binding of the plush weft is confined to two ends throughout, so that when cut up between the bindings the pile will form a rib or cord. In Fig. 98 we have



Fig. 97.

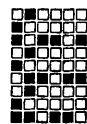


Fig. 98.

the same cord on a three-end twill back, otherwise known as the "Jeanette" back. In these two patterns there is nothing which calls for special remark, except the formation of the cord: it is one of the most simple which can be made. In Fig. 99 we have one on a four-end twill ground, which is a more perfect form of cord. These cords, to give the best effects, should be rounded on the top ; that is, the pile forming the centre of the cord should be longer than that forming the sides, so that it will stand above it and give a rounded appearance. In the patterns given in Figs. 97 and 98 this will take place to a slight extent, but in pattern Fig. 99 it will be more

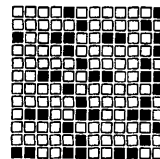


Fig. 99.

marked. Take the two plush picks which occur between each ground pick. The first pick has a float of four and then of six ends alternately; the second pick is the same, but the long float of one follows the short one of the other. The cutting will sever both threads in the centre of the float, so that the longest ends of pile will be in the middle of the cord, and the shortest ones at the sides or edges. This, then, will give a greater degree of roundness than in Figs. 97 and 98. Although the pattern in Fig. 99 will give a rounded cord, in many cases it is desirable to have even more roundness and prominence imparted to it; this may be done by giving three or four different lengths of float to the pile weft,

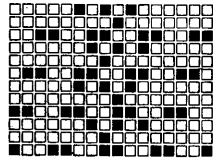


Fig. 100.

and generally arranging them so that the longest are slightly predominant in quantity; such, for instance, as that in Fig. 100, which would produce a very bold cord. In this pattern one of the two plush picks forms the edges of the cord only, while the other forms the intermediate and the centre, thus giving more threads issuing from the centre of the cord than the edges. This would make the cord very full up the centre, but as part of this would fall towards the edges instead of remaining perfectly erect, it will supply proper roundness to the cord. Cords of this description may be made of varying widths, and with any degree of roundness; and they may not only be made as plain straight cords, but as fancy ones, and of varying sizes.

113. Diagonal Cords.—It is not necessary that we confine ourselves to cords running either the length of the piece, or simply across it, parallel or at right angles to the edges, but they may run diagonally, and the weft which forms the pile rib may either be introduced to form the rib solely, or it may take part in the formation of the ground. After the consideration we

have given to straight cords it will not be necessary to say much about diagonal cords: the principle of structure and binding applies equally to both; the roundness of surface on the cord required in one may be equally desired in the other, and the mode of obtaining it would be the same. In fact, instead of binding all the plush picks upon a given number of ends, they would be distributed upon all the ends composing the fabric, and following each other in a diagonal direction.

114. Figured Plushes.—Figures may be formed with weft plush in the same manner as cords or diagonals, simply by binding the plush weft into the cloth where figure is to be formed, as though the whole surface were to be covered, and where there is to be no figure, either let the plush weft enter the ground as part of it, or float loosely over it. In the latter case, the loose material which is not forming pile will have to be cut away. Some very pretty effects may be produced in this manner, as also in the formation of figures by different lengths of pile, or by the use of different colours of pile weft. In fact, we have in this system of ornamentation the means of producing great variety of effect, as well as most useful fabrics, not only for wearing but as warm articles of clothing.

115. Chenille.—Chenille is another class of fabric, if we may so term it, which though used for a great variety of purposes, may be classed among weft plushes. The mode of its manufacture is by weaving weft into a warp having its threads set in small groups a short distance apart. After the piece of cloth is woven, the whole of the weft is severed between each group of warp threads, thus cutting the whole fabric up into

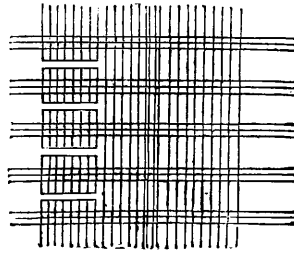


Fig. 101.

narrow shreds, as in Fig. 101. Here the warp threads are shown in groups of three, and are intersected by the weft in regular order; sometimes these warp threads weave with the weft in perfectly plain order, but in the best formed chenilles they are woven as gauze, thus holding the weft more firmly in the warp, making the cutting more easy and certain, and making a more durable article. After the chenille is cut it is twisted, all the three threads of warp being thus formed into one, with the short threads of weft projecting from it all round, making as it were a fringed thread. This twisting tends to hold the weft fringe still more firmly in the threads of warp, so that if in the plain woven fabric it can be held sufficiently firm to resist being pulled out in cutting, it will become more secure after the twisting operation.

116. Sham Plush.—One of the uses to which chenille is sometimes applied is the production of what may be termed sham plush; that is, it is woven into a cloth as weft, and the loose fringe formed on the thread, as before described, projects itself through between the warp threads, and so gives the fabric the appearance of a plush. If it is woven into a plain piece, there is, of course, the same quantity of plush on each side of the cloth, but if thrown pretty loosely on the face it will present very much the appearance of an ordinary plush, and can be made much more economically. One thing which is necessary in making cloths with chenille weft is to have the warp threads pretty wide apart, so as to give the loose fringe an opportunity of projecting itself between them; if put into a closely set fabric it would not have an opportunity of doing this, and would consequently be nearly, if not entirely, lost. Chenille, if judiciously used, gives some very pretty effects indeed, and at a cheap rate compared with what can be done with other kinds of plushes.

117. Warp Pile.—We now come to the question of the formation of pile or plush on the surface of

fabrics with warp. The principles involved in the formation of pile of this description are similar to those of weft pile, the warp taking the place of weft, but the *modus operandi* is different. In the formation of weft pile two wefts and one warp are employed; in warp pile, two warps and one weft. In the former the cutting takes place usually after the cloth comes from the loom, in the latter usually in the loom, or the pile may be left uncut and form loops; so that we have two forms of warp pile, commonly known as "cut" and "loop" pile, or "cut" and "Terry" velvet. Whether the pile be cut or uncut the structure of the cloth is the same; it is merely a question of using the knife or not. We will first examine what is known as common velvet—as there are several modes of forming the pile, or rather of binding it into the cloth—so that we may obtain a more ready and accurate idea of the general principles upon which the binding is effected.

118. The Structure of Velvet.—In the first place, velvet is formed by the pile warp issuing from the cloth, passing over a wire, and then passing into the cloth again, where it is interwoven, so as to secure it firmly. We may bring the whole of the pile warp at once over the wire, or we may bring only a portion of it, but in either



Fig. 102.

case we must consider the binding, so as to properly secure it; and in the event of bringing only a portion over the wire at once, we have the double consideration of binding and proper distribution. Suppose we first bring the whole of the pile warp over each wire, as shown in the section in Fig. 102, we bind the pile threads into the ground in the order of plain weaving between each wire. In this section the loops are shown

just as they are formed by the wire, except at *a*, where they are shown as cut. Now, one feature of this section must strike the reader: the pile issues from the cloth after a pick is inserted, passes over the wire, and returns to the cloth before another pick is inserted. To secure the pile properly in the cloth it must pass *under* the pick which precedes the wire, and also that which follows it, and the ground thread next to it must pass *over* both these picks, so that virtually both are in one shed. It must not be supposed from this section that the pile thread necessarily forms part of the ground, that is, that the thread seen here and the ground thread accompanying it are the only two representative threads of the cloth; but a ground thread accompanies the pile thread in the order of interweaving in the ground, so forming a double thread throughout, except in passing over the wire, when they separate. Thus this arrangement secures the pile firmly into the fabric, and the double pick has also another advantage—namely, that the pile threads issuing from and returning into the cloth between two picks which are contained between the ground threads in the same shed, and which are beaten as closely together as the thickness of the pile warp will permit, are held firmly together, thus supporting each other and standing erect upon the surface of the cloth. This method of binding the plush gives all the security to the binding which is required, but it will form distinct rows or ribs across the piece. If the pile warp be thick enough, and spread itself out sufficiently on being cut, these rows will be hid, but if the cloth be doubled back, each row will at once disclose itself. This is certainly a characteristic of all velvets, and is the feature we referred to in Art. 106, which is imitated by the velveteen when two sets of plush picks and one ground pick pass into practically the same shed, thus giving a sort of ribbed effect to the back of the piece, and showing the plush in rows. If we are making our cloth with fine ground weft these rows would be so close together as not

to be at all objectionable; in fact, not visible to the unassisted eye. Again, in the process of weaving we must consider the effect of weaving in this manner. If the warp be a smooth thread and not over thick, as silk, for instance, we may raise or depress all the pile threads at once, without fear of "choking" the shed, but if the pile threads be very thick, or not of the smoothest nature, or too closely set, then there would be a probability of "choking" as they pass between the ground threads, and probably also the rows and the openings between them would be too decided. Then in such cases we must divide the pile warp into at least two portions, and bring each portion over the wire alternately. In doing so we alter the structure of the cloth. Practically, each portion of the pile warp is bound into the fabric, just as shown in Fig. 102, but as we have *two* portions to consider, *each* to be bound in a similar manner, the order of succession of ground picks in their relation to the ground warp must be altered. A section is given in Fig. 103, showing the method of binding the warp when bringing only half over the wire at once. The black line



Fig. 103.

represents one portion of the pile warp, and the dotted line the other portion, the ground end being represented by the double line. In this, as in the previous arrangement, the pile issues from and returns into the cloth between two ground picks which are in the same shed, being held so exactly in the same manner. Again, on returning into the cloth it passes under one pick, over two which are in the same shed, and under another, when it again issues from the cloth; so that practically each portion of the pile weaves into the ground in precisely the same way as in the previous case—namely, three ground picks and a wire, two of the picks being practically

one, so far as this portion of the pile is concerned. Then the other half of the pile warp issues from and returns to the cloth between the next pair of picks, thus making a loop at every two picks of the cloth, but two picks always going into the same ground shed, being separated by the pile warp as it issues from and returns to the cloth. Such being the nature of the structure when the pile warp is brought to the surface in halves, there must be a better distribution of the pile. The firmness of the binding and the texture of the ground cloth will be practically the same in both methods of working, but in the second the rows of pile will not be so decided, their greater frequency, and the fact of only one half the pile coming to the face at once, tending to equalise the distribution, and give a more regular appearance to the pile, more especially if thick yarn, or yarn made from strong fibres, be used.

What we have said has more especial reference to velvet, or cut pile. If it be uncut, forming loops, so far as the binding or the pile running in rows is concerned, there is no advantage in either system, because the pile will always stand in rows, just as it is left by the wire, but by bringing half the warp up at once we can get the rows closer together; and although each row of the pile brought over each wire cannot be quite so much in quantity as if all the warp be brought up at once, yet the increased closeness of the wires, and the fact that we can have the warp more closely set, will enable us to form a greater quantity of pile on the cloth.

119. Pile formed without Wires.—Loop pile may be formed without the use of wires, but its appearance is not so regular; although formed in rows, the loops do not stand perfectly straight, nor exactly equal in height; thus they intermix with each other, and give a very rough appearance to the fabric. This kind of pile is most used for bath towels and similar articles.

120. Ornamenting Pile Fabrics.—We must now turn our attention to the ornamentation of pile fabrics. This

we may deal with under two heads: first, the decoration of pile fabrics, and second, the decoration of fabrics *with* pile.

The first idea which naturally occurs in connection with the ornamentation of fabrics is the use of colour. In ordinary velvets, whether cut or uncut, colour can only be used under certain conditions, and consequently can only give some specific character of ornamentation, and not be used in a general way. The pile formed on the surface of the fabric entirely covers the ground cloth; then any ornamentation which may be visible must be formed with the pile warp. If we introduce variety of colours into that they must necessarily run in stripes; figures could not be formed. The warp consists of a number of threads laid side by side. If these threads are of different colours, a given number of one colour, and a given number of another, when woven into the fabric, and forming the pile on the surface, exactly the same stripe must be presented on the cloth as in the warp, so that our power of ornamentation in that direction is limited. Then our chief power of ornamentation must be by forming patterns in or with the pile itself, in a great measure without the aid of colour. When we speak of the ornamentation of pile fabrics, we naturally conclude that the whole surface of the cloth is covered with pile, or at least that the greater part is so covered, or that some ornamentation is formed in the pile itself, or by its being formed in varying quantities on the fabric.

First of all, we may produce pattern by the pile varying in length. When such is the case it will usually be in stripe form across the piece, because the difference in length is produced by wires of different sizes being inserted under the pile warp during the process of weaving, so that it would not be very convenient to form figures in this manner. Of course figures can be so formed, but the expedient is not very frequently resorted to.

The next means of ornamentation is by the combination of velvet and terry—that is, cut and uncut; and this

is very frequently employed, figures of terry being formed upon a velvet ground, and *vice versa*. The same warp is employed in the formation of both kinds of pile, but two kinds of wires: one provided with a groove for guiding the "trevette," or cutting knife, or having a knife formed at its extremity so that it cuts its way as it is being drawn out, and the other being a plain wire which when drawn out leaves the loop intact. No prettier effects can be produced than by this combination of velvet and terry; although both are of the same material, and of the same colour, the contrast between the loop and the cut fibres marks the pattern very distinctly. One great advantage of this mode of ornamentation is that the texture of the ground cloth is not at all affected, the interweaving of the pile with the ground remains the same; the same amount of pile is formed all over the surface of the fabric, the cut and terry simply taking the place of each other, so that the usefulness of the article is not impaired, either in its strength or in the wearing surface, there being no inequalities whatever in the pile. In fact, this kind of figuring bears the same relation to pile fabrics that damask does to ordinary figured cloths. Figures may be formed upon velvet grounds by ceasing to form pile at intervals; for instance, taken in its simplest form, if we weave say half an inch of velvet in the ordinary manner, then cease to insert wires, but continue to let the pile warp interweave with the ground, we should form plain cloth, having two picks of weft in each shed, and with two ends going together as one. We are now assuming that the pile is formed by bringing half the warp at once over the wire; then we should have alternate stripes of velvet and plain cloth. But instead of forming simple stripes we may let our plain cloth form figures, and the figures may assume any form. Then we are ornamenting by the introduction of patches of plain cloth, such patches taking the form of figures, and being distributed according to the fancy of the designer, or the special effect intended to be produced. When figures

are formed in this manner, the plain portion of the fabric is a little more loose in texture than when pile is formed. As will be seen on referring to the sections of velvet in Figs. 102 and 103, when pile is formed, the warp separates the two ground picks, which otherwise go into the same shed, but if pile is not being formed, the pile warp simply lies under them along with the ground warp, so that there is nothing to separate the two picks, consequently they will lie closer together and occupy less space. Now, if one portion of the fabric has two picks together as one, and another portion has the same two picks separated by a series of double threads, one must of necessity be firmer in texture than the other. Perhaps this difference is not such as to have a material effect in the majority of fabrics, yet it is necessary to be aware of its existence, since if the pile warp be very thick, or the figures be not equally distributed, it may be detrimental to the structure, and a knowledge of the possible cause of defects enables us all the more effectually to guard against them.

In addition to irregularities in the texture, the wearing surface is also irregular, the velvet standing up as a projection on the surface of the fabric; but for the purposes to which such goods are usually applied this is not a matter of much importance. Plain figures of this description upon velvet grounds are about the most simple mode of ornamentation, though a very effective one, the design produced being of an embossed character. In fact, common velvets are frequently made to imitate them by being embossed, but these are not so good for wearing purposes as when they are properly figured, because that portion of the pile which has been flattened by pressure to form the figure will become loose with friction, and gradually rise to almost its former position and so destroy the pattern, whereas if the pattern be woven in, nothing can destroy the clear definition of the figure except the actual wearing away of all the pile of the ground—a circumstance which cannot often occur.

121. Combination of Pile and Figuring with extra Material.—Fabrics figured in this manner are like those figured with velvet and terry, necessarily all of one colour; but variety of colour may be obtained by the introduction of extra material, after the manner pointed out in reference to ordinary fabrics, and in this way some of the richest possible effects produced; the density of colour which is always a characteristic of velvet, and the variety of light and shade produced by the pile, being wonderfully relieved, and giving the most beautiful effects by the introduction of bright or contrasting colours. There is probably no class of ornamentation applied to fabrics which gives such magnificent results as combinations of velvet with coloured figures.

122. Pile or Velvet Figures.—We now come to the ornamentation of fabrics with plush or pile, and what has been said of the ornamentation of pile will practically apply to this, in so far as structure of the cloth and wearing properties are concerned; the mechanical operations required for the formation of patterns are also the same. In fact, we may almost sum up the difference by saying that in one case the plain or figured ground cloth becomes an ornament to the pile surface, the latter of which predominates largely in quantity; and, in the other case, the small quantity of pile which forms a figure becomes an ornament to the ground cloths. The fabric which we wish to ornament with velvet figures may be anything—plain, twilled, satin, figured, or gauze. It is made on the ordinary principles. The warp which is to form the pile may take part also in the formation of the ground; it may form figures in the ground, or may be dealt with in any manner when not forming velvet; then when it is required to form velvet it begins to interweave with the ground cloth in the ordinary manner of plain velvet, and is also passed over wires in the same manner. Sometimes the velvet is formed in stripes; when such is the case there is no trouble with the arrangement of the design, further than to provide the pile ends in the warp,

and consequently in the arrangement of the pattern upon paper, at the places and in such quantities as are requisite. The stripes may be plain or figured; when figured, the pattern is produced by simply passing such ends over the wire as will form the figure desired, and leaving the rest in the ground cloth. If the figures be distributed over the whole surface of the cloth, at greater or less intervals, then they must be distributed equally; in fact, the same rules must be observed as for any ordinary figures. Plush figures upon a ground fabric differ from plain figures upon a plush ground in one respect—namely, that the figure may be different in colour from the ground, more especially if the figures be small, because then the pile warp would be treated as extra material, and thrown to the back when not forming pile. Of course, in plain figures upon plush ground, a similar effect may be produced by the introduction of extra material, as we pointed out for the formation of extra spots; but this is not so general a practice as introducing extra warp to form plush figures. Then again we may combine extra material for the formation of other figures, after the manner of ordinary cloths between the plush or velvet figures, or we may figure with the ground fabric. In fact, we may combine with velvet figuring all other forms of ornamentation which can be applied to fabrics, and our velvet figures may be either cut, or terry, or both.

123. Plush Figures upon Gauze Ground.—We have already referred to the formation of plush upon gauze ground, but that will call for a few more words here. As it is shown in Plate 12, Fig. 14, the pile is formed *upon* the gauze; that is, the twistings of the gauze threads take place between the loops of the pile, so that really there is no solid ground fabric under the pile. This is a very pretty and useful mode of working, but will only serve for very light fabrics, and does not permit of any other mode of ornamentation being applied along with it. Now, we may frequently wish to combine plush figuring

with some other upon gauze ground, or plush figuring with gauze upon some other ground. Suppose, for example, that our plush is to be surrounded with plain upon a gauze ground; then in the first instance we combine plain with gauze in the usual manner, then, as plush is to be formed, we cease the plain working and adopt that which will give a proper ground for the plush, and proceed to the insertion of the wires. This mode of working, in addition to enabling us to make a heavier cloth than if the plush is upon the gauze direct, will also make the plush appear better by being more dense. Again, the plain cloth may predominate, and figures be formed alternately by plush and gauze, or we may further call the use of extra material to our aid; so that we may be said to have here all the different methods of ornamentation at our command at once, to apply as we please. There is, perhaps, nothing which produces such striking effects as the combination of plush and gauze, whether any other order of weaving be combined with them or not; the contrast between the density of one, and the open perforated character of the other, always giving a very decided character to the whole design, and, at the same time a very pleasing one.

To the designer there can scarcely be any more pleasing duty than the designing of figured velvets; he has so much scope for the display of artistic merit, and also of complete technical knowledge of the structure of fabrics.

124. The Production of Special Effects in Plushes.—In dealing with warp pile so far, we have confined ourselves chiefly to velvet, or fabrics having a very short pile; but there are numerous other kinds of pile fabrics in which the pile varies, though in principle of structure they are practically the same. But although they are the same in structure, yet great variety of effects is produced by varying lengths of pile, by special preparation of the pile warp before being put in the loom—such as printing, curling, waving, &c.—similar to the

operations we referred to in connection with west pile; and, again, special effects are often produced in the process of finishing after the fabric leaves the loom, such as tinting to produce the imitation of skins of animals, and other effects.

125. Brussels Carpets.—Figuring with colour upon pile fabrics involves a different arrangement of the structure and also of the pile threads, unless the pattern is printed. We might take as an illustration Brussels carpets, in which well-defined patterns are formed by a variety of colour, and see what is the principle of structure, and how far it will apply to others. The pile itself is formed exactly the same as in ordinary or terry velvet—namely, by the insertion of wires under the pile threads—but the process of selection of the threads is different. In weaving ordinary velvet we bring either the whole or half the warp to the surface over each wire, but in Brussels carpet we may be said to have a

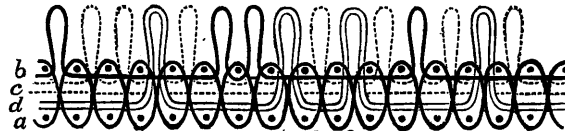


Fig. 104.

series of duplicate ends, each of a different colour, and from these we select one, according to the pattern we require. Again, in ordinary velvet the pile warp interweaves into the ground just the same as the ground warp, except at the point where pile is formed; but in Brussels carpet it does not, but is contained as a straight thread in the body of the cloth when not forming pile. Take the section Fig. 104; the ground warp is represented by the lines *a*, and the weft by the dots, the three colours of warp by *b*, *c*, and *d*. Now the ground cloth is plain in one sense. If the ground warp threads be separated from the pile warp, and considered only in relation to

the weft, they will form a plain cloth with two picks in each shed, but taken as they stand, the ground picks are separated by the pile warp. In fact, the pile warp is held between the ground weft, and intersected by the ground warp, so that if no pile or loops were to be formed, we should have a plain cloth with a stout packing in the middle, the packing threads being perfectly straight, and taking no part in the formation of the cloth, except to give bulk to it. Between every pair of ground warp threads there is one thread of each colour of pile warp which is to be employed. Then, for the formation of the pattern, *one* of each of these sets of pile threads is raised between each pair of ground picks and passed over a wire, it then returns to the cloth, and if required to form the next loop is again raised, and so on, until its own portion of the figure is completed, when it remains in the cloth until again wanted to form figure. In the same manner the pile threads are treated; they are lifted over the wire to form a loop whenever the arrangement of the pattern calls for their presence on the surface, and as soon as that portion of the pattern is completed they return to the cloth, and continue to form the body. From this it will be seen that although there may be three, four, five, or six colours, and consequently as many separate pile threads between each pair of ground threads, only one of each set is brought to the surface at once, so that there is always the same quantity of pile on the surface, and the same substance in the body of the cloth, no matter what the pattern may be, or how frequently the pattern changes from one colour to another.

Then the advantages of this mode of structure are that we have uniform surface and body of cloth; and we have pattern formed by colour only, and any amount of variety in the pattern will not affect the structure or quality of the cloth. The pattern being formed by differently coloured threads coming to the surface in succession, is very clear and well defined, and the whole of the pile material being embedded in the body of the cloth

makes the fabric both bulky and soft. One peculiar advantage, from the useful point of view, which Brussels carpets possess, is that each thread which comes to the surface to form a loop, being only one of a number, is well embedded with the rest in the body of the cloth, so that when the foot is placed upon it, it is pressed into a naturally elastic body of material, which serves as a cushion for it, enabling it to give way under the pressure of the foot, and also by its elasticity to spring back to the original position, thus reducing the wear and tear considerably.

126. Tapestry Carpets.—Another class of carpets which are made to imitate Brussels are known as tapestries. The structure of the cloth presents somewhat the appearance of Brussels, but instead of there being a number of threads together of different colours between each pair of ground threads there is only one, and that is printed so as to form the pattern. In fact, each pile thread is printed in colours according to the pattern to be formed, proper regard being paid in the process of printing to the length of warp which will be required to form the loop, and also for bending round the weft. Then they are put together in the warp in their proper order, and, as we have said, woven after the manner of Brussels carpet, but one printed thread serving for a number of coloured ones. This is a most economical method of producing figured carpets, but of necessity does not produce so serviceable an article as that which it imitates. There is no substance in the body, except what is known as the backing, and as this consists of stout linen, there is not the same elasticity as in the worsted body of Brussels carpet, and therefore not the same tendency to reduce wear and tear.

The structure of the Wilton carpets is similar to that of Brussels, but the pile is cut, or practically the difference is the same as that between cut and terry velvet.

127. The Varieties and Properties of Plushes.—We have now enumerated the principal kinds of plush or pile

which are made. There are many modifications of these in use, in the production of different kinds of fabric for different purposes, but these are modifications of minor details generally: the principle of structure is not affected by them. There are numbers of patent plushes, all claiming some advantage over others, but still, the improvement is usually in some trifling alteration of binding or distribution, or perhaps more frequently in the method of production, but the general principles we have referred to cannot be far departed from without impairing the structure of the cloth, or even if that is not actually done, there can be little advantage gained. One very economical method of making velvets, which has been attempted over and over again with varying degrees of success, has been within recent years brought to something like a state of perfection—namely, weaving two cloths together, and the pile passing from one to the other; they are then severed in such a manner as to leave a proper proportion of pile upon each cloth, thus dispensing with the use of wires, and consequently reducing the cost of production very materially. But even in this, the principle of structure of each cloth remains practically the same as if they were woven with wires; it is only a modification of the means by which the article is manufactured. With respect to the utility of pile fabrics, little need be said more than we have already pointed out. From the nature of the surface, as well as the structure of the body of the cloth, they must necessarily form very warm articles of clothing, the closeness of texture and the intermixing of the loose fibres of the pile all tending to assist in retaining warmth. They are also soft and pleasant to the touch, and altogether pleasing as articles of dress or furniture; one remarkable feature to which we have already referred being the richness of colour, and the variety of light and shade which they present, more especially when arranged in folds, the undulations placing the loose fibres in so many different positions to reflect the light, and this variety of reflections

giving richness and variety to the colour and lustre of the whole fabric.

In their wearing properties plushes are also very valuable, there being scarcely any fabric of the same weight which will prove more durable, so that they combine all the properties which go to make cloths valuable—richness and beauty with utility.

CHAPTER IX.

GENERAL COMPARISON OF THE DIFFERENT CLASSES AND STYLES OF FABRIC.

128. *The Considerations involved in the Structure of Fabrics.*—We have dealt pretty fully with the different principles of structure of fabrics and their ornamentation ; and it will perhaps be desirable now to examine a little more fully some of the considerations involved in their structure, to make a comparison of the different classes and styles of fabric, and also to deal with some forms of ornamentation which we have not touched upon, and the special method of their application.

We may first recapitulate generally some of the points discussed in the earlier chapters, so that we may take a more comprehensive view of the whole.

Dividing, for the moment, all fabrics into two distinct classes, without entering into their particular structure, we may say that the one is intended for useful and the other for ornamental purposes. Taking the purely useful, we have the question of strength before us, the necessity of the fabric being able to bear strain, or friction, or both ; then we have to regard it as an article of clothing, its power of retaining the warmth of the body, or of resisting climatic influences. In the first case one of two con-

siderations comes in; either we must have a strong, compact, well-formed thread, of which to form the cloth, or the threads must be so interlocked with each other as to make the whole fabric as it were one solid mass. If the threads are of such a nature that all the fibres of which they are composed are spun intimately together, forming a smooth-surfaced, even filament, then they will stand separate from each other in the fabric, and its entire strength will consist of the multiplication of so many units; and if the cloth is to bear a great strain, more especially if this strain is likely to be localised, either each individual thread must be very strong, or strength must be obtained by having a great number in a small space. The strength of individual threads may be obtained in two ways: either by having it constructed of fibres of great strength, or by having the fibres well twisted together. Combined with the strength of the thread, the order of interweaving of the two sets of threads of which the cloth is composed must be taken into account, and, as we have shown of ordinary fabrics, the plain cloth, or that in which the two sets of threads interweave alternately, is the strongest for the quantity of material which it contains (we are leaving gauze out of the question, as being an ornamental fabric). If the capacity of the fabric to bear strain is to be in one direction rather than another, as in the warp or weft, then that material must predominate, and we arrive at the class of cloth showing a rib in one direction or the other. We have here, then, the general considerations of strength immediately before us, and although we have spoken only of plain cloth, the remarks will apply equally to twilled or other fabrics, in which we have resorted to a different order of interweaving, either for the purpose of obtaining greater weight or for ornamentation.

In cloths formed of the kind of thread we have spoken of there will be openness of texture, and the size of the openings between the threads will be in the direct ratio to the diameters of the threads in a

cloth where warp and weft are equal in quantity. Thus, to obtain closeness we must increase the quantity of either warp or weft. To do that is to increase the weight. Now, if our cloth is to be a light one, and we wish it to be still of a close texture, we may obtain it to some extent by altering the structure of the thread. Instead of having a smooth, even thread, we may have a considerable amount of loose fibre on the surface; these loose fibres will help to cover the interstices, and in the process of finishing, if the fibres of one thread be made to interlock with those of other threads, the compactness of the fabric will be increased. But this is not all; the interlocking of fibres gives additional strength. Not only do the warp threads support each other, but the weft threads interlock with them, and the whole fabric becomes more compact, not merely as far as closeness of texture is concerned, but as regards tensile strength, and also the power to resist friction. Thus we have here a very intimate relation between the structure of the thread and the strength of the fabric, as well as its closeness of texture; so that it is evident the character of the thread is an item we cannot afford to ignore in determining the structure of the cloth.

Apart from the question of material or structure of thread, we must now consider how these conditions can be obtained in the structure of the cloth only. If we resort to twilling—that structure which most nearly approaches to plain cloth—we obtain in the first place greater closeness of texture than in an ordinary plain fabric, because of the necessity for introducing a greater number of threads, to compensate for the looser order of interweaving. We obtain also greater strength for the same reason, and also of course increased bulk. Then, again, this increase may be in the weft, in the warp, or both, according to the character of the twill we employ. If we take satin cloths—one form of twilling—we obtain all we require in strength and closeness of texture in one direction only—that is, by an increase of

either warp or weft, in number of ends or in thickness, more generally by the increase of ends. Our next alternative is a resort to double cloths, which gives us the means of increasing weight, strength, or closeness of texture to any degree. Then we have here, in the structure of the threads, and the structure of the fabric, in simple form, all that we require to enable us to make the cloth fulfil all the conditions of usefulness.

129. Ornamentation of Fabrics by the Use of Colour.—Now with respect to ornamental fabrics. As we have shown, we may ornament with colours, with patterns formed upon the fabric, or in the structure of the fabric itself. We will first turn our attention to the question of ornamenting with colours, not with a view to dealing with the theory of colour in general—that has been already done many times in works on decorative art, including, of course, textile fabrics, in a much more complete manner than could possibly be attempted here—but to consider it in its connection with structure of the fabric, and see what will affect or interfere with its use, and how far this interference may necessitate the ornamentation assuming some particular form or character.

It has been pointed out in a previous chapter that the ornamentation of plain cloth must be by the use of colour, or by the predominance of either warp or weft, so as to produce cords running the length of the piece or across it; but this predominance of one of the materials will also affect the use of colour. When weft and warp are equal in plain cloth, we may introduce coloured threads into either one or the other with a fair chance of their being visible on the surface. Then we may form either stripes or checks, just as we use coloured threads in the weft or warp, or both; and the variation in those threads, in both colour and quantity, will give us great scope for the display of ingenuity and taste. True, the patterns always run in straight lines, yet they may be made both pretty and effective by proper regard being

paid to variety of line and colour. But it is only when warp and weft are equal, or nearly equal, that we may use colour in both warp and weft at will. We will suppose, for example, that the warp is predominating very largely, that the number of ends per inch greatly exceeds the number of picks; then the weft will be completely hid, and whatever colour it might be it would not be seen on the surface of the cloth; so that in such a case we are precluded from using variety of colours of weft, and consequently, the cloth being plain in structure, we can only apply colour to form stripes running in the direction of the warp, seeing that the only coloured ends which can be visible must be in the warp. On the other hand, if we are making a corded cloth, with the cord formed in the warp, then the weft would predominate largely in quantity, though not necessarily in the thickness of the threads; but the closeness of the weft picks would completely cover the warp, so that whatever might be the colour of the warp, it would not be seen, at least not sufficiently to permit of a pattern of coloured ends being formed by it. So that whether the warp or weft predominate, we can only use colour in that portion of the fabric. Precisely the same rule will apply to twilled or satin cloths, and perhaps even in a more marked degree than in the majority of plain cloths. In either twill or satin cloths, where the warp or weft is brought much to the surface, it also predominates largely in actual quantity also; so that the other material is thrown absolutely to the back of the fabric, and is not seen at all on the face. Thus we can ornament only in the direction of the threads which are on the face, and we are therefore necessarily confined to stripes.

Although we cannot form anything but stripes by the use of colour in fabrics where either warp or weft predominates on the face, and when we confine ourselves to the material which forms the ground or body of the cloth, yet we are not precluded from the use of extra weft or warp to form checks. But of course the cloth will cease

to be purely plain, twill, or satin, as the case may be. We will take as an extreme instance a cloth, say such as a repp, in which the warp predominates very largely, and introduce coloured threads in the warp; these colours will stand out very prominently, because the modification usually produced by interweaving with the weft is not present here, the weft being so completely hid. Then if we wish to form a check upon this, our coloured weft must not interweave with the warp in the usual manner, or it will be lost, but it must be thrown to the surface of the cloth, and interweave with the warp threads only at intervals. In fact, it must form either a twill or satin with the weft predominating, and by this means and this only we may form our checks as distinctly as we please. If it is a cloth in which the weft forms the surface, then the coloured extra threads must be in the warp.

In forming figures upon such cloths as we are speaking of, the use of colour is most effective. Suppose the warp is a light colour and the weft a dark one, and that a figure is formed by bringing the weft to the surface, the warp preponderating on the surface all over the ground; in the ground the colour of the warp only will be seen, the weft being hid, and in the figure the weft only will be seen, so that the pattern will stand out very prominently. If the colours be properly suited to each other, so as to form an harmonious contrast, the effect will be most striking.

Then in using colour for the ornamentation of fabrics when the coloured threads form part of the groundwork of the cloth, it is evident we must take into account the structure of the fabric, and only use the colour in such manner as will be effective. When we are using extra colour or coloured threads for the sole purpose of ornamentation the conditions are quite different—whether we use them in the weft, in the warp, or in both—from those which exist when the coloured threads form the ground fabric; when they are extra threads we may treat them as we please, bring them to the surface in long

or short periods, or bind them into the cloth, so as to intermix the colour with the colour of the ground threads, and so modify their effect. In short, we employ them for decorative purposes only, and need to use proper discretion in their disposal, so as to produce the effect desired, with little or no regard to the structure of the ground fabric, except such as has been previously pointed out.

130. The Use of Threads of mixed Colours.—In speaking of coloured threads we generally mean threads which are one colour throughout, but we are not necessarily confined to coloured threads of this description in ornamenting fabrics. We may twist two differently coloured threads together, and so produce a parti-coloured one, known in the trade as “granderelle;” or we mix fibres of different colours together, in the preparation of the material for spinning, and so produce “mixture” yarn; or we may have the fibres of which the thread is to be composed printed in one of the intermediate stages of preparation, and so produce the “melange” yarn; or we may have the threads printed. From such fancy yarns as these we may obtain very pretty effects upon fabrics which may be perfectly plain in their structure; or if a pattern is formed in the fabric, it may be of the simplest kind. The whole effect may be a mixture, or melange. We may introduce the twisted, coloured, or printed threads into otherwise solid coloured fabrics, or coloured threads into mixture fabrics. These extra threads, as we may term them, may either form part of the ground cloth or interweave simply as ornamenting threads, according to the kind of effect to be produced, whether it is to be of a mild, tame character or a striking one. In fact, we have a wide field thrown open for the exercise of ingenuity in the use of these fancy threads. The use of “mixture” or “melange” threads generally is for the production of a tertiary coloured effect upon the fabric with very small patches of strong local colour; and if several striking colours are introduced into the mixture it does this in the most

effective manner. The intimate mixture of the fibres in the yarn will, when woven into the cloth, insure to the utmost the tertiary effect being procured, while on moderately close observation the local colours will assert themselves, and even at a distance will give a bright, sharp freshness to the whole.

In cloths where no specially striking effect is intended, the best means of ornamentation and of producing prettiest effects is by the use of "mixture" threads.

131. Fancy Yarns in Fabrics.—In addition to fancy yarns composed of differently coloured fibres, or by the twisting of differently coloured threads, many very good effects are obtained by twisting two threads together of the same or different colours, at different degrees of tension, so that one wraps loosely round the other—say, for instance, a thick thread twisting more or less loosely round a fine one—and presents to the eye a kind of crimped effect; this, when woven into the fabric, if judiciously used will be very pretty. Again, loops may be formed upon the thread by one thread running in loosely during the process of twisting while the other is held tight, or one thread may be given off at a regular rate of speed, while the other is varied in speed, so producing not only different thicknesses of thread, but, if the two threads are of different colours, different coloured effects. All these give us powers of ornamentation merely by their introduction into an ordinary fabric. We now come to the question of the ornamentation of fabrics in their structure, and we will consider it first apart from the question of utility.

132. Ornamentation of Fabrics in their Structure.—In plain cloths we can form patterns in one way only—namely, by the formation of ribs, which may run either lengthwise or crosswise in the piece; these ribs we may vary in size, or place at varying distances, but we have no further power of ornamentation. In ordinary twill cloths we have similar ribs running diagonally

across the fabric, which we may vary in size and distance apart, but unquestionably we obtain the best effects when we either combine these diagonal ribs with small figures, or simply run small figures in a diagonal direction. There is no field so wide for obtaining different patterns in the structure of the cloth as in the combination of diagonal lines and figures. The variety of lines, heavy and light, and the combination of forms give us a power of ornamentation which is not to be exceeded by any other method where we do not call in the aid of colour. There is no branch of the subject which should be more carefully studied by the textile designer, especially where his province is as much the designing of fabrics as of patterns.

Next we come to the formation of figures by the ground weft, warp, or both—that is, by the material which forms the ground fabric ceasing to interweave, and so forming pattern by the weft, or warp, or both, lying loosely on the surface. By this mode of figuring we can produce any variety of form in the figures, and, by proper regard to the order of binding or interweaving, ornament the fabric to any extent, the only limitation being a due regard for the structure of the fabric. Then we have figuring with extra material, which again gives us the power of introducing additional colours, as well as the formation of distinct patterns on the surface ; so that our power of forming patterns is extended beyond that when the figures are formed by the ground material alone, and if we combine the two methods we have a still further extended power. In fact, the extent and elaborateness of our designs are without limit, and may fairly be likened to the use of colour and brush. Figuring with double cloths may perhaps best be compared with the use of extra material, as we have not only a figure of one colour upon a ground of a totally different colour, each formed by different materials, but any amount of figuring may be introduced without affecting the structure of the cloth, and moreover, the

fabric is reversible and may be used on either side. The advantage of figuring with double cloth, apart from the question of utility, is that the figure is perfectly solid in colour, upon a ground equally solid.

Gauze, net, and lace are forms of ornamentation quite different from all other classes of fabric, and for lightness and elegance of fabric, as well as for the variety which may be introduced into the design, far exceed all others. Gauze is perhaps the most simple, and in the forms in which it is now generally made is probably the easiest of production; at any rate, it possesses one advantage over both the others—it can be combined with ordinary woven fabric, either for the purpose of varying the design, or for ornamenting a cloth of closer or heavier texture. The other two will give a greater degree of openness and lightness.

Plush ornamentation is peculiar to itself; it may be made to form simple figures, or the pattern may be in the plush itself. In what are commonly known as velvets—that is, where the pile is very short—the ornamentation is usually confined to the use of colour, in stripe or check form, or the formation of figures by the pile; but in what are commonly termed plushes, where the pile is longer, the ornamentation more generally takes the form of making the pattern in the plush itself, either by waving, crimping, or varying the length of the pile, or some such expedient. We have used the terms velvet and plush here in the popular sense, not with the intention of making a distinction between the two, for they may be taken as being practically synonymous, so far as the manufacture of such articles is concerned.

133. Ornamentation by different Tension of the Threads, etc.—In addition to the methods of ornamentation we have referred to, there are many others which can scarcely be called regular, but are the result of some freak or fancy on the part of the designer or manufacturer—such, for instance, as the introduction of slack or tight ends in the warp, either singly or in numbers.

Suppose we allow a single end at intervals to run into the cloth much slacker than the rest of the warp ; it will crimp all along as the cloth is formed, and if it be a different colour from the body of the cloth, it will assert itself very strongly and produce quite a novel effect. Again, if a number of these threads have different degrees of tension, and of different colours, the effect will be still more novel. Another use of tight and slack ends is to form crimped stripes. Suppose one portion of the cloth is woven quite plain, and the rest twilled, or satin, the two running side by side in stripe form :— the twill or satin, if not very much more closely set in the reed, will permit much more weft being inserted than the plain ; then if the warp threads come off separate beams, one for the satin and the other for the plain, and the latter is allowed to go in quite slack, the weft as it is beaten in will carry the plain cloth forward, while the satin portion is quite straight, and so cause regular crimps or waves in the plain portion. These crimps may be increased or decreased, made more or less prominent by varying the setting of the warp threads in the plain or satin portions, or by varying the tension at which the warp threads are held.

134. *Utility combined with Ornament.*—We may now consider the question of utility combined with ornamentation, or, in other words, in all the various forms of ornamentation with which we have dealt, examine into their effects upon the fabric, and see how far they will affect its utility. Beginning again with plain cloth, as we have shown, when warp and weft are equal, there is no ornamentation except by the use of colour ; but we have a strong useful fabric, not heavy, except so far as the thickness of the threads of which it is composed makes it heavy, and not of a close or compact texture, owing to the order of interweaving of its threads, but yet strong and useful for the quantity of material which it contains. If we ornament it in its structure, it must be by the alteration of the relative quantities

and thickness of the warp and weft; and in doing so we increase closeness of texture, generally also bulk and weight of fabric. By increased closeness we obtain necessarily increased strength; for although each unit of strength, as represented by any single thread, may be less than in an ordinary plain cloth, the combination of these units will give greater strength to the whole. So that by ornamentation we increase usefulness both in wearing properties and in the power of retaining warmth as an article of clothing.

When we ornament by twilling, we again obtain practically the same results—namely, increased weight, strength, and closeness of texture. The order of interweaving of necessity produces these results, but in different degrees, by the different kinds of twilling; so that it becomes necessary for the designer in making his pattern to consider thoroughly its effect upon the fabric, and the kind of fabric he desires to produce; and the relative quantities of warp and weft must be carefully proportioned to the design of the twill.

When we come to figuring with the material which forms the ground fabric—that is, when the fabric is of a given structure, and a figure formed by the weft and warp ceasing to interweave, and one coming to the surface as loose material—whatever may be the structure of the ground cloth, the formation of the figure must in some degree detract from it. If the ground is plain, we shall have a firm texture, though perhaps somewhat open; but when figure is formed, we have positively no texture, simply so much loose material; in that case the usefulness of the fabric is decreased, and just in the ratio of the amount of figures introduced. If the figures be small and closely set together, the texture of the cloth as a whole will be looser; if they be large, then it will give extreme looseness in the figured portion, and will not much affect the ground, which will be in proportionately large patches; but the cloth will be very irregular in texture, and this of itself is a serious drawback. Then,

for useful purposes, the small figures, equally distributed, are preferable; for if the texture be very much loosened, we may to some extent compensate for it by the introduction of more material, either in warp or weft, or both, and treating it somewhat as we should treat a twilled cloth. Whatever applies to figures upon plain cloth also applies equally to figures upon any other ground, when the figure is formed by loose material.

If our figures are formed upon the principle of diapers or damasks—that is, by the warp and weft merely changing places, and still preserving the same order of interweaving—then our figures may be as large or as frequent as we please, without in any degree impairing the utility of the fabric.

When we introduce extra materials for the formation of figures, we in no degree affect the ground cloth, either for better or worse; it is merely applying so much colour to the surface, adding certainly to the bulk of the fabric at that point, but not necessarily increasing its usefulness, the extra material being in most cases simply laid loosely on the surface, so that it possesses no special wearing qualities, and will not add materially to the powers of the cloth for keeping warm. Of course we are speaking of the formation of spot figures by extra material. If the extra weft or warp be distributed over the whole area of the fabric, then it becomes a different thing; especially if it be bound into the cloth at the back, for it will then form a kind of double cloth, and often really two distinct fabrics. Of course in such cases we add to the fabric in every way; we increase bulk, strength, and closeness of texture, and have a better wearing and a warmer article, as well as one more ornamented. Double cloths should always be treated under two distinct heads—first, when one of the cloths forms merely a lining; and second, where the two cloths exchange places to form patterns. The former may include all cloths where either two warps and two wefts, or where one warp and two wefts are used, if

one surface be different to the other in texture and in pattern, and where one is intended for the wearing surface and the other merely as a lining. The second should include all cloths which are reversible—that is, which are wearable on either side, or in which either side may be made the face—whether there are two distinct cloths, or merely two faces formed either by two wefts and one warp, or two warps and one weft. In the first class will be included all fabrics which have a fancy face and a plain back, and which for wearing purposes are extremely useful. The texture of the face is usually fine, and ornamented according to the purpose to which it is to be applied, possessing generally all the qualities of useful fabrics. The back is of a more or less plain character according to the weight to be obtained, or it may be governed by the pattern and texture of the face, so that they may bear a proper relation to each other, its chief purpose being to give weight, strength, and warmth. In producing heavy cloths, as those required for overcoats, this principle is absolutely necessary, because the proper weight and texture of cloth could not be obtained in a single cloth. If we obtained weight it would be at the cost of fineness, and fineness would be obtained at the cost of weight; but by the combination of two cloths, or two surfaces, we can comply with both requirements at once.

When the cloth is reversible, both fabrics or both sides of the same fabric are equal in quality and texture, though perhaps different in colour. Each surface may remain the same throughout, or they may exchange places. Their exchanging places is merely for the purpose of forming patterns; it will not affect the structure or utility of the fabric as a whole. If the fabric consist of two separate cloths these will exchange places bodily, each preserving its own individuality; they continue to weave weft with warp in each cloth as though no exchange had taken place. If it consist simply of two wefts and one warp, or two warps and

one weft, the wefts or the warps only exchange places ; but on whichever side of the fabric they are weaving, they still preserve the same order of interweaving weft with warp. In fact, it may be said to be a double diaper, or damask, inasmuch as weft and warp always bear the same relations to each other in their orders of interweaving, whichever may be uppermost, so that whether figured or plain, the utility of the fabric is not impaired in the slightest degree. With respect to gauze fabrics we need not say much as to their utility ; they are essentially fancy or ornamental cloths. Strength they may possess, but for warmth and general wear they are not specially suited, so that we need only regard them, except under exceptional circumstances, from a decorative point of view, and if we should have to consider them for purposes of utility, it will be in combination with other orders of working, and the conditions which apply to other fabrics will also apply to them.

Plushes are essentially useful fabrics, as well as heavy ones, and in ornamenting them we very rarely impair their utility, except in the slightest possible degree. The body of the cloth must at all times be a very strong, compact structure, so as to hold the pile with sufficient firmness ; and whatever ornamentation is introduced either with or in addition to the pile, or whatever is done with the pile, will not much impair the structure of the body. The wearing surface may be more or less affected, but that is not generally a serious matter, but the body of the cloth will never be much affected. This is equally true of both weft and warp pile.

When we ornament with coloured threads we do not affect the utility ; the structure is not altered. We determine the structure of the cloth to suit it for the purpose to which it is to be applied, and then vary the colours of the threads of which it is composed, so that we first say what the cloth shall be, and then how it shall be ornamented with colour ; and although we may have to consider the structure in applying the colour

yet the colour cannot affect the structure nor its utility as a fabric. If we ornament by varying the degrees of tension of the threads, then we do impair the structure, for any strain thrown upon the cloth will be thrown upon the threads which are tight, and as they are only a portion of the whole, they cannot be expected to bear as much strain without fracture as if the strain were equally distributed over the whole fabric. Consequently fabrics of this kind must be made for purely ornamental purposes, and never considered as articles of utility, unless the slack threads are very few indeed.

135. The Special Knowledge required in the Manufacture of Fabrics.—We may now understand the special knowledge required in the manufacture of textile fabrics, and upon what it is dependent. We have first to consider the nature of fabrics, and the uses to which they are to be applied. Having determined what we require, the character of the fibre from which the fabric is to be made, and the structure of the thread, we must next enter fully into the question of the structure of the cloth, considering it first from the useful point of view, then from the ornamental, or from a combination of the two. In any case thorough mastery of the different structures, of the various modes of ornamenting in the structure, and also of the effect of ornament upon structure, so as to know the extent to which utility will be impaired or increased by the particular method of ornamenting, is absolutely necessary. Given all this, along with knowledge of the mechanical operations of weaving and also of decorative art, and the designer possesses all the materials for the successful following of his vocation; he will only further require those qualities which are essential in every walk in life—energy, perseverance, and a right application of his industry and knowledge.

GLOSSARY.

Angle of Twill.—The angle which a twill forms with the weft or warp.

Backed Cloths.—Cloths having a back woven upon them which serves as a lining.

Beams.—Rollers upon which the warp threads are wound side by side before being put in the loom. There are also cloth beams upon which the cloth is wound as it is formed.

Binding in Cloths.—The securing together in the process of weaving two separate cloths, or extra material used for figuring or other purposes on an ordinary single cloth.

Bobbin-Net.—An open perforated fabric formed by a series of threads crossing and partially twisting round each other.

Checks.—Patterns which are usually formed by coloured threads crossing each other at right angles.

Chenille.—A thread having loose fibres projecting from it.

Choking the Shed.—When the warp threads are so numerous, or of so rough character that they will not pass through between each other, and separate readily into two portions between which the shuttle may pass.

Cockling.—When the cloth, instead of presenting a smooth, even surface, is irregular, some portions standing up in bubbles.

Cords.—Cloths with ribs which run longitudinally, or in the direction of the length of the fabric.

Corduroys.—Cords formed with cut pile.

Crammed Stripes.—Striped fabrics in which one portion contains more warp threads in a given space than another portion.

Cutting Plush.—Severing the threads which are to form the "pile" or surface of the fabric.

Damask.—A cloth said to be named from the city of Damascus, formerly made of silk, but now of worsted or linen chiefly.

Density of Pile.—The closeness with which the threads of velvet or plush are set together.

Diagonals.—Patterns arranged to run in a diagonal direction across the fabric.

Diaper.—A cloth similar to damask, but with the pattern of a "chequered" character.

Double Cloths.—Two separate fabrics woven and fastened together in the process of weaving.

Doups.—A special arrangement of healds used for gauze weaving, and so arranged that they may cause the warp threads to cross each other.

Elongated Twills.—Twill which do not run across the fabric at an angle of forty-five degrees.

Extra Warp or Weft Figures.—Figures formed upon a fabric by material which takes no part in the formation of the body of the cloth.

Figured Cloths.—Fabrics having a pattern formed upon them by the order of interweaving of the weft and warp of which they are composed.

Figured Twills.—Figures running diagonally across the fabric.

Floats.—Where the weft and warp of which a fabric is composed do not interweave with each other. Sometimes patterns are formed by "floats" only, and sometimes "floats" are formed accidentally in the process of weaving, and produce imperfection.

Flushing is sometimes used in the sense of "floats."

Fraying.—One set of threads slipping upon the other, and so producing imperfections in the fabric.

Gauze.—A light perforated fabric in which the warp threads are made to twist more or less round each other.

Healds.—An arrangement for effecting the separation of the warp threads, so that the shuttle carrying the weft can be passed between them. The heald consists of a series of cords having an eye in the centre, and attached at each extremity to a flat piece of wood, called the "heald shaft," the warp thread being passed through the eye of the heald. Whenever the heald shaft is raised or depressed the warp threads are also raised or depressed, and so the warp is separated into two portions for the shuttle to pass between.

Jacquard Machine.—An apparatus for separating the warp threads in a similar manner to healds but on a more extended scale, and consequently facilitating the production of elaborate patterns.

Lace.—An open perforated fabric produced by the threads of which it is composed being twisted together in such a manner as to form patterns.

Lappet Figuring.—Figures or patterns produced on a fabric by a warp thread being made to cross and recross on its surface by means of a "lappet frame."

Madras Muslin, or sometimes called Indian Muslin.—A light fabric figured by the insertion of thick weft threads, which are cut away where there is to be no figure.

Net.—A fabric formed in a manner somewhat similar to lace, but having its perforation equal.

Pile.—The threads which issue from and form the surface of fabrics such as velvets.

Plain Cloth.—A fabric in which the warp and weft threads are placed at right angles to each other, and which interweave alternately.

Plush.—A fabric the surface of which is covered by short threads which issue from the body of the cloth.

Repps.—Fabrics ribbed across the piece.

Sham Plush.—An imitation of a plush fabric produced by using Chenille weft. Sometimes sham plushes are made by "raising"—that is, dragging—the fibres partly out of a cloth of ordinary loosely constructed fabrics.

Shed.—When the warp threads are separated for the shuttle to pass through.

Shuttle.—A small apparatus for carrying the weft, and which is passed to and fro through the warp.

Swivel Shuttles.—An arrangement of small shuttles for forming figures on a fabric, somewhat after the manner of embroidery.

Tabby.—A name commonly applied to plain cloth.

Twill.—A pattern running diagonally across the fabric.

Velvet.—A short or closely shorn plush.

Warp.—The threads which run lengthwise in a fabric.

Weft.—The threads which run crosswise in a fabric.

Yarn.—The threads of which a fabric is composed.

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