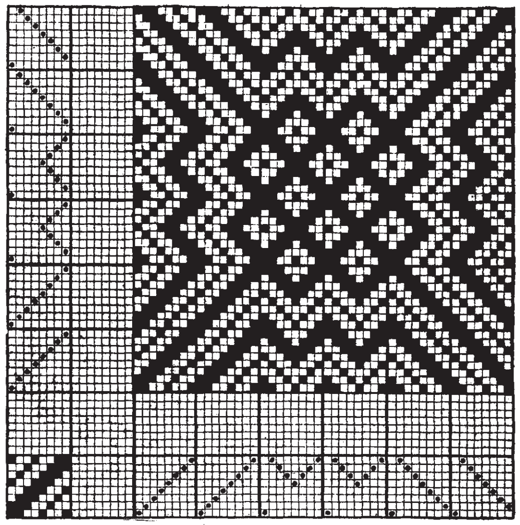


Fig. 93.

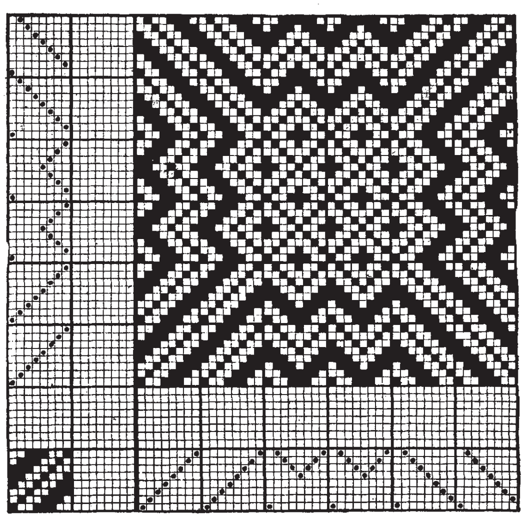


Fig. 94.

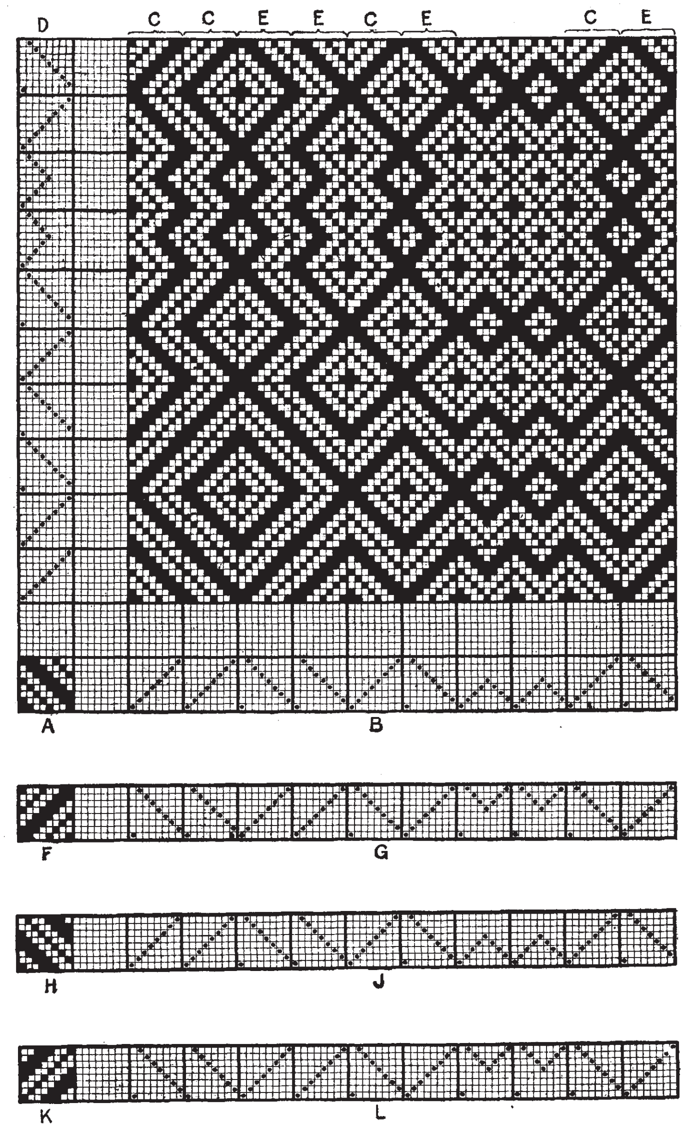
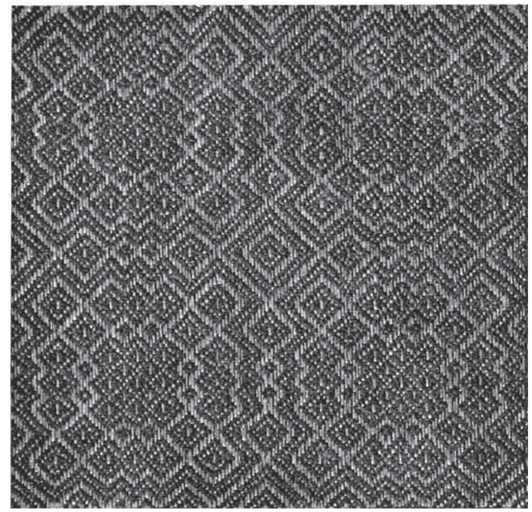


Fig. 95.

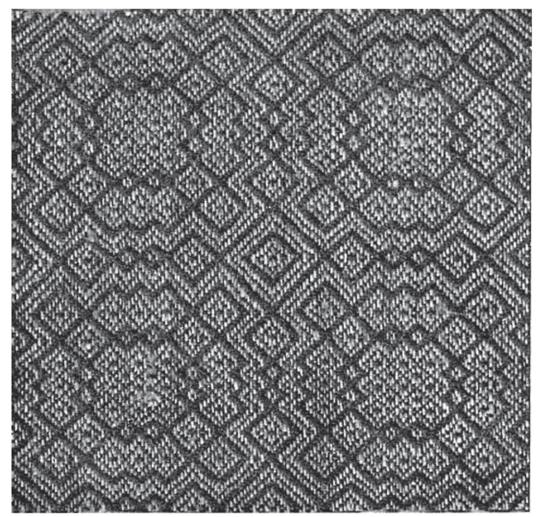
requirements are the draft and the weaving plan, the latter being arranged from the draft. The first eight threads marked T from the 1st to the 48th pick constitute the weaving plan for Fig. 88, but with the same draft and part U as weaving plan, it is possible to produce the design in Fig. 92. Similarly part V is the weaving plan for Fig. 92, but part W may serve to produce Fig. 88.

The number of diamond designs is greatly increased if both methods of production—*i.e.*, with drafts as at B and F in Figs. 83 and 84—are combined. Thus, still adhering to the same 8-thread weave, we have, by the joint method of drafting, made the diamond shown in Fig. 93, and a different design would result if the initial weave twilled in the opposite direction. An alternative method of obtaining a similar design is illustrated in Fig. 94, produced as shown by commencing the initial weave with the thread $\frac{1}{2}\frac{3}{2}$. Again, the same weave, but twilled to the left, may be used if another effect is desired.

The foregoing demonstrates clearly that it would be extremely difficult, if not altogether impossible, to define the possible limits of this joint method, even if we were confined to one weave unit. It has been shown that any desired size of diamond may be obtained even with a small weave; the same principle may be employed when using a more elaborate weave, the diversity of effect increasing with the varied character of the weave. It is impossible to show this except by large designs, and these when reduced to the proportions necessary for reproduction would lose all their effect. We, however, conclude this unique method by a design of a rather larger size, as shown in Fig. 95. Here we show three distinct sizes of diamonds formed by the heavy lines; in addition to these, there are diamonds of a different character, and also semi-lozenge figures. The

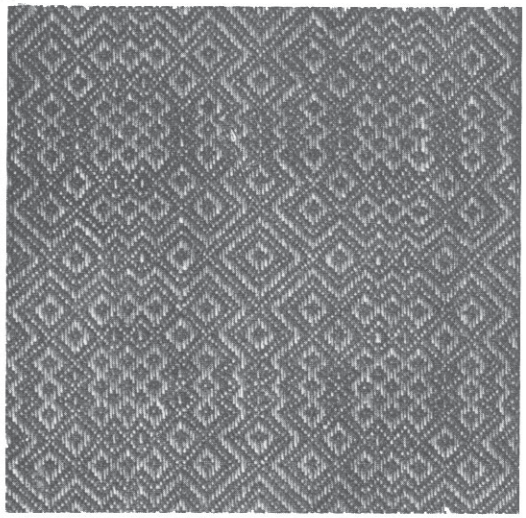


M

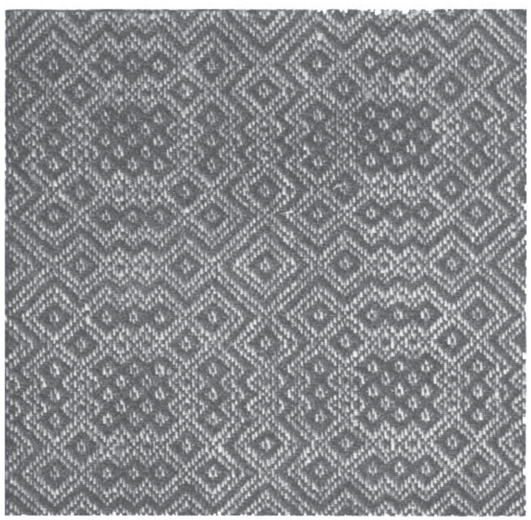


N

Fig. 96.



O



P

Fig. 97.

means by which the effect has been obtained are clearly shown in the figure :—

A is the base or unit weave.
B „ draft of the cambs.
C „ weaving plan.
D „ picks arranged in order of draft.

We think that this figure is sufficient to prove that, with suitable arrangements of drafts, it is possible, theoretically, to obtain diamonds graduated from as large as we wish to the smallest effect obtainable by the particular weave adopted.

Figs. 96 and 97 are photographical reproductions of cloths made from designs of the above nature. Pattern M is made from the design in Fig. 95, while pattern N is the reverse side of the same cloth. Pattern O, Fig. 97, is the right side of the cloth, and pattern P is the reverse side of the same cloth made from a design composed of the unit weave H and draft J, Fig. 95. A different design would result if plan K were taken for the unit base ; but if, in conjunction with this base, the draft L were employed, and the picks arranged to correspond, the same design would be obtained. Similar remarks are applicable to the weave units and drafts A, B, F, and G. The reader is advised to work out designs from drafts B and G, using part E as the weaving plan.

Having explained at some length the possibilities of the straight or rolling twill in the production of diamond patterns, we must now consider the methods to be followed when basket weaves are utilised for similar purposes. It has been shown that there is practically no restriction with the former kind of weave—a base or unit weave on any number of threads and picks may be chosen, and the turning point in the draft fixed at will. In patterns where the basket weave is present, however, certain limitations are presented. In breaking up a three or other odd float, as explained in reference to S, Fig. 87, the warp threads only were considered; but it is quite clear that if the required condition obtains with respect to the initial thread in the twill weave, it will apply likewise to the initial pick. This is clearly shown at S in Fig. 87, for the first thread and the first pick begin and end in exactly the same manner. These remarks, however, do not apply without modification when splitting up a 3 or a 5 float in a basket weave. Where such a weave occurs, it is obvious that so far as the warp threads are concerned this splitting up may be done on any one of the three or five threads respectively, according as the basket effect appears in solid blocks of 9 or 25 squares. With a basket or block of 9 squares, the only possible way of breaking up the group, provided that the foundation lines of the diamond are required to appear in basket, is shown at P in Fig. 98. The solid marks represent the unit weave as it should be commenced, and it will be observed that the beginning and the finish of the first thread are identical with the corresponding parts of the first pick. Should the basket effect be required to form the inside portion of the diamond, then the arrangement should be as at Q in the same figure. Here the choice of the initial thread and the initial pick must be such that both the twill part and the basket part—the latter both in the way of the warp and of the weft—will be split so as to fulfil the necessary condition of having one square more of the total float at the beginning of the base weave than at the end. In both designs, the first turn of the weave, *i.e.*, in the way of the warp, is shown in crosses; while the turn in the weft is illustrated by dots. The observance of these little yet important details enables one to produce the basket

parts in their proper sizes, although every case of the

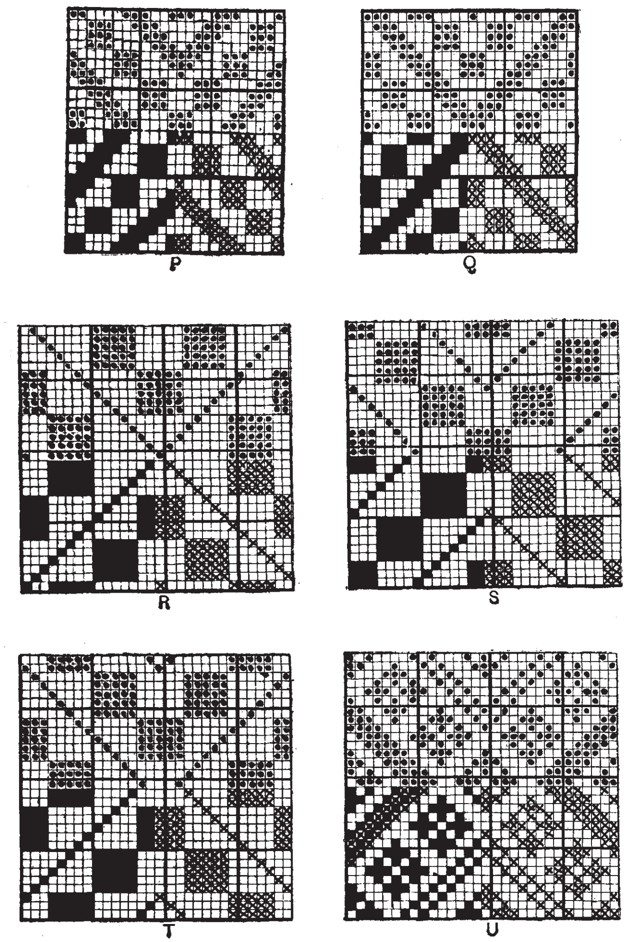


Fig. 98.

form of Q cannot be satisfied in this manner. Should the student seek to apply these instructions to a diagonal weave on 9, 15, etc., threads and picks, where three or five groups of basket appear in the weave, and where the straight twill float is over an odd number of picks, he will find that it is impossible to get an effect similar to Q in the above figure. In other words, with such a weave on an odd number of threads and picks, it is impossible to get the diagonal parts in continuous straight lines, and at the same time have perfect squares in the basket parts of the design. To obtain a perfect result, the number of threads and of picks in the unit weave adopted must be equal to $2mn$, where m = any number greater than 1, and n = the number of threads or picks in the basket group. It is easy to see that the number $2mn$ is even. If the number of threads in the unit weave were odd, and the float of the straight twill part also odd, it is evident that their difference would be an even number. Now, when from this even number we deduct the float of the basket—an odd number—we are left with an odd remainder which cannot be split so as to give equal spacing on each side of the main diagonal lines. Designs R and S, constructed from the 15-thread twills given, demonstrate this clearly, although perhaps not exhaustively. The weaves might be commenced at other points, but similar imperfect results would ensue. R is a very imperfect design, and would never be used in practice; S is a feasible design, for here the basket parts are perfect, but the spacing on each side of the basket is unequal. This could be remedied by adding another row of marks to the twill parts on the right and left-hand sides of the design, but the unit could then be used only as it stands—the twill part would have a float of two, and consequently could not be utilised to form continuous diagonal lines. Similar remarks apply to

design T, which differs slightly from the last examples. These designs are given with little ornamentation, in order that the method of construction may be clearly seen, but all three might be modified, and probably improved, by judiciously adding some and taking away other spots. Design S has been so treated to form design U in the same figure. The space on each side of the diagonals is equal, but in order to obtain this result it has been necessary to add the marks ✕ to the solid unit, and to make the corresponding alterations on both sides of the design. Such alterations show clearly that the design may be considered as being formed from an irregular unit, and not from a regular weave.

The method just described leads us naturally to the third method of forming diamonds, as illustrated at A, Fig. 99. It consists of first forming the foundation or base lines as indicated by the solid marks—that is, commencing on the first thread and first pick, and running out one diagonal on the desired number of threads and picks; then commencing on the second thread and last pick, and twilling in the opposite direction. The four half diamonds thus formed may be filled in as fancy dictates, but generally in symmetrical form, while keeping in mind the cloth for which the design is intended. If they require filling in with straight twills it is only necessary to observe that the marks added within the diamond shall be situated at regular distances from the base lines. The top and bottom parts of A show this method of filling. If, however, any basket weaves or other small spot effects are to be introduced, some little consideration will require to be given before the marks are added, in order that the space at disposal may be properly utilised, and that a symmetrical arrangement

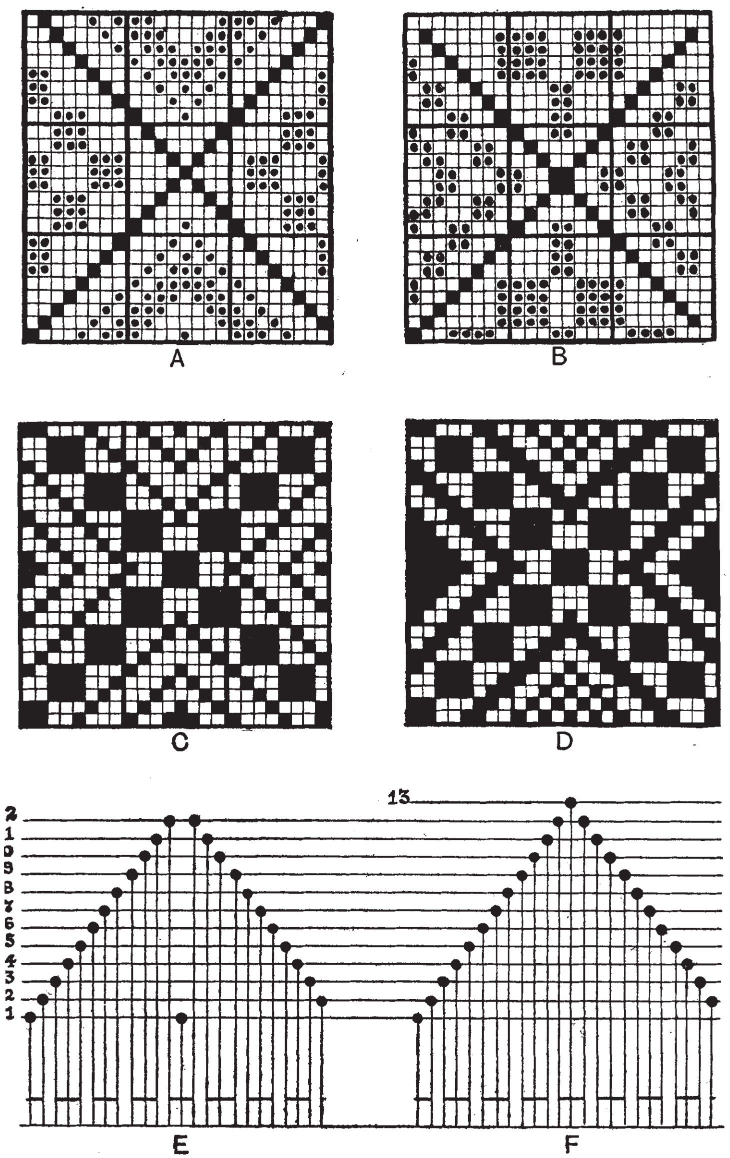
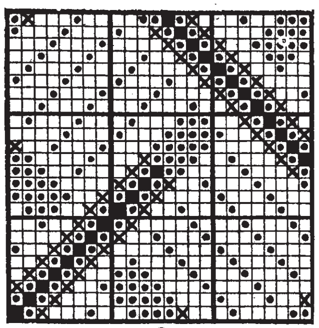


Fig. 99.

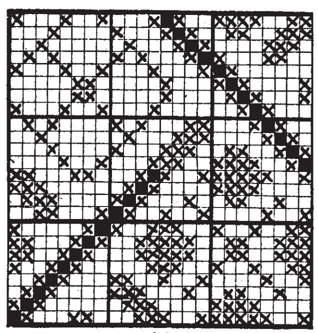
may be obtained. Methods of calculation might be formulated to give assistance in this respect, but the simpler way is to find out by trial what is most suitable. This may be done by beginning at the centre of the diamond and then working outwards and around it. The right and left-hand portions of A have been treated in this manner. Design B, Fig. 99, is developed on the same principle, but on an odd number (23) of threads and picks. The design shows that if an odd number be selected, a double thread—technically termed a "flat"—will result. Except on special occasions, two threads working as one is a distinct fault, and should be avoided. It will be seen that the base at A, Fig. 99, is made on exactly the same principle as that for the honeycomb design already given in A and B, Fig. 55 (p. 69).

Designs C and D in Fig. 99 have been introduced to show that the system of drafting at F may be derived from that at E by altering, if it is thought desirable, the centre of either diamond or the centres of both. Consequently, after the design has been prepared according to the method of drafting illustrated at E, any symmetrical alterations may be made on the pattern with an increase of only one shaft in the draft. Such alterations affect the draft only so far as the similarity of the turning threads is concerned; when these differ a shaft is required for each, but when they are alike they may be drawn on one shaft. A comparison of the drafts E and F shows that in the latter the thirteenth thread has been transferred to an extra or thirteenth shaft, due to the change effected in design D, as compared with the original design C. The reeding is indicated by the short horizontal lines as being in threes. This order prevents the breaking up of the basket portions.

The fourth method of forming figures of a diamond nature, or what might be termed diamonds with interlacing foundation lines, consists in arranging the foundation or base lines on the principle illustrated by the solid marked squares of G, Fig. 100, and then adding to or taking from these marks, as seems most desirable. In G, which is arranged on 24 threads and 24 picks, the solid marks were first twilled straight for 12 threads and picks; then beginning on the thirteenth thread and the twenty-fourth pick, the twill was reversed to the twenty-fourth thread and thirteenth pick. The crosses were added next, and finally the dots to complete the design. H, in the same figure, is a slightly different development on the same base lines.



G



H

Fig. 100.

Double interlacing effects may be obtained by similar methods, as indicated at J, Fig. 101. This result might be classed under the third system of forming diamonds, since, if two parallel bars of marks form the base line of the design, the consequent line of blanks between them might be taken as the guide. The solid bars in such cases must be the same distance apart from the corner square or true diagonal of the design. Having determined such distance,

and the extent of the float for the solid bars, the latter are twilled or run out in the ordinary way, sufficient squares being left blank where the twills intersect to break the continuity of the line. Design K, Fig. 101, shows the same base lines, but separated by a wider gap. The foundation lines in this design are almost completely over-

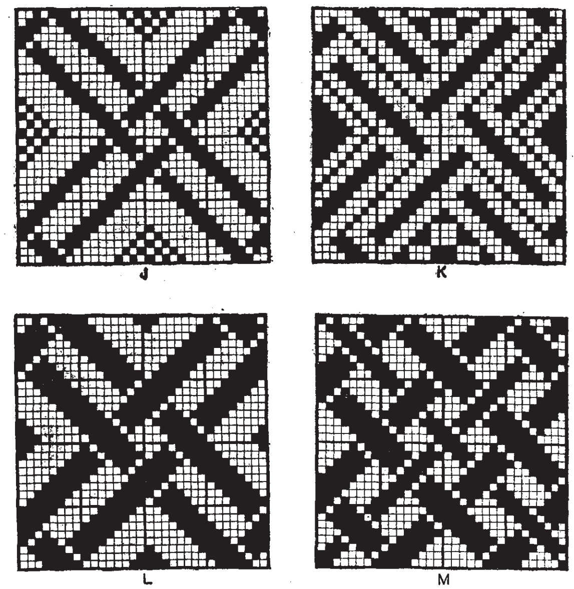


Fig. 101.

shadowed by the amount of detail added. The effect desired is all a matter of taste, but examples of this kind point out the desirability, if not the necessity, of studying closely the various methods of development. If the base lines are required to be very prominent, then broader lines and less detail should appear; this is emphasised at L in the same figure. Design M shows a further example, but composed of three bars in both directions. The diamond effect, or base, is almost completely lost because of the relatively small size of the design. In Fig. 102 the same base lines have been applied in a modified form, and, although some detail has been added, the constructional lines are much more distinct.

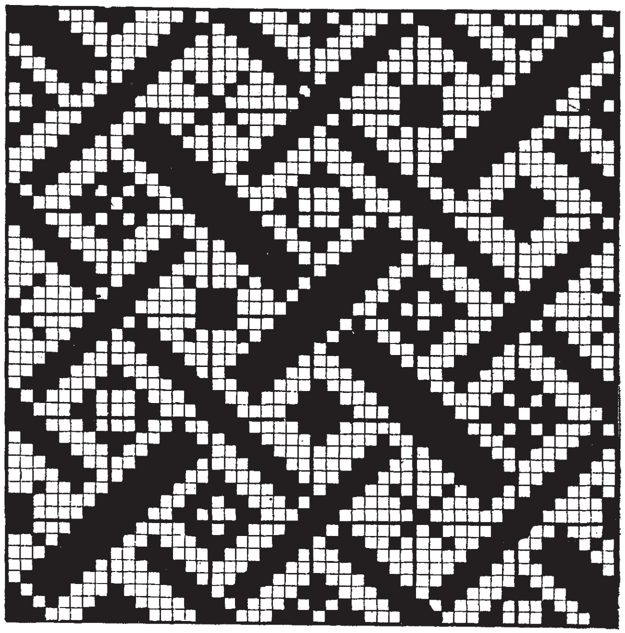


FIG. 102.

Designs of the above character, although approximately symmetrical, are yet sufficiently removed from the strict fulfilment of that condition to require a straight draft; they are, therefore, generally beyond the range of a dobby machine of ordinary compass. For the production of these designs, a harness or jacquard machine is desirable. It

should, moreover, be mounted, say, for 192 or 384 hooks or threads—numbers which contain many sets of factors.

CHAPTER VII

DICES

Dice Patterns.—All patterns of a counterchange character, of which there is a large variety, and for the production of which there is practically an unlimited field, may be classed under the above head. The 2-shaft plain weave, in its elemental form, is a perfect example of this condition of counterchange, although from a structural point of view it is unsuited for designs of a dice character. This weave, however, and its derivatives (see Figs. 8 to 22, pp. 11-19), provide us with an almost endless variety of suggestions or motives for the development of dice patterns. In all such patterns, produced from warp and weft of one shade or colour, the effect depends primarily upon the predominance of the warp and of the weft in contiguous rectangles, and to ensure that the yarns will predominate on the surface of the fabric, and in equal proportions over the different parts of the design, the two weaves which are chosen for the structure of the cloth are almost invariably the counterpart or complement of each other. All fundamental straight twills, satin weaves, and a few of their derivatives, are available for this purpose, although some are more suitable than others, and are therefore more often used. For linen goods the weaves most usually employed are the two 4-shaft broken twills and the two 5-thread sateen weaves, while occasionally sateens on a greater number of threads are used. Straight twills are also employed for these goods, and usually with satisfactory results. The best effects are naturally obtained from weaves which permit the warp and the weft to predominate to the greatest possible extent in their respective rectangles; nevertheless, in the choice of any particular pair of weaves it is necessary to take into

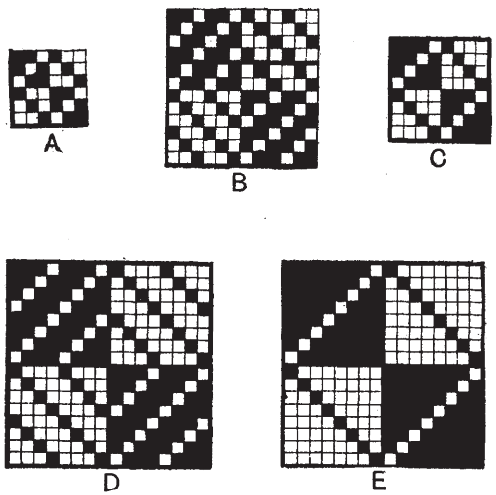


Fig. 103.

consideration the sett of the cloth, the kind of machine at command, the use to which the fabric is to be put, and finally its price.

Five dices of a simple character, which have been produced from straight twills, are shown in Fig. 103. Design A requires six shafts, and so does design B, but the same draft will not do for both. Similarly, eight shafts are required for designs C and D, but again the drafts will be different. Although designs A and C are distinctly dices in principle, they are much too small to produce such effects in the cloth. Designs B and D may be considered as the smallest sizes of dices, and even these are suitable only for moderately coarse textures. Nevertheless, they illustrate the two chief principles which are essential to the proper construction of such patterns. In each case it will be observed that the twills run in opposite directions in the adjacent portions of the design, and that where the warp float portions meet the weft float portions, the contiguous threads, as well as the contiguous picks, are the exact opposite of each other. In other words, the threads "cut" and thus firmly bind the edges of the pattern. This very desirable condition in dice patterns is more fully illustrated in Fig. 104, which shows at F and G respectively the incorrect and correct methods of treating the 4-thread broken twill. In G, which shows four repeats of the twill in each section, the first and last threads and the eighth and ninth threads form two pairs of cutting threads. A similar cutting effect obtains between the first and last and between the eighth and ninth picks. This, however, is not the case with the incorrect design F, where, although the twills have been reversed, and the first and last threads, as well as the eighth and ninth threads, cut correctly, the corresponding picks do not cut. In this instance the fault is due to the order adopted in developing the weave. In the correct method the order of marking is 1, 3, 2, 4, while the order of marking in the incorrect dice is 1, 2, 4, 3. The order of marking makes no difference in the cloth, provided that an all-over weave be used; it is only when two weaves of a warp and weft float respectively are combined, as in dices, that any attention to order of marking is necessary.

A defect sometimes urged against the correct method, as illustrated at G, occurs at the junction of the eighth and ninth threads and picks, where the four adjacent squares form plain weave. This defect is repeated at the junction of the sixteenth and first threads and picks, and it produces a somewhat open or pinhole effect. To obviate this result, the weave is sometimes started on the second

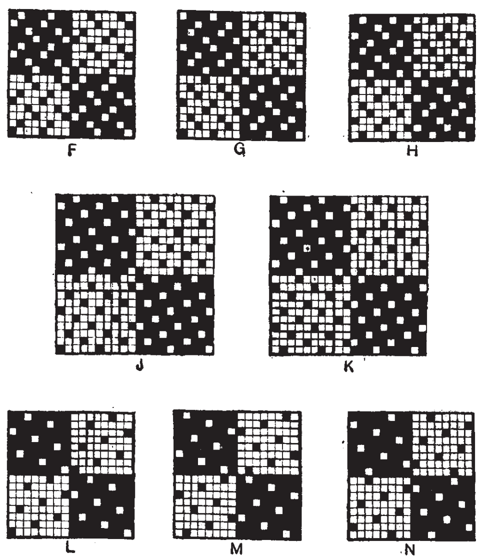


Fig. 104.

thread, as shown at H. The order is still 1, 3, 2, 4, commencing on 2; the arrangement is therefore 2, 4, 1, 3. This is probably the better way in which to arrange this weave for the production of dices, since, in addition to obviating the above defect, it is in keeping with the regular method of beginning the 5-thread and the 8-thread sateen weaves—viz., on the second thread. The incorrect

and correct methods of arranging dices from the 5-thread sateens are shown respectively at J and K. The incorrect dice from the 8-thread sateens appears at L, while two correct arrangements are illustrated at M and N. In designs H, K, and M, the first point is placed on the second thread—a fact which can easily be remembered. Although this thread is in general as satisfactory as any other, still it is not the only satisfactory thread, as design N testifies; moreover, in special cases it is unsuitable. The incorrect dices, F, J, and L could, obviously, have been made to cut if the top half of each design had been made the reverse of the lower half—and designs can be so treated —but, if this were done, more difficulties would be introduced in designs of a more complicated character, as for example, Fig. 107.

Having explained the conditions which are essential for the production of perfect dices, and emphasised them by illustrations, we shall now endeavour to show how to determine the correct starting point or points. In Fig. 28 (p. 29) we have shown how it is possible to obtain all the sateen weaves from the fundamental units; and at A, Fig. 105, we reproduce one of the 8-thread sateens. If we examine this weave for two successive picks, which read from opposite sides of the design in precisely the same order, we shall find that the third and fourth picks, as well as the seventh and eighth picks, fulfil this condition. Any weave which contains two such picks may be split up between them, and then used for the formation of correct dices. The first and last picks of the ground weave will then be, as it were, the images of each other. This is clearly shown in weaves B and C in the same figure, and the dices formed from these units have already appeared at M and N in Fig. 104. The 10-thread sateen weave D, in Fig. 105, has been split up in the same manner, and the designs E and F show the two correct ways of starting the weave, while G and H illustrate their respective dices. A dice pattern from an irregular sateen appears

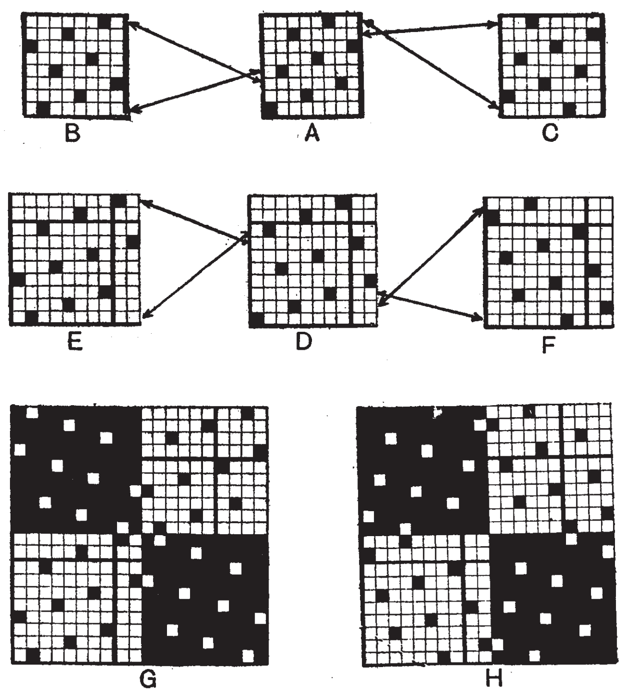


Fig. 105.

at J, Fig. 106, while K, which is of an entirely different character, is made from the same base weave, but starting on the fifth pick. Weave L shows the regular method of arranging the 6-thread sateen twill, weave M shows the arrangement after splitting up the weave between the first and second picks, while design N illustrates the smallest

dice which can be made from weave M and its complement. It is easy to see from weave O that all fundamental straight twills may be used for dices, and weave P demonstrates that all the above weaves on an even number of threads may be split up in the middle and then used for

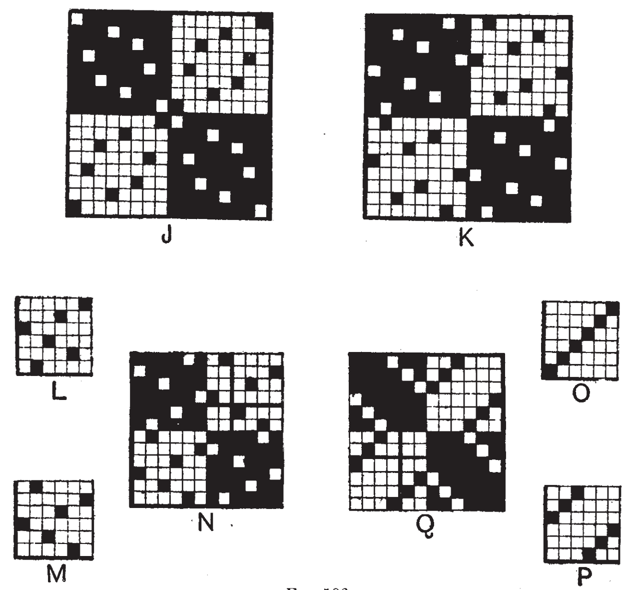


Fig. 106.

similar purposes. Design Q is a typical example of a dice made in this manner, the base weave being P.

In every case the unit weave, or any multiple of it, is first arranged in the proper manner as illustrated; the first thread of the opposite or right-hand part is then carefully arranged to cut with the last thread of the unit twill, while each succeeding thread (reading to the right) in the dark portion or warp figure is made the complement of each succeeding thread (reading to the left) of the light portion or weft figure. The two complete weaves or parts change places for the second half of the design. By attention to these details it is possible to construct any dice pattern in which the different portions will be perfectly bound. This statement naturally assumes that the number of threads and picks in each rectangle is a multiple of the twill or sateen weave used; if otherwise, special precautions are necessary. It must be remembered that all these figures have been made on the smallest possible scale: the characteristic feature of dice patterns can be obtained only when each weave is repeated two or more times in both directions.

As has already been mentioned, there is no limit to the number of ways of combining these weaves for dice and similar patterns, and in Fig. 107 we introduce a simple design on the same lines. The pattern is complete on 40 threads and 40 picks, and is composed of the same two 4-thread broken weaves that form design H, Fig. 104. The draft immediately under the design in Fig. 107 shows that eight shafts are required. The weaving plan is indicated by the first eight threads of the design, and 40 cards would be necessary if no automatic machine were used.

All the above dices are technically known as "two-division" designs—a method of distinguishing them which is due to the fact that, if all like vertical groups were placed together, there would be but two divisions. Each division requires the same number of shafts as the unit weave contains threads; thus, a 2-division design made from the 5-thread sateens requires 10 shafts (the example in Fig. 107 is a 2-division design requiring only 8 shafts).

When this class of 2-division work is made a speciality, the dobby machines are sometimes so arranged that only

4, 5, or 8 cards are necessary, according as the dice is made from the 4, 5, or 8-shaft weaves. Each card has two rows of holes, the cutting of the top row being opposed to the cutting of the bottom row. Either of the

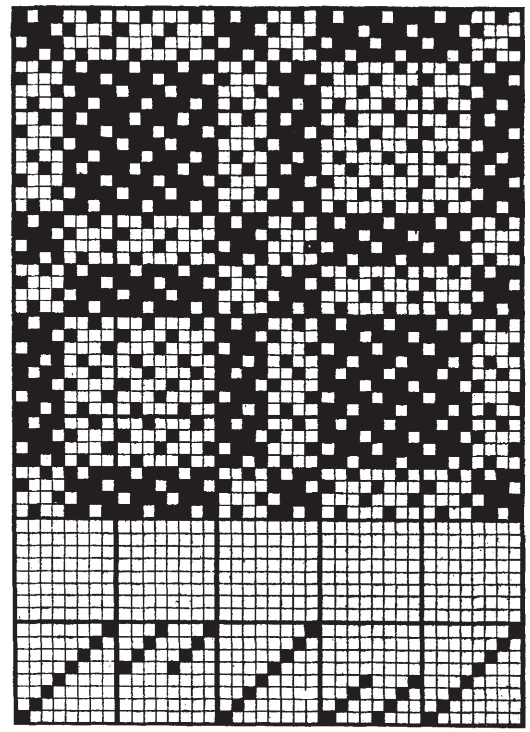


Fig. 107.

two rows may be brought to act against the needles of the dobby, and thus change the various sections from warp flush to weft flush, or *vice versa*. The controlling chain, which determines whether the upper or the lower row of holes on the card shall be in action, may be built to suit any 2-division pattern.

When a dice pattern consists of three, four or more different parts, it is termed a 3-division, 4-division, etc., design, and such patterns may be woven by a dobby machine fitted with the necessary number of needles, by a jacquard, or by the special automatic cardless dobby made by Messrs. Robert Hall and Sons, Bury. Fig. 108 shows ten designs of this type of dice, but a careful examination will show that all the ten are of the 4-division class, and, moreover, that all are composed of different arrangements of the same four divisions. The draft on 20 shafts at the bottom of the figure will do for all the designs, and, if an ordinary dobby be employed, the weaving plan shown to the right would be necessary for the production of the first design. All the other designs could be made with the same cards, provided that the draft be suitably altered in each case. If the draft remains as shown, then a fresh set of cards would have to be cut for each pattern.

The cards or lags which are used in the ordinary dobby are replaced in the automatic cardless dobby by a series of chains. Each chain controls (in this case) five shafts, and it is only necessary to move it every five picks; so that for a design on 20 shafts and 155 picks, only four chains, each composed of thirty-one links; are necessary. The parts marked 1, 2, 3, 4 in the weaving plan are obtained by the four chains shown immediately under the designs. Each large link represents five threads or shafts and five picks of the $\frac{4}{1}$ sateen, while each small link represents the same number of the $\frac{1}{4}$ sateen. The four chains and the four parts of the weaving plan may be compared in the figure by commencing at the left hand of the chains and at the top of the weaving plan. One great advantage

of the cardless dobby is the fact that no alteration of

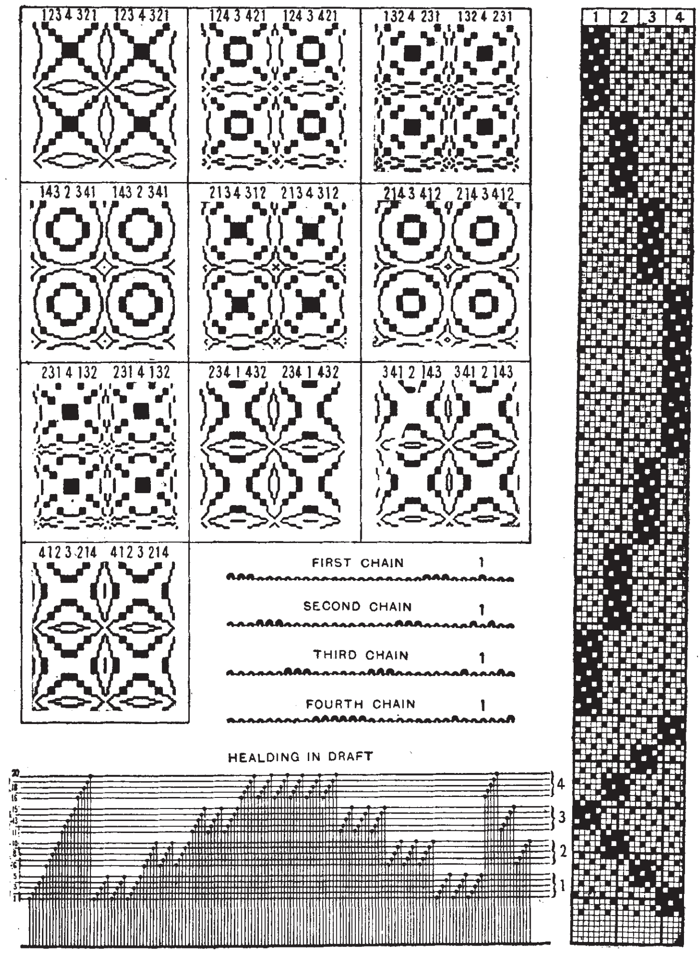


Fig. 108.

the draft is required for the production of the ten designs shown ; all that is necessary is to change the positions of the chains according as the pattern alters—a method which, although easy in the case of separate chains, is clearly impossible when the full weaving plan is on one set of cards or lags.

All the designs in Fig. 108 are continuous, or all-over effects, and the draft given would, consequently, be repeated until the desired width of cloth was obtained. If side borders were required, then any part of the draft which would give a satisfactory effect could be repeated for a convenient number of times at both sides of the fabric. This arrangement would be quite sufficient for piece-goods, and still leave the design and cards continuous. In many cases, however, it is desired to complete the appearance of the towel or the tablecloth by the addition of a cross border, and this border is usually the same pattern as the side border. Whenever this desire is put into effect, it is essential to use a special set of cards in the ordinary dobby, or a special set of chains in the cardless dobby. In some cases the centre chain may be made to form the cross border, while in many cases part of the chain may be utilised.

Two such bordered designs are illustrated in Fig. 109. The top part of either design would do quite well for a cloth with a side border, and both could be produced by the four chains illustrated in Fig. 108. The draft for the centre part of design No. 1 is the same as the draft in Fig. 108, with the exception that it has been commenced in the last group of five shafts instead of in the first group of five shafts. This arrangement simply means that the positions of the four chains must be altered, and it has been adopted simply for a variation, and for educational purposes. The side border is merely a repetition of the

first 20 threads and of the last 20 threads until the desired width of border is obtained.

The cross-border part in design No. 1 is the same as

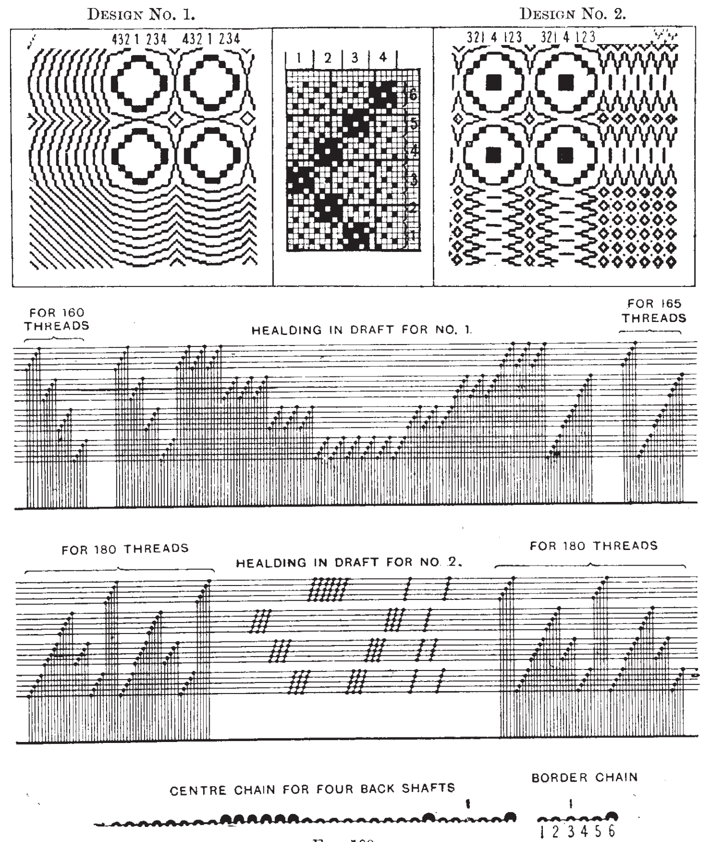


Fig. 109.

the side-border, while the corner part is a straight twill. The different parts of this border are obtained in a similar manner to those in Figs. 89 and 90. We cannot enter here into a discussion of the merits of the machine, nor into a description of it, but we may say that if any continuous part of the centre design appears in the cross border, the chains may be made to continue in one direction, or to reverse at will. These desirable movements are obtained by the introduction of an auxiliary controlling chain.

Design No. 2 in the same figure is specially interesting, for either the heavy part of the design or the small effect may be used for the centre of the cloth, and the other for the corner piece. The same long chains are still applicable, and one of them, as well as the draft, appears at the bottom of the drawing. Six repeats of the draft, or three times the amount shown, are required for each side border. The centre part should consist, if possible, of a certain number of repeats, minus the last 35 threads in the last repeat; this arrangement would make the pattern perfectly symmetrical. Weaving plan No. 2 shows only the arrangement of the shedding for the cross-border part; the short chain at the bottom of the figure is for group No. 4. Four links would give the same effect if the chain reversed on the third and sixth; a reduction here, however, would necessitate a greater number of links in the controlling chain, in addition to an excessive amount of reversing. If the reversing were done in this way, the last four links of the large chain would be utilised for the border. A better way would be to use the last four links and the first three links—seven in all,—thus reducing the reversals by one-half. The choice of any particular method of reversing naturally depends upon the character of the design, and upon the length of the chain.

Fig. 110 shows all the possible ways of arranging four groups or divisions, but it will be seen that numbers

1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, and 15

are respectively identical with, but start at different points from

24, 18, 22, 12, 16, 10 23, 17, 20, 14, 21, and 19.

A method of adapting the first design for a simple

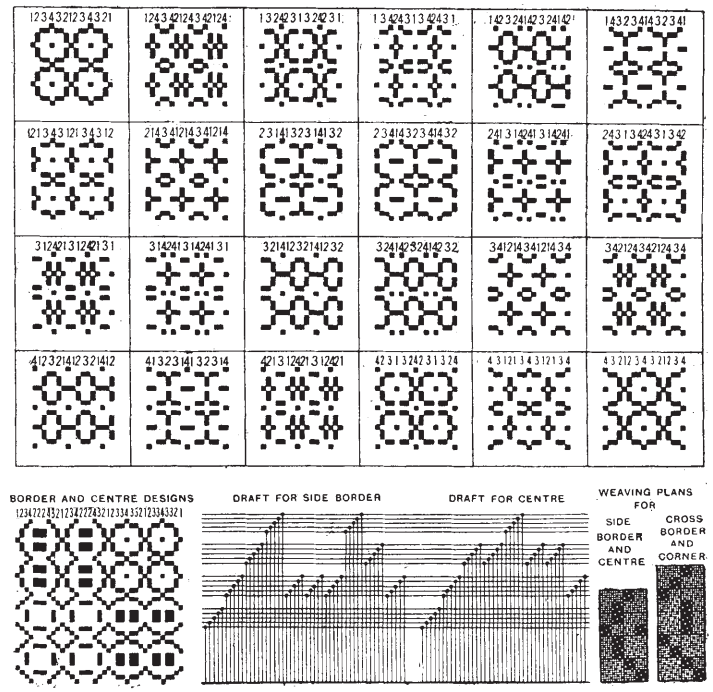


Fig. 110.

bordered cloth is illustrated at the bottom left-hand corner of the figure, while alongside to the right appears the drafting and the ordinary weaving plans. The latter would be replaced by four chains and a controlling chain if arranged for the cardless dobby.

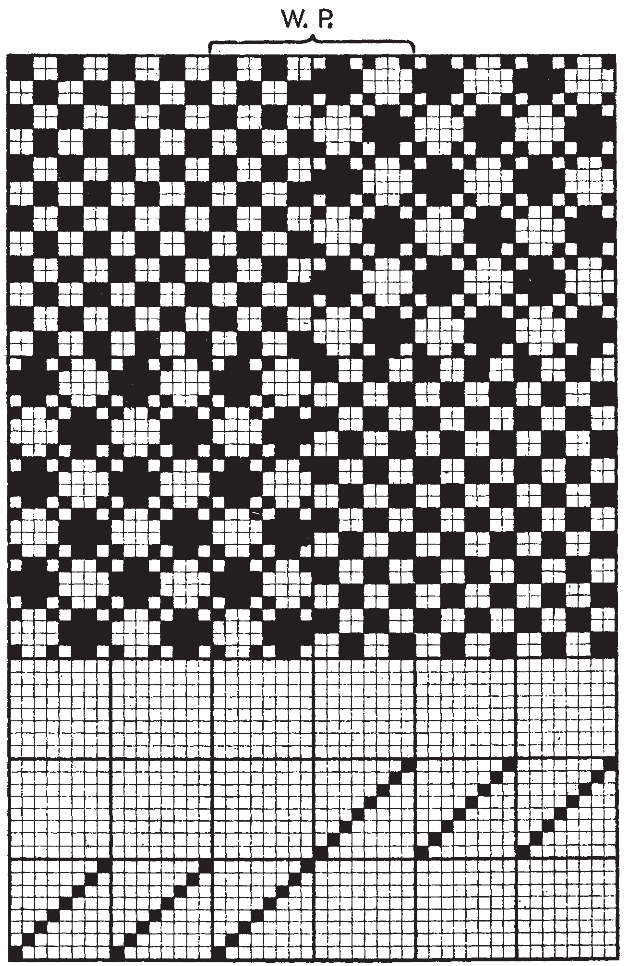


Fig. 111.

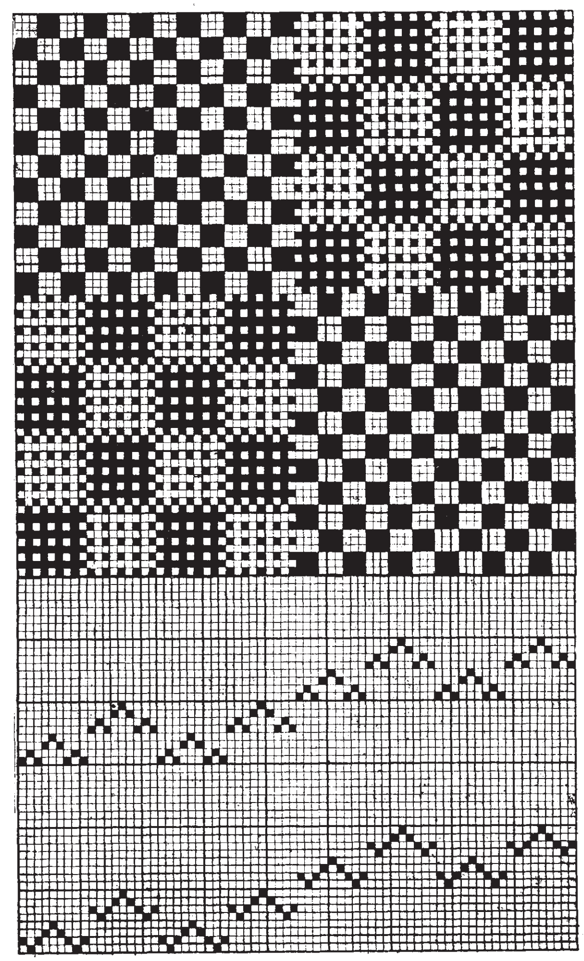


Fig. 112.

All the aforementioned dices are formed from weaves which result in fabrics possessing flat surfaces. These fabrics are intended for the most part for table decoration or other domestic use, and they serve admirably for such

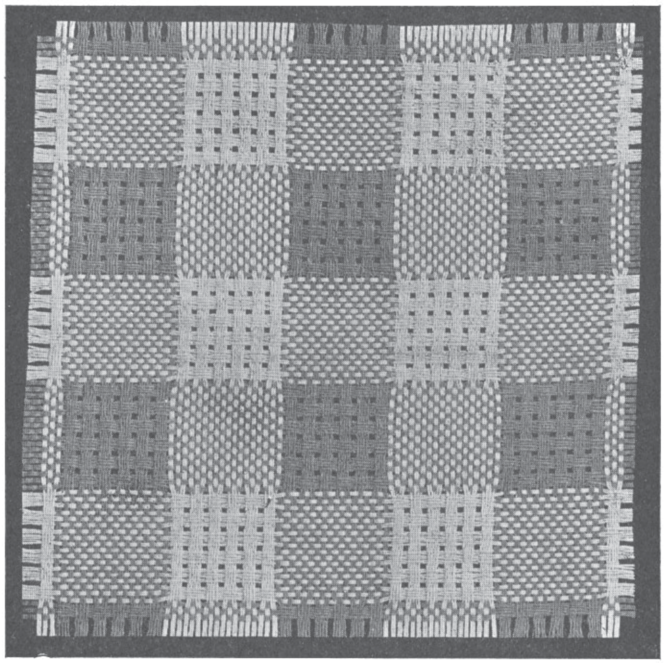


FIG. 113.

purposes. The development of dice patterns, however, is not confined to cloths of this character, but is also largely applied in the ornamentation of fabrics directly intended for decorative purposes. Such fabrics may be made up as piano covers, sideboard covers, duchesse covers, stand covers,

table centres, tea-cosy covers, cushion sacks, bedspreads, various kinds of mats, and all varieties of fancy articles. The cloth may be used just as it comes from the factory, or, if the nature of the cloth is suitable, it may be further decorated by embroidery. Fig. 111 illustrates a small dice of this character. It is made from the 8-thread imitation gauze and the 4-thread basket weaves. The draft appears at the bottom of the figure, while the weaving plan consists of all the 48 picks and the 16 threads bracketed and marked W.P. A more elaborate example is shown in Fig. 112, made from the 18-thread imitation gauze and the 6-thread basket weaves. Two different drafts are given for this pattern, and the weaving plans would consist of the proper 16 threads selected from the design. Thus:—

Weaving plan for the top draft consists of threads

1, 2, 4, 5, 10, 11, 13, 14, 37, 38, 40, 41, 46, 47, 49, 50,

while for the bottom draft the weaving plan would consist of the following threads:—

2, 3, 4, 5, 11, 12, 13, 14, 38, 39, 40, 41, 47, 48, 49, 50.

The cloth made from the design in Fig. 112 lends itself admirably to further decoration, but it may be utilised with good effects without further treatment. Fig. 113 is a photographic reproduction (half-size) of such a cloth, woven with two colours of warp and two colours of weft. The structure of the cloth is identical with Fig. 112; it differs only in the number of repeats of each unit for each dice portion. If the design in Fig. 112 were woven in the same sett of the reed as Fig. 113, it would produce a cloth two-thirds the size.

CHAPTER VIII

SPOTS

Spot Patterns.—Of the various methods of technical design employed for the embellishment of textiles, it may be safely asserted that the system of developing simple spot patterns on the surface of the fabric, in some well-defined repeating order, is, by reason of its simplicity, more widely applied than any other single system of ornamentation. The term "spot" is here used in its narrowest interpretation, although it is regularly applied in a much wider sense to many sizes and forms of ornament; the term is also understood to include the many different orders of arranging small figures.

In almost all ornamented textiles it is considered desirable, and in most cases necessary, to arrange the ornament in some definite and regular order, and spot patterns form no exception to this rule. Except in the simplest cases, the object of the designer should be to obliterate, as far as possible, the simple base upon which the design has been built. Spot patterns, in the strictest sense of the word, are, perhaps, more suited to adorn dress materials than any other type of fabric, for the simple reason that the cloth is cut up into pieces of comparatively small proportions, which are, however, still large enough to admit of a few repeats of the figure. As a consequence this type and setting of ornament are extensively employed in the production of silk, cotton, woollen, worsted and linen goods for the various articles of dress. This wide range of cloths, however, does not by any means exhaust the

applications of this valuable method of ornamentation, for it is used largely in table damask and other domestic and household fabrics, as well as in many cloths used for upholstery, floor covering, and other decorative purposes.

All ornament may be considered as being dependent upon some form of contrast, otherwise the figure could not be distinguished from the ground. The essential requirements of most spot patterns are that they should be comparatively small; hence, when the warp is the same colour as the weft, the floats in the figure, although generally longer than those of the ground weave, are still comparatively short. Consequently, if the whole is to be effective, the ground of the fabric should be developed in plain, basket, rib, simple twill, sateen, or some such non-conspicuous weave. When coloured yarns are used in conjunction with weaves of a two or more ply nature, the contrast may be, and often is, obtained with the same simple weave in both ground and figure—a difference in the lengths of the floats being no longer necessary. Although this is the case, it very often happens that different weaves are used in the two parts of the cloth; indeed, in several instances, the figure is formed, not only by distinct colours, but also by distinct weaves from those employed in the ground. There is really little restriction as to the number of colours which may be introduced either in the figure or in the ground, but for the ground part it is customary to use only one kind, the shade or tint of which is usually of a quiet monochromatic nature.

From what has been said it is very apparent that spot patterns may be produced in many ways, but in the meantime we shall confine our remarks to those of the simplest character, reserving the description of the more elaborate systems for the proper time and place.

The only method of adding ornament to single mono-coloured cloths, neglecting the effects obtainable by yarns of different counts, by fancy yarns, or by yarns with different directions of twist, is to change the order of the interweaving of the warp with the weft at certain well-defined places of the cloth. The development of the pattern at these places is therefore restricted to the floating of the warp, of the weft, or of both in some different order to the floats or weave in the ground. While it is essential that a regularly repeating weave should be used for the ground, no such restriction is placed upon the part allotted to the spots—in the case of large figures some modification must naturally be made, but the figure in these cases can hardly be said to come within the limits of spot patterns. The production of these simple spot patterns resolves itself, therefore, into a system of floating of warp or weft threads according to the size of the different parts of the spot, but the limitation thus imposed still affords plenty of scope for the inventive mind to evolve quite a number of distinct effects. Variety in form, difference in size, and change in order of arrangement, as well as in the position of the figures, may all be employed in order to produce something novel. Circles, stars, triangles, diamonds, lozenges, rectangles, and irregular geometrical figures, as well as small floral effects, may be used either separately or in conjunction with each other in the same cloth. The spots may also vary in size from, say, one-quarter of an inch to one inch in diameter, or all may be of the same size. Any practicable order of arrangement of the figures may be used —*e.g.*, the base may be on the diamond, or what may be also called the plain weave base, or it may be on the straight twill, broken twill, or sateen principle. There is really no restriction, nor is there any fixed rule; but, in

general, it will be found that the most satisfactory results are obtained when the base is planned on the plain weave, 4-thread broken twill, or the 6-thread imperfect sateen.

In Fig. 114 we show four repeats of a design, with a spot of diamond form, arranged in the plain weave or diamond order, and surrounded by a ground weave which is also plain. The complete design occupies 24 threads and 24 picks. The design is capable of being drafted

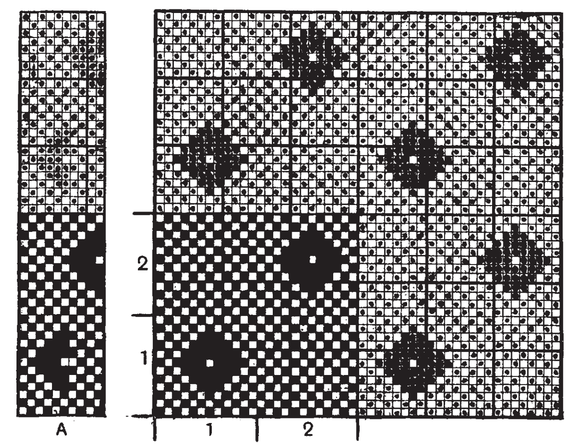


Fig. 114.

on to ten leaves which would rise and fall according to the weaving plan A, shown in solid to the left of the design. It is not always the best policy to reduce the designs to the least possible number of shafts. Much depends upon the extent of the orders likely to be received, upon the weaving rate for the number of shafts, and upon the variety of patterns in the range. Thus, if a large quantity of cloth were required of the same setting, and with similar arrangements of symmetrical figures on a plain ground, the best method would be, not to reduce to ten shafts as shown, but to employ a dobby fitted with sixteen shafts, and to arrange the draft as follows:—

1, 2, 3, 4, 5, 6, 7, 6, 5, 4, 3, 2 } = 24 threads in
Then 8, 9, 10, 11, 12, 13, 14, 13, 12, 11, 10, 9 } pattern.

Many similar patterns could then be produced without taking the warp out of the loom, or, at the most, with tying-in a warp of a different count or colour. In general, however, it is much more desirable to employ a jacquard with a capacity of 200, 300, or 400 hooks. With the smallest of these, and a repeating tie of 192 hooks, a cloth with 60 threads per inch may still have a finished pattern nearly three inches in width.

Designs such as Fig. 114 may be constructed in the following ways:—

(*a*) On what we have termed the plain weave base.
(*b*) On the diamond base.

Both systems, which are illustrated in Figs. 115 and 116, have their advantages, but we may say that the cloth produced by both methods would be identical except near the selvages. In the plain weave base, Fig. 115, the design paper is divided into four large blocks of 12 threads and 12 picks each by the triple lines A B and C D, thus representing on a larger scale the four small squares of the plain weave. In two of the large blocks we have introduced the figures in precisely the same way as the marks appear in the plain weave. The centre of the figures must lie on the diagonal line E F, or on a similar one drawn from the other two corners, and as near as possible midway between the two corners of the squares C E B and A F D. Care must be taken that the figures occupy similar positions in the two quarters of the design.

There are twelve squares in the first block crossed by the diagonal line, and the pattern occupies, in the diagonal direction, five squares; therefore, it is impossible for the middle spot to be exactly in the middle of the line. It is placed on the seventh; but it would have done equally well on the sixth, except for convenience in card-cutting.

In the diamond base, Fig. 116, we have drawn a diamond G H J K, which occupies just one-half of the design, while the other half is equal to the diamond, but is represented by the four equal triangles at the corners; we have also drawn a diagonal line L M. If the centre of

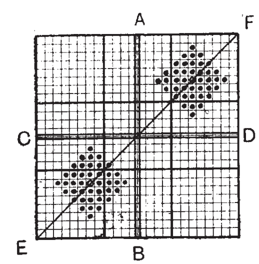


Fig. 115.

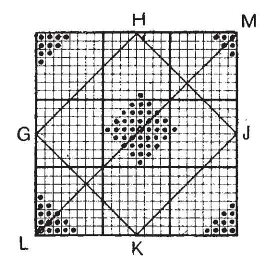


Fig. 116.

the figure contains an odd number of points diagonally, the central point may be placed on the first square as shown, and the remainder of the figure worked round it. The centre of the other figure would be on the same line L M, but twelve squares higher up, since twelve is half the total number employed. It is easy to see that in both methods the only guide required is the diagonal line.

When the ground of a design is plain weave, it is desirable that the floats of the figure or spot should all be odd, so that the figure and the ground may fit correctly without altering the shape of the former. It is also an advantage when painting in such figures to observe that the outline fills squares where odd threads intersect odd picks, and where even threads intersect even picks. If this be done it will be found unnecessary in practice to fill in the ground weave, since the card-cutter may be instructed to cut odd punches on odd picks, and even punches on even picks for the ground. A further important principle essential to the proper designing of detached figures, and also of all damask designs, is well illustrated in the above design. We refer to the arrangement of the ground weave so that no part of it will touch the figure to the detriment of the outline of the latter. Where the ground weave is $\frac{1}{1}$ plain, as in Fig. 114, this principle may be easily observed by arranging the figure as already indicated; but with other ground weaves it may be, and very often is, necessary to break the continuity of the twill or weave to avoid spoiling the outline of the figure. This will be fully illustrated as we proceed.

Fig. 117 shows a design on 48 threads and 48 picks, with a rectangular figure arranged in the 4-thread broken twill order. This order 2, 4, 1, 3, which has also been used as the ground weave, is shown in solid squares on the first 4 threads and 4 picks, and is marked A. Variety is obtained by inclining the rectangles and their diagonal twills at different angles. Spots such as these may, of course, be woven without any break of the float, but this depends entirely upon the character of the design, the sett of the cloth, and upon the yarn. The boldness or prominence of the spot increases with the length of float, but if the sett be open and the yarns fine, it may be necessary to limit the length of the float to a few squares in order to make the cloth sufficiently firm in texture.

In setting out the design on point paper, the 48 threads

and 48 picks are divided into the same number of compartments as there are small squares in the base weave. Thus—

$$\left\{\begin{array}{ll}\dfrac{\text{Threads in design}}{\text{Threads in base}} = \text{number of threads for each spot; and} \\ \dfrac{\text{Picks in design}}{\text{Picks in base}} = \quad ,, \quad \text{picks} \quad ,, \quad ,, \end{array}\right.$$

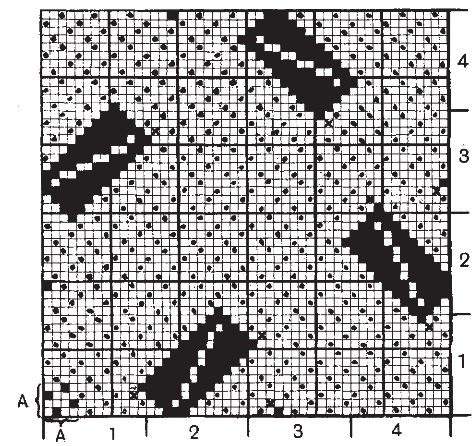


FIG. 117.

The threads equal the picks in the unit or base weave shown in solid at A, and the threads also equal the picks in the design.

$$\therefore \frac{\text{48 threads and picks}}{\text{4 threads in base}} = \left\{ \begin{array}{l}\text{12 threads and also 12 picks for} \\ \text{each spot.}\end{array}\right.$$

This division is simply an enlargement of the base weave A, and the spot patterns are placed in precisely the same order on the design as the solid squares are in the base—viz., 2, 4, 1, 3. Each spot should occupy the central, or else the same relative position in its respective portion of the design, no matter how it is inclined. This rule may be departed from to the extent of a single small square up or down, or to the right or left in some special cases, particularly where such departure will be more suitable for the continuity of the ground weave, but it is not desirable to deviate any further, since doing so would upset the general distribution of the figures. It

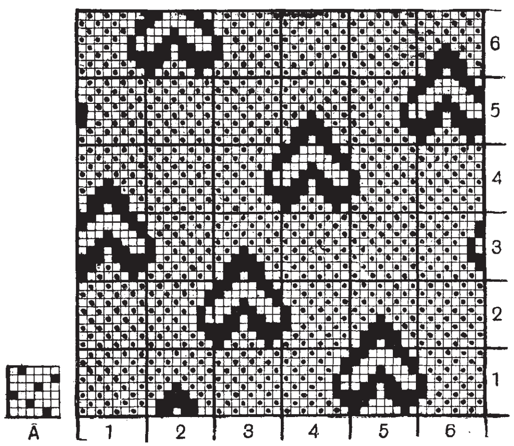


FIG. 118.

will be observed that no part of the ground weave has been allowed to interfere with the outline of the figure, but a close examination will show that in eight distinct places, two for each figure, the continuity of the ground weave has been broken purposely to obtain this desirable result. The eight places referred to in the ground weave are indicated by a cross (×) instead of by the customary dot.

Fig. 118 illustrates a warp and weft spot, arranged in

the 6-thread broken sateen order, on 48 threads and picks, the ground weave being $\frac{1}{\ \ 1}$ plain. The 6-thread sateen, or basis of arrangement, is shown in the detached figure A on the left.

$$\frac{\text{48 threads and picks in design}}{\text{6 threads and picks in base}} = \left\{ \begin{array}{c}\text{8 threads and picks for} \\ \text{each spot.}\end{array}\right.$$

The six large spots have been arranged in these thirty-six large divisions in precisely the same order as the small spots are distributed in the small detached base A. In the design, however, the centres of the spots do not appear exactly in the centres of the divisions, but each part of the spot appears in one division in just the same position as it does in any other. The particular place of starting the figure in all-over effects is generally of no account, and any starting point may be chosen if it facilitates the operations of drawing, painting, or card-cutting, and does not interfere with the general distribution of the figures.

When the figures are detached, as in the above three designs, it is important to notice that the ground weave must repeat on the total number of threads and picks in the design, and we would again remind the student that, while the ground weave may be anything which will fulfil this condition, the best results will generally be obtained with weaves of a simple character, since they contrast much better with the comparatively short floats of the spots than do weaves of a more ornate nature. It is, of course, not essential that the spots should be confined within the limits of their respective divisions; each one may be extended as much as is wished, provided it does not interfere with the others.

CHAPTER IX

DAMASKS

Damask Designs.—There is probably no pattern development in textiles of more ancient origin than that practised in damask weaving. According to popular belief, this particular branch of the weaving industry was introduced into Eastern Europe from Damascus in the early Christian era, but it probably originated farther East still in that ancient and most interesting land, China. It has, naturally, undergone many modifications since its introduction—modifications which have combined to place it among the highest developments of the weaving art as applied to textiles of single or simple structure.

Damask weaving is more or less extensively applied in all the textile industries, but more particularly in those connected with cotton, linen, and silk—in the two former for the production of tablecloths and covers generally, in cotton, as well as in worsted, for dress goods, and in the silk industry for upholstery and decorative fabrics in general, and for the better class of dress goods. In addition to those fabrics which are made of only one material, there are many which contain two or more different kinds of fibrous yarns. In some of these fabrics the individual yarns are all of one colour, while in others there is a variety of colouring. It is hardly necessary to point out that dyeing may give valuable aid in improving the appearance of a cloth. The best results are, naturally, obtained where colour is

employed in conjunction with yarns of the finest fibre—results which cannot be approached with white or grey yarns of a considerably coarser character, or of an uneven nature.

In what is now known as a true damask, the pattern is developed by permitting the warp, in some parts, and the weft in others, to float on the surface of the fabric in practically solid masses. The two sets of floating yarns are at right angles to each other, and each set in turn, as has already been stated, reflects the light more effectively than the other, and so renders the pattern visible. Each series of threads is, of course, stitched to the other at regular intervals for the purpose of forming a firm texture, but such stitching points are carefully chosen with the view of preserving a practically solid surface of warp, or of weft, as the case may be. In the relatively coarser cotton and linen textures the 5-thread and the 8-thread weaves are generally employed for stitching purposes, although in the finer grades of table damask the 10-thread and the 12-thread sateens are sometimes used. In silk goods, *e.g.* silk pictures, it is not unusual to find the 16-thread sateen employed. In some of the finer table damasks the ground of the cloth is developed in the 5-thread sateen, and the figure in the 8-thread sateen. This is done with the object of making the figure appear bolder, and, consequently, richer. Difference in texture should, however, be indulged in only sparingly, unless it can be arranged equally over the whole width of the fabric. It often results in an appreciable difference in the take-up of the warp yarn, and causes considerable trouble to the weaver through part of the warp hanging slack.

Since the introduction of the jacquard machine many cloths have been woven under the general name of damask —cloths in which other weaves, of a more ornamental nature than the true sateens, have been introduced. These new weaves change slightly the structure of the cloth, but they introduce novelties and variety. They are resorted to, and rightly so, only to a very limited extent in table linens, although the practice is much more widely adopted in cotton and silk, and in articles of linen manufacture not intended for table decoration of an ordinary type. Such fabrics have, however, in virtue of this departure, lost their true damask characteristic, and on this account are, in some centres, referred to as brocades. The designer of these fabrics, besides sketching and arranging the general outline of the figure, must give consideration to the different weaves in which the various portions of figure and ground of the fabric are to be developed. It is, in general, desirable that a balance of texture — *i.e.*, the interweaving of the warp with the weft — should be preserved in the various portions of the design; but, on the other hand, many excellent results are obtained by a decided contrast in the texture of the different parts.

The weave structure of a proper damask fabric is very simple, and is, in many instances, beyond the control of the designer. Designs for cloth to be woven on this principle are therefore more or less art productions arranged to meet the necessities and restrictions of harness mounting and reproduction generally. It is not our intention to discuss the wide and much-debated question as to what the nature of the ornament selected for damask designs should be, but, since the surface of the fabric is perfectly flat, we are of the opinion that the treatment of the ornament should also be flat. Designers should reflect

that their duty is to ornament the fabric, and not to consider the latter as a medium through which they may develop flights of the imagination. In table damasks, with which we now desire more particularly to associate our remarks, suggestions for ornament are taken from all forms of life, but chiefly from floral subjects. Suggestions are taken from other sources, and many excellent designs are woven in which the ornament, which has no counterpart in nature, consists entirely of graceful curves, lines, and forms, but which, nevertheless, appeals to the cultivated taste. Still, it is true that the great majority of designs are based upon some well-known flower or plant, since such designs appeal most successfully to the general buying public. The flower or plant selected for treatment should be used more for the purpose of suggesting lines of growth and beauty of form than as an object for mere reproduction on the cloth.

In the production of true damasks there are two well-defined systems of weaving:—

1. The full harness system, in which each needle and hook of the jacquard employed controls only one thread in any one repeat of the design, and for which all stitching points of the sateen binding weaves used must be indicated on the design paper, and also cut on the cards for the jacquard machine.
2. That system in which the binding twill of both ground and figure is automatically inserted by the shedding mechanism. For this system no twill requires to be inserted on the design paper, nor cut on the pattern cards.

The latter system is generally adopted for the finer fabrics because of its economical application to the production of very large patterns.

Two distinct methods of weaving are employed in which the twills are automatically inserted :—

(*a*) The pressure harness method, in which an ordinary one-hook to one-needle jacquard is used, but each hook of which may control two or more successive threads in one repeat of the design. In this method the figure only is controlled by the jacquard, and the twill is automatically woven by a set of five or of eight shafts situated between the figuring harness and the reed.

(*b*) The self-twilling jacquard method, in which each needle controls two or more successive hooks, and therefore two or more contiguous threads of the warp in each repeat of the design. The cards control pattern only, but the twill is automatically introduced in both ground and figure portions of the cloth by mechanism which suitably controls the lifting blades of the machine griffe or brander.

In both methods (*a*) and (*b*) each card may be presented to the needles of the jacquard for two or more successive picks. (For a more detailed description of both methods see *Jute and Linen Weaving*, Part I., "Mechanism," pages 174 to 198.)

From a consideration of the automatically twilled system, which is the more complex of the two, but which is still the more direct descendant of the ancient methods, it is clear that the outline of the pattern so produced will be inferior to that developed by the full harness system of weaving. In the latter, each thread of the warp in any repeat of the design is under independent control, and

therefore the outline of the figure may move in any direction in steps of single threads of warp, and also of single picks of weft, since only one shot is inserted for each card. In the so-called common harness method, however, the outline of the pattern, except in very exceptional cases, must change in steps of two or more threads of warp or picks of weft, according to the number of contiguous warp threads controlled by one needle, and the number of picks inserted for one pattern card.

Notwithstanding the indifferent outline—a defect which becomes less apparent as the fineness of the sett of the fabric is increased—and other defects of a minor character also incident to the system, it is yet very widely applied. This is because the system effects enormous savings in the production of those cloths with very large figures—

1. In the cost of designing.
2. In the number of cards required.

Assuming that each needle controls two warp threads, and that two picks of weft are given to each card, then a direct saving of 75 per cent is effected in the cost of designing, cards, and cutting alone, as compared with the same design produced in the same quality by the full-harness system. Moreover, the reading of the design by the card-cutter is reduced to its simplest form.

The common harness system is also economical in respect that one set of cards may be and often is utilised, within limits, for the production of the same design in various widths of any one quality; it is also theoretically applicable to the production of the same design in similar widths of different qualities, although it is seldom taken advantage of in this respect. How it may be so adapted will be explained in detail at the proper time.

A designer for table damasks may commence his sketch designs under one or other of two conditions. Firstly, he may have no knowledge of the quality of the cloth, or of the exact nature of the harness mounting to which the design may ultimately be applied. Should this be so, he will probably arrange the sketch to suit some average quality and widely adopted harness arrangement. Still, should his sketch be accepted, there will in all probability be considerable alterations or adaptations to be effected. Secondly, and preferably, he may know exactly the quality of the cloth, and the harness arrangement for which the design is intended. We shall, necessarily, assume these latter conditions.

Table damasks vary very considerably in sett or quality from about 30 threads per inch of warp and weft in the case of low cotton warp unions, to about 140 threads per inch of warp and 200 picks per inch of weft in the finest linen goods, while considerably higher quantities are used in silk damasks. These figures refer to the threads and picks per inch in the finished condition of the fabric—a condition which we shall assume in all our calculations in this section, since we regard it as the safest course to pursue to make sure of the correct proportions of the figure. We are well aware that in certain districts it has been customary to calculate the dimensions of a sketch from the sett of the cloth in the loom condition; but, since cloth made from vegetable fibres contracts in width and increases in length in the process of finishing, it is not surprising to find many finished fabrics with distorted figures, due to the almost unavoidably wrong proportion of picks of weft to threads of warp.

The general style of the ornament depends greatly upon the sett of the fabric, hence only bold, simple designs should be chosen for low and medium qualities up to about

60 threads per inch. Finer lines and more detail may be introduced when the cloth contains 65 to 70 threads per inch, while practically anything of the designer's creation may be developed when 90 threads per inch and over are used.

Besides controlling the general style of the pattern and its fineness of detail, the sett of the cloth also determines the particular design or point paper which must be used. Most qualities of table damask are shotted either "square" or "over square"—that is, they have either as many weft threads as warp threads per inch, or the weft threads predominate over the warp. Some few cloths are under-shotted, but they are the exception. In any case, however, the same rules apply. Where the cloth is to finish "square," the ruling of the design paper used must also be square, thus:—8 by 8, 10 by 10, 12 by 12, 16 by 16, etc., according as the jacquard machine to be used has 8, 10, 12, or 16 needles in one short row of the needle board. 8 by 8 paper is regularly used for 16-to-the-row jacquards; it is the correct proportion, and the heavy line occurring every eighth cord acts as an additional and intermediate guide to the card-cutter.

Where the cloth is not "square," the ruling of the design paper per block is determined—

1st. By the number of needles in one short row of the jacquard for the warp. (The vertical ruling for all kinds is fixed by the number of needles in a short row.)

2nd. By the ratio of the weft threads to warp threads per inch or other unit in the finished fabric for the weft.

In all ordinary design paper the heavy lines of the ruling divide the sheet into perfectly square blocks of a convenient size. These are further subdivided vertically to represent warp threads, and horizontally to indicate weft threads, the number of divisions in each direction being determined as indicated above, and by the numerical example below.

Example.—Find the ruling of the design paper for a cloth to count 60 warp threads and 65 weft threads per inch finished. A 600's or 12-row jacquard to be used.

Obviously, the design paper must have 12 vertical divisions per block to correspond with the 12 needles in the short row; while the horizontal divisions for the weft will be found as follows:—

$$\text{Number of vertical divisions} \times \frac{\text{picks per inch}}{\text{threads per inch}} = \text{horizontal ruling.}$$

$$\therefore\ 12 \text{ vertical divisions} \times \frac{65 \text{ picks}}{60 \text{ threads}} = 13 \text{ horizontal divisions.}$$

In other words, 12 by 13 paper must be used.

It is sometimes impossible to get the exact proportions required—as, for example, when a cloth to be woven in a 600's jacquard should contain, when finished, 64 threads per inch and 72 picks per inch.

$$12 \text{ vertical divisions} \times \frac{72}{64} = 13\tfrac{1}{2} \text{ horizontal divisions.}$$

But

$$\frac{12 \text{ vertical divisions}}{13\frac{1}{2} \text{ horizontal divisions}} = \frac{8 \text{ vertical or warp divisions}}{9 \text{ horizontal or weft divisions.}}$$

Therefore, for a cloth containing 64 threads and 72 picks, one or other of the following three courses may be adopted:—

1st. Use 8 by 9 paper, as found above, and paint the figure, without distortion, upon the proper number of threads and picks; then re-rule the paper vertically in 12's by hand for the card-cutter's guidance.

2nd. Use 12 by 13 paper, and distort the design in painting by elongation to occupy the proper number of picks in the proportion of $13\frac{1}{2}$ weft to 12 warp.

3rd. Use 12 by 14 paper, and distort the design by compression to occupy the proper number of picks.

One of the two latter methods would probably be adopted, although the first method would be most likely to give the best result. Any ruling of design paper may be had in whole numbers; but some rulings are, naturally, in much more constant demand than others.

The foregoing remarks and calculations apply only to those cloths which are woven on the full harness system. Other methods which will be duly indicated are applicable to common harness designs. To sum up, the quality or sett of the cloth acts as a guide to the designer with regard to the general style of design which should be adopted; it also limits or restricts him as to the fineness of detail. At the same time, it determines the ruling of the design paper, or point paper, upon which the sketch must be transferred and the weaves introduced before the cards can be cut. The harness mounting and the quality of the cloth, on the other hand, regulate the dimensions of the actual size sketch and the positions and order in which the various units of the design will be repeated across the width of the cloth. Briefly, the design and the harness mounting are interdependent—the one cannot well be considered without the other. Designs may, of course, be originated to suit any particular arrangement of the harness, and a harness may be mounted to suit any design, but it is better if both be considered together. When originating a sketch, a designer will naturally try to make the most of the machine at his command; but it is not desirable to sacrifice simplicity in the harness mounting in order to secure what may seem to be an elaborate pattern.

Harness mounts or ties are of three kinds:—

1. Straight through or repeating ties; sometimes, but inadvisably, we think, termed "lay-over" ties.
2. Centred, pointed, or gathered ties.
3. Combinations, in different ways, of 1 and 2.

Except in very special cases, the number of threads in the weave employed, and the number of hooks in one short row of the jacquard, should each be a measure of each section of the tie or mount. Thus a 5-thread sateen weave on a 400's or 8-row jacquard should have the various sections of the mount in multiples of 40 threads.

5-thread sateen and a 600's or 12-row jacquard in multiples of 60 threads.
8-thread sateen and a 400's or 8-row jacquard in multiples of 8 threads.
8-thread sateen and a 600's or 12-row jacquard in multiples of 24 threads.

If this rule be observed, the various sections, besides being multiples of the twill, will be complete on full rows of the machine, and thus tend to simplicity and to the minimum of trouble and error on the part of all concerned.

Since the dimensions of tablecloths are usually in multiples of $\frac{1}{4}$ or $\frac{1}{2}$ yard, it is desirable that the repeating portion of the design should be 9 or 18 inches in length and width, so that the various sizes of cloths may be

obtained by increasing or decreasing the number of repeats. When the style of design will permit, it is also desirable to arrange the ornament so that it may be broken at a half repeat without such a break being unduly evident. In this way intermediate sizes of cloths may be readily arranged for. Similar remarks apply, although perhaps in a modified degree, to napkin designs.

Where the complete effect of the pattern—as in the case of a large border produced by the aid of a small number of hooks—is dependent upon the repetition or the reversing of any part or of different parts of the harness, the art of the designer should be exerted to conceal effectively such repetition as far as possible. The general effect of a pattern will be much less pleasing to the eye should the plan of mounting be prominent than if the same be concealed or subdued by the designer's skill.

Before entering into the details of harness arrangements, it may be advantageous first to consider a few particulars concerning the various full harness jacquards in use at the present time. Jacquards may be made of any convenient size, but it is natural to find that certain well-defined sizes have been adopted by each branch of the textile industry. These sizes will naturally vary according to the extent of the figuring required. When very large patterns are desired, it is often thought advisable to adopt a medium or a fine pitch jacquard in place of two or more machines of a coarser pitch. Fig. 119 illustrates a few cards of different sizes and different pitches; all are used in connection with damask weaving, and since all are reduced to the same scale, the relative pitches and sizes remain correct.

The standard British pitch is represented by card A, which is for a 600's machine. In this pitch—

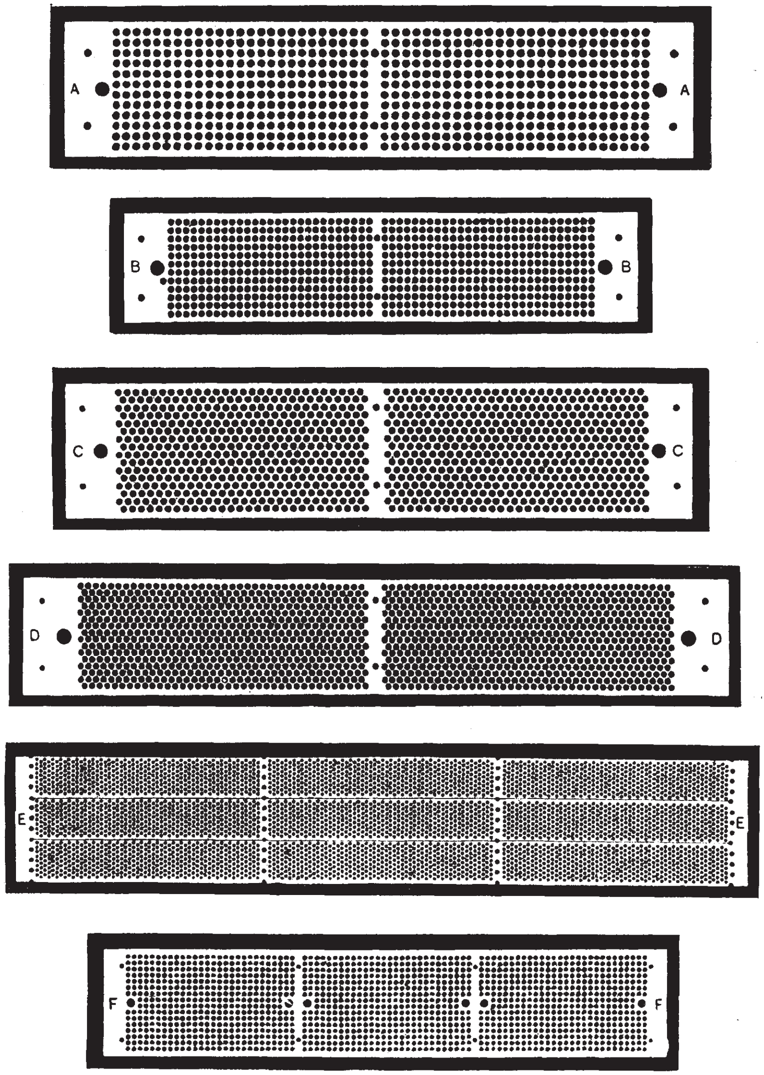


Fig. 119.

The 400's jacquard has	51 rows of	8 hooks each	= 408 hooks.
„ 500's	„ „	10 „	= 510 „
„ 600's	„ „	12 „	= 612 „

The 600's jacquard has occasionally 76 rows of 8 hooks each, while a 900's has 75 or 76 rows of 12 hooks each. Nearly all smaller sizes are the same pitch, but these are seldom used except for lettered goods in linen, for narrow fabrics, and for small effects in dress goods and similar material.

Card B is for a	660's machine with	55 rows of	12 hooks.
„ C „	912's „	57 „	16 „
		or 114 „	8 „
„ D „	1216's „ with	76 „	16 „
		or 152 „	8 „

Several Continental machines are made in multiples of 28 rows of 16 hooks each, thus giving 448, 896, 1344, and 1792 hooks per machine. The cards for these machines, which are of the Verdol type, are represented by card E. Other machines, on account of several incomplete rows, have only 440, 880, 1320, and 1760 hooks; this type, which is also Continental, as well as British, is illustrated by card F.

The above cards illustrate several of the different pitches in daily use, and they indicate that many efforts have been made to obtain machines of a large figuring capacity which will also be economical in the use of cards. They also show that a designer may have many machines at his command, although it is unlikely that any manufacturer will have more than two different pitches in his factory—the standard pitch and another,—since each pitch requires its own card-cutting and repeating machines, and card lacing or stitching apparatus. Multiplicity of systems, or of types of machinery, does not assist in the direction of economy in production, nor is it desirable from the employés' point of view.

Machines of 400's or 40 design capacity are extensively used in the manufacture of doilies of all qualities, lettered and damask bordered towelling, figured glass cloths, diaper and damask towels, stair coverings, table napkins in low and medium qualities, tray cloths, and low-quality tablecloths. They are also occasionally used in conjunction with larger machines to supplement the figuring capacity of the latter. Of all the different kinds the 600's or 60 design machines are probably the most extensively used in the fine and medium linen trade. One machine is usually sufficient for a doily or a napkin, but two or three machines are used for the majority of medium-quality tablecloths. Two or three of such machines are now, however, often displaced by one or two of the finer-pitch and larger-capacity machines already referred to.

As doilies are amongst the smallest articles woven with the jacquard machine, we will consider one of these cloths as the first example in damask designing and mounting. Doilies may be divided into two common classes—those which are ornamented by needlework after weaving, and those which receive all their ornamentation in the loom. A very popular style of the former class consists of a circular piece of cloth, from 3 to 6 inches diameter, on which a specially prepared circular pattern has been woven. After the cloth is woven, the complete circular patterns are cut out, and the edges whipped by a special machine, in order to prevent fraying. This whipping also strengthens the edges and makes them suitable for the application of crochet work. When no crochet work is intended, the doily is usually provided with a fringe. Although these cloths are made more for the decoration

of circular articles than for those of other shapes, it is a common practice to arrange the design so that the finished fabric may be equally suitable for square and circular cloths. When a fringe is required it is usual to weave two cloths in the width; the fringe all round may be 1 to $1\frac{1}{2}$ in. in length, so that a 12-in. doily may have, say, 10 in. of solid cloth. If from this 10 in. we deduct $\frac{1}{2}$ in. on every side for the plain satin cloth, we have 9 in. for the actual pattern. Assuming 70 threads per inch finished, we have :—

$$9 \text{ in.} \times 70 \text{ threads per inch} = 630 \text{ figuring threads.}$$

Designs for doilies are usually symmetrical or semi-symmetrical in style—generally the latter, since the strictly symmetrical design is somewhat stiff in character. In the above case of 630 threads a purely symmetrical design could be arranged on a 400's jacquard, but such an arrangement would not utilise the machine to its fullest capacity, nor would the resulting design be as effective as that which may be obtained by mounting a portion of the jacquard "single"—that is, by having in this portion only one harness cord attached to each hook. Naturally the designer has increased scope, and better designs are likely to result when the number of hooks in the single part of the mounting is increased, but there is a limit to the number of hooks which may be used for the single mount. Suppose this doily of 630 threads had to be woven in a 400's jacquard. It is clear that the difference between the total number of threads and the total number of hooks indicates the number of hooks for the double portion :—

$$630 \text{ threads} - 400 \text{ hooks} = 230 \text{ double portion}$$

—that is, 230 hooks must each control two harness cords—

one on each side of the single portion. It is also clear that the total number of hooks minus the double portion must be the single portion :—

400 hooks − 230 for double = 170 hooks for single.

Therefore :—

230 hooks	double	× 2 =	460	threads
170 „	single	× 1 =	170	„
400 hooks controlling			630	threads.

But, as already shown, it is desirable, whenever possible, to have the various sections of the mount in multiples of the twill and short rows of the jacquard; assuming that the 5-thread sateen is to be used, multiples of 40 would be necessary to suit this requirement. By inspection we see that the nearest numbers to satisfy these conditions, and to be approximately the same as those already found, are 240 and 160. Giving effect to this condition, the complete harness arrangement would be :—

Needles Nos.	1 to 3 =	3	idle			
„	4 „ 8 =	5	for 5-thd. sateen	= 60	thds. =	$\frac{6}{7}$ in.
„	9 „ 248 =	240	„ double . .	= 480	„ =	$6\frac{6}{7}$ „
„	249 „ 408 =	160	„ single . . .	= 160	„ =	$2\frac{2}{7}$ „
		408	needles.	700	thds.	10 in.

It will be observed that in the above arrangement no provision is made for the working of a plain or other selvage; but such provision is unnecessary, since the machines employed are always provided with 4 or 6 extra hooks for working such selvages or edgings independently of the needles actuated by the pattern cards. Fig. 120 shows a design of this character, and a plan of the harness reed or comberboard arranged to suit. In numbering the latter, the leading hook, or No. 1, is at the left-hand side

and at the back of the board or harness reed, as the case may be. This is in accordance with one of the two methods of numbering in general use.

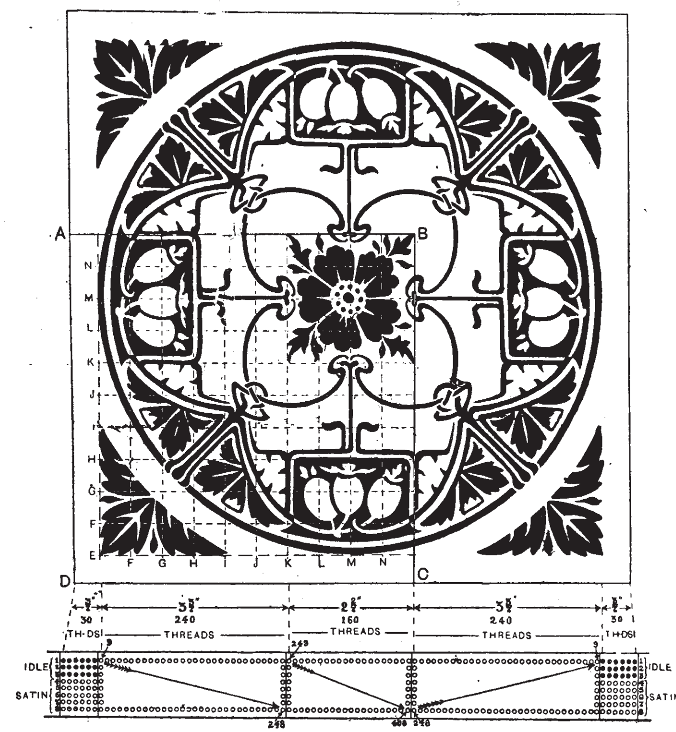


Fig. 120.

When facing the needle board of an ordinary jacquard machine we find it divided into two sections, one of 26 rows of 8 or 12 needles on the right of the division, and the other of 25 rows on the left; in all, 51 rows of needles. The division is caused by the omission of one row of hooks to allow room for the centre lacing of the cards. It is customary to select the first needle, and therefore the first hook from the first row on the right hand of the 26-row section; in some districts the top needle is selected as No. 1, while in other districts the bottom needle is the leading one. Both methods are practised to about the same extent (in actual working the one has no advantage over the other), but care must be taken to cut the cards to correspond to the system of mounting chosen. If the top needle is chosen, then the hook in that row next the needleboard is No. 1, and if the cards fall over the warp—that is, at the back of the loom—No. 1 harness cord must also be at the back of the comberboard or reed. If, however, the bottom needle is taken, then the hook farthest from the needle board—that is, the one next the spring box of the machine—is No. 1, and No. 1 harness cord must pass through the front of the comberboard if the cards fall over the warp. Cards cut for either method will suit the other by turning them over; still it is much better to see that the systems of harness mounting and card cutting are arranged to correspond to each other.

Where cards fall over the weaver's head the positions just described are moved through an angle of 180°, so that No. 1 hook and cord, instead of being at the left and back of the board, are now at the right hand and the front in one case, and at the right hand and back in the other. Whether the harness is mounted with the leading hook or thread at the left hand or at the right is immaterial in the case of damask, since it is seldom desired to show a twill or a diagonal of any kind in any particular direction—the twill has often to incline the same as some part of the ornament, but if the twill is turned in the opposite direction the ornament is likewise turned. Nor is it generally material

even in the case of lettered or other similar goods, because a proper manipulation of the lacing or of the working of the cards is usually sufficient to cause the lettering to read in the proper way. It is usual, however, to adhere to one method in any continued explanation, and the one we have adopted is that indicated in Fig. 120. This method requires the design to be turned upside down, and read from right to left in card-cutting, but this proves to be no obstacle in the way of production, or of accuracy of work. When the first hook or cord is at the left and at the front, the design does not require turning, and the reading is, consequently, from left to right.

When No. 1 is at the back, as in Fig. 120, Nos. 2, 3, 4, etc. follow in succession towards the front until one short row (eight in this case) is reached. In the example under consideration, however, the first three hooks are idle; hence no harness cords are passed through the corresponding openings in the first six rows of the harness reed. Hooks 4 to 8 control the first thirty and the last thirty threads of the warp—that is, six repeats at each side of the 5-thread sateen weave. The thirty-first thread of the warp is the first thread of the actual pattern, and is controlled by hook No. 9. The succeeding hooks are then taken in consecutive order till No. 408 is reached. Up to this point—that is, for 430 threads—the draft or drawing-in of the warp is from back to front of the harness reed, and, of course, from left to right; but, from the 431st thread onwards, while continuing from left to right, the draft is arranged from front to back. In other words, the 431st thread is controlled by hook No. 248, the cords from which go to the front of the harness reed, since all cords from one long row of the jacquard pass through the corresponding row of the harness reed. Succeeding threads of the warp are then drawn in from front to back until the extreme right hand is reached. The general direction of the draft in each part is indicated in the diagram by arrows.

We have stated that two such cloths are generally woven in the width of a narrow loom; when this is done it is evident that a second section of the harness reed or comberboard must be filled in exactly the same way as the one indicated. Sufficient space would be left between the two sections to permit of the inside fringes being formed, while "catch threads" would be arranged about $1\frac{1}{2}$ in. from the outsides to retain the weft for the outside fringes. A few plain threads or simple gauze threads might also be introduced close to the cloth of the doily to prevent the outside threads of the cloth from moving laterally from their proper position.

A distinct advantage results when every hook of the jacquard is occupied by a mount of the above type, for strictly symmetrical patterns, as well as semi-symmetrical ones, may be woven without any alteration in the tie-up. To illustrate this, let us consider a cloth of the same size and sett as the one just given on 640 threads. Such a cloth, with a strictly symmetrical design, would require only 320 hooks, and if a 400's jacquard were used, 80 hooks would be left idle. But the mounting illustrated in Fig. 120 may be used without alteration for this pattern if the designer paints or drafts half of the complete design on the first 320 figuring hooks, Nos. 9 to 328, and completes the total number of 400 cords or threads on the design paper by re-drafting, in reverse order, 79 out of the last 80 cords in the design—that is, Nos. 327 to 249 inclusive. This arrangement would be tantamount to a centre tie of the single part, turning on the 328th hook. A harness

cord would be empty in the middle of the cloth, and, if necessary, the warp could be re-reeded from this point to close up the fault caused by this omission. Any long float at the centre could be checked by a proper placing of the twilling dot on every fifth pick. This method saves the trouble and expense of mounting another loom and machine, and is applicable to cloths and designs of all dimensions, as well as to doilies.

When transferring the sketch in Fig. 120 to design paper, the designer confines his attention to that part enclosed by the rectangle A, B, C, D. All to the right of this boundary is produced in the cloth by the doubling of the harness, and the upper part of the pattern by the combined action of the doubling of the harness and a set of cards similar to the first set, but laced backwards. To begin with, he divides up the sketch by parallel lines into a series of squares, the number of which is arbitrarily chosen to suit the total number of small squares in the design paper. In the case under consideration there are 400 each way, if we neglect the first or odd row of the jacquard (part of which is idle and part working the satin) and assume that the cloth, and therefore the design paper, is square. Ten divisions would, therefore, be a suitable number in which to divide this sketch, since it would give 5 blocks of 8 cords each, or 40 cords of the design paper per division each way. If a finer division is necessary, the part A, B, C, D may be divided into the same number of divisions as there are large blocks in the design paper. The former method is usually adopted for large designs. The design paper is then divided to correspond to the sketch; the lines on the design paper being usually marked in chalk, and those on the sketch in pencil. The latter are represented on the design in Fig. 120 by the dotted lines E to N. When both sketch and design paper are squared off, the designer proceeds to transfer the sketch to the design paper by freehand, being guided in the process of enlargement by the corresponding squares on the respective sheets. In some cases the enlargement may first be roughly indicated in chalk, then a finer and more accurate outline may be pencilled in, after which the figure portion is painted in solid colour with scarlet, vermilion, or crimson lake. The outline of the painted design should always be firm and decided, to enable the card-cutter to decide immediately when changing from ground to figure; the colour should also be as transparent as possible, so as to show up the divisional lines of the design paper, and the twilling dots of black or of white which it is necessary to insert afterwards.

The above method of enlargement is that which is in general use, although repeated attempts have been made to devise means for automatically enlarging the sketch. A mechanical method sometimes adopted is that in which the pantograph is used. This instrument consists of four light rods joined together to form a parallelogram, the sides of which are extended to convenient distances beyond their joints. Fig. 121 is an illustration of such an instrument. Point A is fixed to some convenient part of the board, B provided with a tracing point for the outline of the sketch, and C with a pencil to reproduce the enlargement on the design paper. Although B and C are movable, A, B, and C are always in a straight line; therefore, since D E and B F are always parallel,

$$\frac{A\,B}{A\,C} = \frac{E\,F}{E\,C} = \frac{D\,B}{E\,C};$$

hence, any movement of B will impart a similar but larger

movement to C—the enlargement being in the ratio of D B to E C. This ratio is increased or decreased by decreasing or increasing the perpendicular distance between the parallel rods D E and B F. The rods are kept parallel by means of screws or clamps at D and F. On account, however, of the inaccuracies in the dimensions and proportions of the original sketch, and the difficulty of adjusting the different sides of the instrument to the proper ratio, the pantograph has not been found to be of much practical value for this particular work.

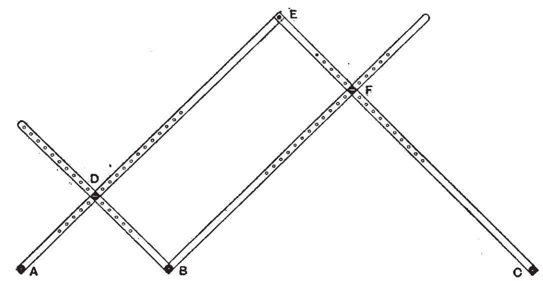


FIG. 121.

Photography has also been employed for enlargement purposes alone, a negative of the sketch being used for the purpose of throwing an enlarged view on to design paper. A pencil tracing is then made by hand round the outline of the figure, which is afterwards painted in the usual way. More recently, in the Szczepanik system, negatives and positives of the sketch were made (the former for the figure and the latter for the ground), and, by the aid of suitable screens, the designs were enlarged to the required degree on sensitised paper. At the same time the binding weaves were inserted, and the paper ruled or squared off into small divisions with the necessary horizontal and vertical guiding lines for the card-cutter. Ingenious as this was, however, difficulty was experienced in the placing of the weave points round the edges of the figure—a difficulty which we are afraid cannot be overcome by any mechanical or automatic means.

In Fig. 122 we show a section of the sketch given in Fig. 120 enlarged to design paper. Part of the enlargement has been left in freehand outline, another part has been outlined in keeping with the squares of the design paper, a further part has been painted solid, while the balance has been painted and twilled in both ground and figure. The first three cords of the design paper have been ignored, since the hooks corresponding to these are idle. The 4th to 8th cords have been twilled with the 5-thread sateen weave, because the hooks corresponding to these cords actuate the satin part of the design. The same 5-thread sateen weave, but twilling in the opposite direction, is used in the figure. Twilling in the opposite direction is adopted with the intention of giving the weaves every opportunity of "cutting" or binding automatically where ground and figure meet. Should the weaves bind naturally it is generally by accident, except in cases where the number of threads of figure intervening between the two ground portions is a multiple of the weave employed. The method of beginning the weave as shown at E (marking the second thread on the first pick instead of the first thread) is one of the two correct methods. Beginning with the second thread and first pick, or with the second pick and the first thread, generally ensures that the various portions of the border, corner, and repeating part of the design will join up properly. In many cases this result cannot be obtained if the weave begins on the first thread and first pick (see J and K, Fig. 104, p. 140). How the twill of isolated portions

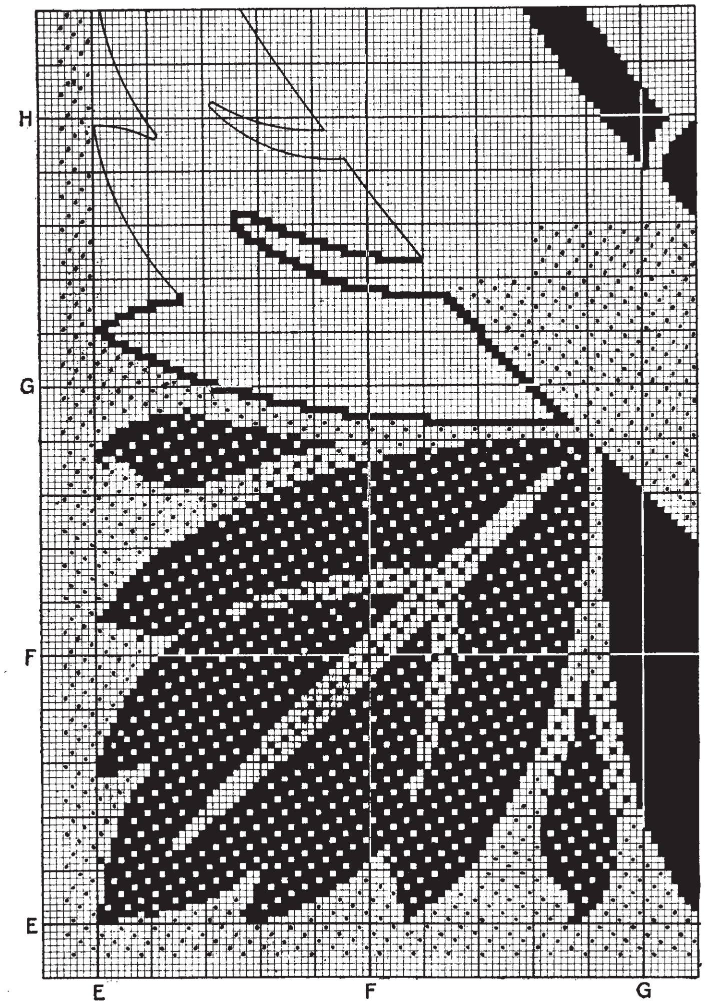


Fig. 122.

of the figure begins does not really matter. In the case of rectangular figures parallel to the threads, and all similar straight line edges, it is always arranged to cut with the ground twill; but for figures with curved edges it may begin at any convenient spot—*i.e.*, where a dot of the ground twill weave comes hard against the outline of the figure. In many parts of Fig. 122 it will be seen that the dots of the twill have been misplaced to prevent their marring the outline of the figure, and in several portions the floating threads have been bound without regard to the perfect continuity of the twill. Where the regular order of the ground twill has been departed from to meet either of the above cases, full squares have been substituted for the customary dot.

When approaching the edge of the figure with the ground twill, it is not essential that every spot of the twill should be inserted; nor should every spot of the figure twill be inserted when nearing the ground. If it were so, the photographical method would probably be a success. With the 5-thread twill the normal float is four in both warp and weft, but in practice this may be extended to six in either direction, on and around the edge of the figure. Where the 8-thread twill is used, a float of ten may be permitted in similar circumstances. In other words, floats of seven and eleven must be checked in the 5-thread and 8-thread twills respectively. This practice of permitting the ground and figure threads at the edges to float slightly in excess of the normal at the edges generally results in an enhanced appearance of the figure. Particularly is this the case in the finer qualities; care must be exercised, however, when the practice is introduced into designs for low quality fabrics.

An important feature in the twilling of the design given

in Fig. 120, and of any design of similar character, is the treatment necessary for the single portion of 160 threads. This part being in the centre of the design, or rather between these portions of the warp which are actuated by the double portion of the harness, must be twilled at both sides to meet with, or coincide with, the continuity of the twill of the double portion. Since the double portions end and begin on the same or a similar thread—No. 248,—the ground twill of the first thread of the single, No. 249, and of the last thread, No. 408, must be alike, and must be continued to right and left respectively in the same manner until they reach the edges of the figure portion intervening. Should no figure intervene, and the twills from both sides meet—an unlikely occurrence, except at isolated parts,—the twill must be broken in the centre to avoid the appearance of a pointed draft. Portions of the figure which do not extend into the double part may all be twilled in one direction in precisely the same way as the figure of the double portion, but those portions of the figure on the right edge of the single must be twilled to join up properly with their corresponding doubled-over continuations.

The second example of mounting is a napkin or serviette. Full harness designs for these fabrics are very varied in character, but, in general, the plan or scheme of each may be placed under one or other of the following:—

1. Designs of a perfectly symmetrical character: these are few in number.
2. Designs of a semi-symmetrical nature, in which a considerable portion of the centre of the cloth is mounted single to permit of any ornament of the monogram nature being woven.
3. Designs consisting of a simple straight-tie border and a straight-tie repeat. This is a very widely-adopted

and serviceable type. Approximately half the machine is mounted for the two borders, and the other half utilised for four or five repeats, as may be found necessary to give the desired width.

Examples:—

$$\left.\begin{matrix}\text{200 border}\\ \text{200 repeat}\end{matrix}\right\} \text{ or } \left\{\begin{matrix}\text{320 border}\\ \text{280 repeat}\end{matrix}\right\} \text{ or } \left\{\begin{matrix}\text{300 border}\\ \text{300 repeat}\end{matrix}\right\} \text{ etc.}$$

4. Designs in which larger borders of the symmetrical or semi-symmetrical types may be obtained by mounting a number of the hooks double and single, as illustrated in Fig. 120, while the remaining hooks are reserved for a simple repeating centre.
5. Designs in which an outer border and an inner border—that is, main and subsidiary borders—are formed on about three-fifths of the total number of hooks, while the other two-fifths are utilised for the necessary repeats. Both borders are separated slightly by an intervening portion of plain satin cloth.

The quality of the cloth and the style of design required are the factors which decide the number of hooks. This number varies from 400 to 1200, but a single jacquard of 600 hooks is generally employed.

Designs of types 1 and 3 are so simple that no further detail is necessary. Type 2 has already been referred to in detail under doily designs, although there are many modifications of this style. Type 4 will be treated fully under the tablecloth example to follow, while type 5 is fully illustrated and described as under. We shall assume a 24 in. finished napkin with 80 warp threads per inch,

that is, with 24 in. $\times$ 80 = 1920 threads, and that a 600's jacquard is to be used, arranged as follows :—

$$\left.\begin{matrix}\text{240 hooks for outer border}\\ \text{120 ,, inner ,,}\end{matrix}\right\} = \tfrac{3}{5} \text{ of } 600.$$
$$\text{240 ,, repeat . . .} = \tfrac{2}{5} \text{ of } 600.$$

The various sections of the mounting are in multiples of 8 and 12; this is because the 8-thread sateen twills would be used in conjunction with the 12-row machine.

2 borders each of 360 threads = 720 threads.
1920 threads − 720 border threads = 1200 threads for the repeats, serge twill, and satin parts.
4 repeats of 240 threads each = 960 threads.
1200 threads − 960 threads . . . = 240 threads, or 120 on each side for extras.

These 120 threads would probably be allotted as 40 for the inner satin, 64 for the outer satin, and 16 for serge or other firm twill weave between the plain selvage threads and the outer satin. The full mounting would therefore be as shown in the table given below.

4 threads	plain . .	×2= 8	threads actuated by needles and hooks independently of the design.						
16 ,,	serge twill .	×2= 32	,,	Hooks Nos.	,,	1	to	4 idle	= 4
64 ,,	outside satin .	×2=128	,,	on	,,	5	,,	12	= 8
240 ,,	,, border	×2=480	,,	,,	,,	13	,,	252	=240
40 ,,	inside satin .	×2= 80	,,	,,	,,	5	,,	12	=...
120 ,,	,, border .	×2=240	,,	,,	,,	253	,,	372	=120
240 ,,	repeat . .	×4=960	,,	,,	,,	373	,,	612	=240
		1928 threads.							612 hooks.

Fig. 123 shows a sketch plan of a simple geometrical design arranged to illustrate the foregoing harness mount; it also illustrates the planning out of the comberboard or harness reed to correspond. The actual sett or pitch of the latter does not at present concern us, but it must be such that the total width of the harness will coincide with the width of the warp in the reed. Now in those sections of the harness marked A and B there are only 8 cords per row, while in all others, with the exception of the extreme outside or serge portions, there are 12 cords per row. But

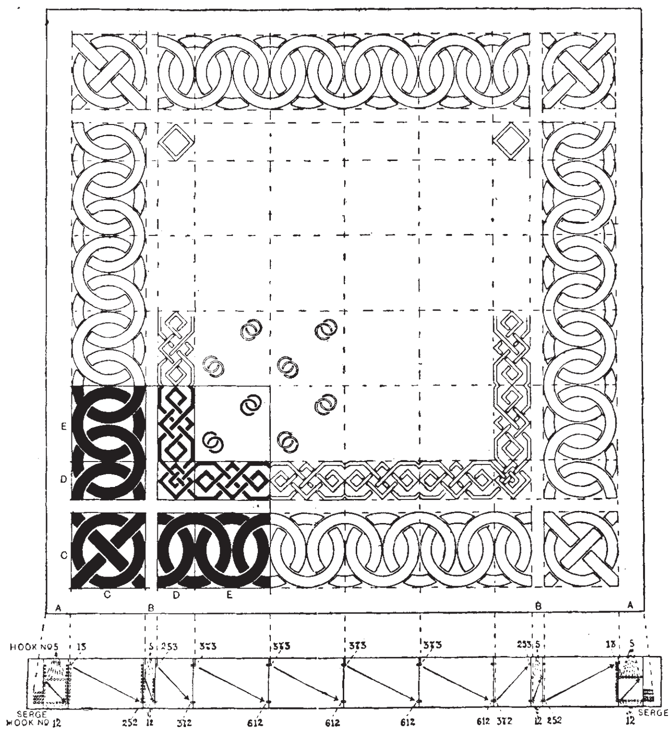


FIG. 123.

since the sett of the loom reed is constant all over, it is evident that in order to have the loom reed width the same as that of the harness reed, the sett of the latter at the portions A and B must be considerably closer than at the main border and repeat parts. The pitch or rows per inch

of the various portions must be inversely proportional to the number of cords per row, and, in the present case, since these are 8 and 12, the pitch of the sections A and B must be 50 per cent closer than the other parts of the harness reed or comberboard. With a comberboard built on the sectional principle, the sections of the requisite pitch could be placed where required, but with a harness reed the common practice is to "crowd" or "cram" the harness to the necessary extent. A constant sett throughout could, of course, be arranged if the satin part were actuated by two rows of the jacquard, but this would reduce slightly the figuring capacity. The first and the last cord of each section of the pattern are indicated by their corresponding numbers, while the arrow heads indicate the general direction of the draft in each section.

The complete unit of the design is shown in solid black, and the various repeats are either continued in outline or indicated by means of dotted lines, which show the extent of each repeat. When transferring a design of this type to design paper, the plain satin portion at B is, of course, omitted, since it is actuated by those needles or hooks which control the portions marked A. Sections C, D, and E are therefore brought close together to form a continuous painting on 600 warp cords, and, should the threads and picks per inch in the finished state be the same, the painting would also occupy 600 weft cords. Mathematical instruments would prove of great assistance in enlarging a design such as this to design paper. The twilling of all damask designs is so much alike that no further illustration is necessary.

In Fig. 123 it will be seen that, besides circular figures, there are horizontal, vertical, and inclined bars or bands. These are in general the same width, but it must be remembered that for the same width the inclined bars require a longer float than the horizontal or vertical bars. When, as is usual, the inclination is 45°, the number of squares or the float of warp and weft for the inclined bar is $\sqrt{2}$ times that occupied by the horizontal or vertical bars; the nearest whole number being, of course, taken. Thus, in Fig. 124, which is intended only for illustrating this fact, the horizontal and vertical bars float over five squares; therefore the float in the inclined part is $\sqrt{2} \times 5$—*i.e.*, $1{\cdot}41 \times 5 = 7$ squares.

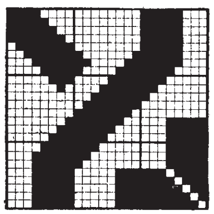


Fig. 124.

Designs for tablecloths are very similar to, although usually a little more elaborate than, those for table napkins; and the five types of mounting indicated under the latter head may be taken, in a general way, as illustrating the more extensive schemes of mounting employed for the larger fabrics. Special mountings may require to be arranged to meet special cases, but these exceptions are, in most cases, simply modifications of one or more of the five types referred to. Recently there has been an increasing demand for extensive borders of the single character illustrated in type No. 3, two 600's machines or 1200 hooks being often used for the border tie alone, with a third 600's machine for the repeat or filling portion. A 900's machine is occasionally used with the two 600's, and when this does not afford sufficient scope, two machines of 1320 hooks each may be employed for one design. The general plan of the mounting is, however, very simple, and we shall illustrate a mounting of the type indicated in No. 4, using two 600's machines. Designs of this type are also very widely adopted, since they give comparatively wide

borders on a relatively small number of hooks. In some cases the single portion of the border of a design of No. 4 type is so arranged that, in addition to forming part of the main border, it may also appear alone between the main border and the filling or centre of the cloth; it thus forms a supplementary border, and is technically known as a "lift-in" border. This type is clearly a combination of the styles indicated in Nos. 4 and 5. The dimensions of the ornament on the cloth are so chosen that the commencement of the supplementary or "lift-in" border coincides with the edge of the table top, while the main border hangs over the edge of the table.

When the width of a border is considerably increased, it is generally desirable, from an artistic point of view as well as for the sake of proportion, that it should also be increased in length. In many cases, therefore, the length of the border repeat is made 16 to 18 in., while the centre repeat is only 8 to 9 in. long. Two repeats of the centre pattern must, therefore, be woven for one repeat of the side border; and, should an odd number of centre repeats be necessary to give the requisite length of cloth, it is obvious that the border pattern must be broken half-way. Sometimes the border pattern is three times the length of the centre pattern. All border patterns of the above nature must be so designed that the breaks will not occur at points which will seriously affect the appearance of the completed design. Since the number of hooks which control the filling or centre is usually much less than the number of picks in such a side border, it follows that the side-border design or painting cannot be used in its entirety for the end border as well, although, under certain circumstances, and with careful designing, half of the side-border design may be, and often is, utilised for the repeat of the end or cross border portion. In order that the side-border pattern may be used as well for the end or cross border, the following essential conditions must be observed :—

1. The number of picks in the repeat of the side border must be the same as the number of threads in the width of the repeating portion of the cloth.
2. The design paper (and, therefore, the sett of the cloth) must be square : 8 by 8, 12 by 12, etc.—since the vertical ruling in one case becomes the horizontal ruling in the other, and *vice versa*.

Specimen mounting, type No. 4, for a tablecloth 72 in. wide, 75 threads per inch finished. Two 600's jacquards to be used—one for a border pattern about 10 in. wide, and the other for a straight tie repeat. The 5-thread sateen weave to be used for both ground and figure. With this weave and a 12-row jacquard the various sections of the mount should preferably be in multiples of 60.

10-in. border pattern × 75 threads per inch = 750 threads.
750 − 600 hooks = 150 hooks to be mounted double.

To retain the mounting in multiples of 60 there must be either 120 or 180 hooks mounted double. Either number might be adopted—120 double would make the border slightly narrower than 10 in., while 180 double would make it a little wider. We shall take 180 hooks for the double portion, and therefore 600 − 180 = 420, for the single, as indicated in table below.

[TABLE.

180 + 420 + 180 = 780 threads for each border.
= 1560 ,, both borders.
75 threads per inch × 72 in. wide = 5400 threads in all.
5400 threads − 1560 border threads = 3840 threads for centre and satin parts.
Say 6 repeats × 600 = 3600 threads for the filling ; then 3840 − 3600 = 240 threads for side serge and satin.
= 120 ,, each side serge and satin.
20 of these may be serge and 100 satin. The full mounting would therefore be as follows :—

First Machine.	4 threads plain × 2	= 8 threads actuated by special needles and hooks.			
	20 threads serge × 2	= 40 ,, ,, ,, ,,	Hooks Nos. 1 and 2 idle	=	2 hooks.
	100 threads satin × 2	= 200 ,, ,, ...	,, 3 to 12	= 10	,,
	180 ,, double border	= 780 × 2 = 1560 ,, ,, ...	,, 13 to 192	= 180	,,
	420 ,, single border		,, 193 to 612	= 420	,,
				612	,,
			Hooks Nos. 1 to 12 idle	= 12	,,
Second Machine :	600 threads repeat × 6	= 3600 threads actuated by	,, 13 to 612	= 600	,,
		5408 threads.		612	,,

Fig. 125 is a sketch of a design arranged according to the particulars given above, with a plan of a portion of the comberboard arranged to correspond. Two repeats are given in the length of the design, and one repeat and a half in the breadth of the repeating part or filling.

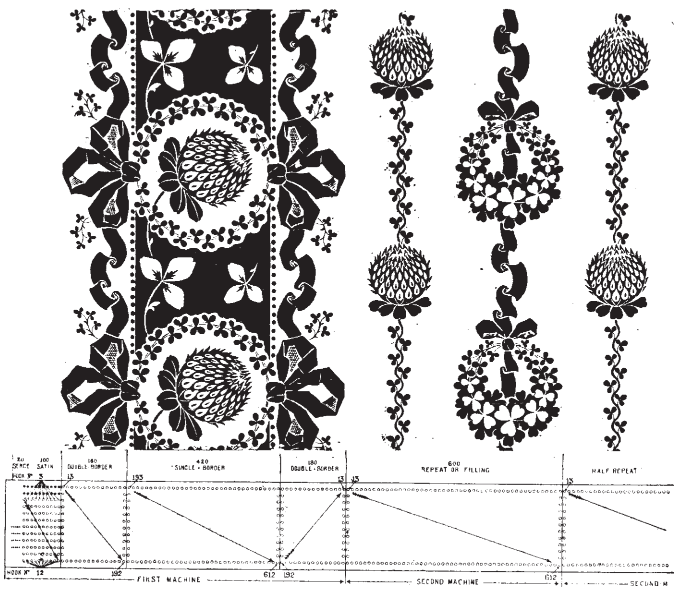


Fig. 125.

This figure illustrates clearly that the design is capable of being broken at a half repeat if necessary, in order to meet the requirements of certain widths. A close examination will also show that it may be broken at half the length as well—immediately above and below the wreath portion of the centre—without unduly breaking the centre pattern. Breaking of the border pattern cannot

always be avoided, but this is of much less importance than breaking the repeating part.

If we assume that the above cloth is to be woven square —that is, to contain 75 threads and 75 picks per inch when finished,—then it is only necessary to paint three sheets of design paper for the card-cutter. If we neglect the ten hooks for outside satins, each sheet would be 600 by 600 square. Sheet No. 1 would contain the corner piece: this is not shown on the sketch, nor is it usually shown by designers in practice, but it must be designed to be in keeping with the border. The side border would be painted on sheet No. 2, while the repeating part of the design would be on No. 3 sheet. This is more fully illustrated by the sketch plan of a complete cloth in Fig. 126, where heavy rectangles have been drawn indicating the various parts of the design taken by each sheet of design paper. Sheet No. 2 is also utilised for the end or cross border portion by turning it through an angle of 90°, as indicated in the figure. Section A of the side border and corner is the image or turn-over of the first 180 threads of sheets 1 and 2, and is obtained by the backward draft of harness cords from hooks 192 to 13; while section B of the cross border and corner is produced by re-cutting the first 180 cards of the corner and border designs, and then lacing them backwards. Should the cloth be shotted "over square" or "under square" it would be necessary to paint a fourth sheet for the cross-border part, since the ruling of the side-border sheet would be unsuitable.

Since the clearest reproductions are those in black and white, no attempt has been made to shade off any part of the design in Fig. 125, although different methods of treating the underside of the ribbon have been suggested. In actual practice, however, the various folds of the ribbon would be shaded, and not represented, as in the figure, by a flat treatment in painting. With the 5-thread sateen twill it is impossible to obtain a very fine gradation in the shading of any portion of a design, although in the example given in Fig. 127 a sufficiently fine gradation has perhaps been

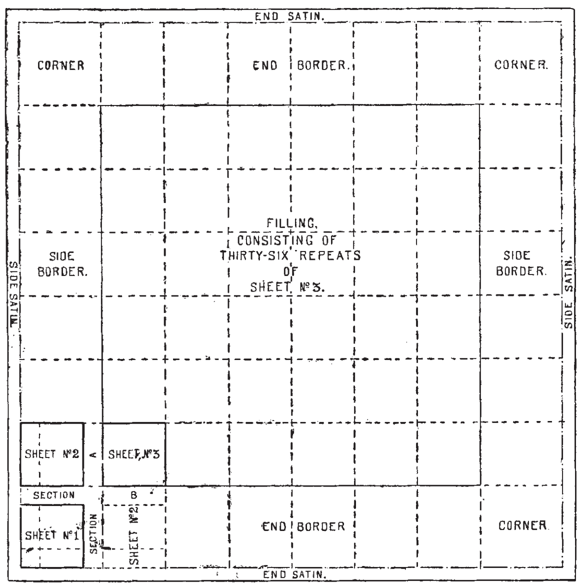


Fig. 126.

obtained to convey the desired impression. In order that the figure may blend or shade off gradually and naturally into the ground portion of the design, the method of shading generally employed is that of running out or continuing the ground twill as far as may be necessary, and then of gradually adding extra dots in the way of the warp to those already marked; or, in other words, increasing the length

of the warp float step by step from a minimum of one pick or mark to a maximum of four or seven, according to the weave employed. One feature of this method, illustrated

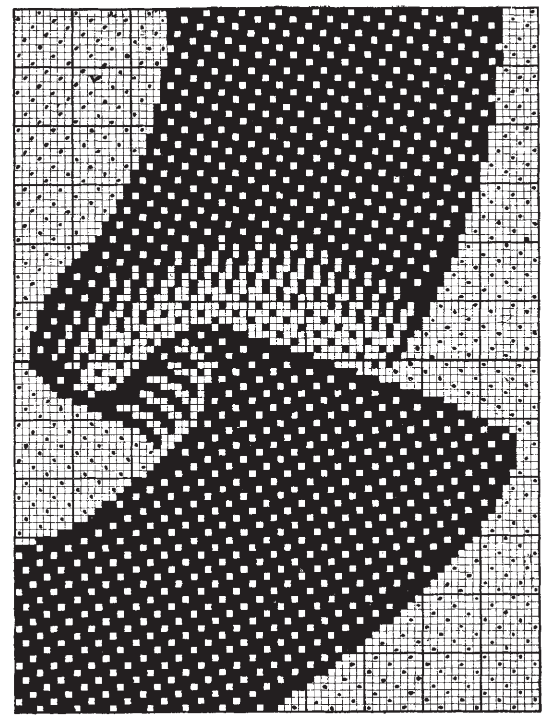


Fig. 127.

in the upper part of Fig. 127, is that the binding twills in both ground and figure run in the same direction. This may or may not be an objection, according to the conditions under which the shading is practised. Should it be likely to prove objectionable, the opposite ground twill may be used for the beginning of the shaded parts. At A in Fig. 128 the twills have been reversed just where the shading commences—that is, between the thirteenth and the fourteenth picks. For the first thirteen picks the step is five picks upwards and one thread to the right; but from the fourteenth pick onwards the step is only three picks upwards. This is clearly shown by the first pick of each float in any diagonal of the shading twill.

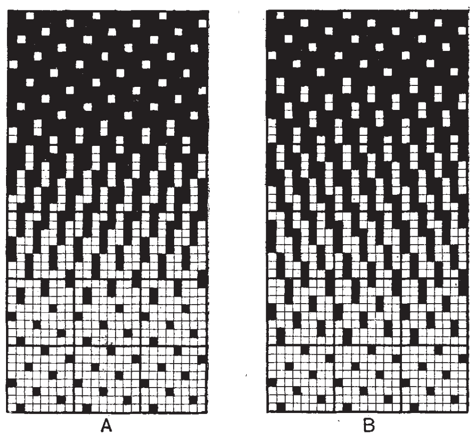


Fig. 128.

The weave may, of course, twill either to left or to right, according to the inclination of the ornament. The twill to left is shown at B in the same figure, where it will be seen that the step is three picks upwards and one thread to the left. The change from ground to figure is more gradual in B than in A, and, when the fundamental sateen twill commences, as shown at B, it has the decided advantage of a perfect gradation to the ordinary warp float weave illustrated at M, Fig. 104 (p. 140). The change from weft float

to warp float is occasionally made by increasing the floats of the picks instead of the floats of the threads. This method is, however, more suitable for cloths where the threads per inch of warp exceed the picks per inch of weft. The particular method of shading adopted must always rest with the designer, who will choose the gradation which happens to be the most suitable for his purpose.

A type of shading which gives a rapid change from ground to figure, and which is well adapted for combination with the 8-thread sateen twill, is illustrated in the upper portion of the leaf in Fig. 129. It is really a 4-thread straight twill rapidly enlarged from a float of one to a float of three. The ground twill of the 8-thread sateen may be readily changed to the $\frac{1}{3}$ straight twill by the addition of alternate marks; then one or two extra marks may be added at will to increase the float to three picks, although a little care must be exercised where the twill again reverts to the sateen order in the figure portion. The gradual development of the change is illustrated in the detached parts of the figure.

Fig. 129 also illustrates the method of applying a straight twill in order to give the effect of relief or of prominence to any part of the figure. The turned-up portion of the leaf in the same figure is scarcely large enough to permit of properly graded 8-leaf shading, but this has been already illustrated in Fig. 128.

The so-called common harness system of damask weaving, whether it be performed by the older and more intricate method of pressure harness, or by the more modern and more desirable self-twilling jacquard, is employed for essentially economic reasons. As we have indicated elsewhere, this system, compared with the full harness system, effects enormous savings, particularly in designing and cards, and indirectly gives the designer wider scope for the production of large and flowing designs. The treatment of the design is almost invariably flat, since the automatic insertion of the

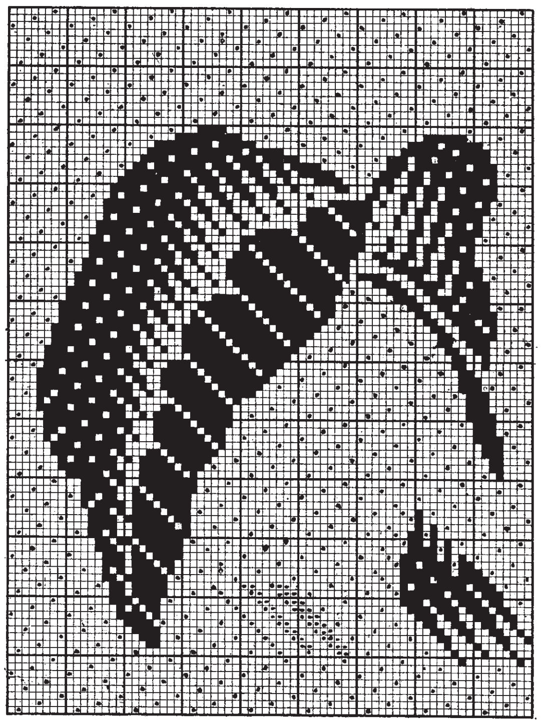


Fig. 129.

twill by the shafts of the pressure harness, or by the twilling knives of the jacquard, makes it impossible to introduce ordinary shading into the cloth. Nevertheless, effects approaching shading are often obtained by a process which will be explained later. Although in special cases under this

system each needle and each card may control respectively only one thread or one pick in each repeat of the pattern, it is more general to find two or more contiguous threads operated by one needle, and each card presented to the needles for two or more successive picks, while in silk fabrics these numbers are often exceeded. Such being the case, it is evident that each vertical and horizontal cord or row of the design will represent two or more adjacent threads or picks in the cloth. Consequently, the designer may introduce much finer detail than it would be wise to attempt in the case of full harness designs; indeed, he may paint single cords in both directions.

Many of the linen and other cloths woven on this system, perhaps the great majority of them, are overshotted to the extent of 50 per cent, or, in other words, they contain 50 per cent more weft picks than warp threads per inch. With the full harness system of weaving it would be necessary in such cases to have the design paper ruled to correspond—*i.e.*, ruled 12 by 18 for 600's machines, and so on; but with the common harness system it is not essential that the ruling of the paper should correspond with the sett of the cloth, since each card may be presented to the needles for any practicable number of successive picks. It must be remembered, however, that the outline of the design will suffer in clearness and sharpness in proportion as the picks per card are increased. In order, therefore, to obtain the best results, paper should be used in which the vertical and horizontal ruling are approximately in the same ratio as the threads and picks per inch of the cloth. Thus, 8 by 12, 10 by 15, or 12 by 18 paper, according to the jacquard to be used, would suit for cloth shotted 50 per cent over square. By using paper ruled in keeping with the sett of the cloth, the number of picks per card is kept at the minimum, and the graceful curves and general fineness of the outline of the design are improved accordingly. This procedure, although often adopted, is admittedly more expensive in cards, as well as in the painting of the design; it is, therefore, very common to find square design paper used, and the proportion of weft to warp made up by increasing the number of picks per card at the expense of the distinctness of the outline of the figure.

In some very fine linen damask, made on the common harness system, and counting about 140 to 150 threads per inch each way, the practice of overshotting is departed from with distinctly beneficial results as regards the general effect of the design, and we think that a more general adoption of this principle, with a maximum of two hooks per needle and two picks per card, would result in a most desirable improvement in many of the designs which at present are woven with three and four hooks per needle, and sometimes with more than four picks per card. Besides, the reduction of the shotting would enable the cloth to be produced more rapidly, and therefore more cheaply. Heavier weft would, of course, require to be used to maintain the original weight, but since heavy yarns are relatively cheaper than the finer counts, a further economy would be effected.

Harness mountings for cloths and napkins worked on the common harness principle are usually very simple in character. For a table napkin the harness may, in extreme cases, consist of a straight through tie from selvage to selvage. Jacquard machines of large capacity are required to weave patterns of this class; but, on the other hand, the designer has unrestricted scope. He should, however, remember that it is desirable to have

both borders practically, if not strictly, alike. Variety in the detail of the borders may be permitted, but the general arrangement of the heavy masses should be the same in both borders. To develop a pattern of the foregoing character on a 27-in. table napkin with 90 threads per inch finished would require a scheme somewhat as under:—

27 in. $\times$ 90 threads per inch = 2430 threads in the warp.

3-in. plain satin, or other simple weave ($1\frac{1}{2}$ in. at each selvage) $\times$ 90 threads = 270 threads.

2430 threads − 270 threads for satins and selvages = 2160 threads for pattern.

$$\frac{2160 \text{ threads}}{2 \text{ hooks per needle}} = 1080 \text{ needles.}$$

$$\frac{1080 \text{ needles}}{12 \text{ needles per row}} = 90 \text{ rows of needles required.}$$

Since such jacquards are made with either 51 rows or 75 rows of needles, it follows that two machines of 51 rows each, or 102 rows in all, would be adopted. Ninety rows would be occupied by the pattern, part would be used for side satins and selvages, and the remainder would remain idle.

In this example we have assumed two machines of 24 hooks per row, with a total capacity of 2448 hooks or 1224 in each. It is therefore evident that the pattern portion of the napkin might be increased beyond 2160 threads, should it be thought necessary, since there are plenty of hooks to spare. To do so, however, to any great extent, would reduce the satins too much, and thus impair very considerably the appearance of the complete napkin.

Other methods of mounting for the same design might be arranged. Thus, a 900's machine (75 rows of 12 needles) with 32 hooks per row might be used. Setting apart one row of 32 hooks for side satins, the remaining 74 rows might be "fileyed" in two ways. Thus :—

$$\text{(A)}\quad \left.\begin{array}{l}2 \text{ rows} \times 32 \text{ hooks per row}\\ 2 \text{ rows} \times 28 \text{ hooks per row}\end{array}\right\} \text{for } 72 \text{ rows} = 2160$$

Then 2 rows of 32 hooks per row . . = 64

Pattern threads 2224

Leaving 2430 threads − 2224 threads = 206 threads for satin, etc.

$$\text{(B)}\quad \left.\begin{array}{l}2 \text{ rows} \times 28 \text{ hooks per row}\\ 2 \text{ rows} \times 32 \text{ hooks per row}\end{array}\right\} \text{for } 72 \text{ rows} = 2160$$

Then 2 rows of 28 hooks per row . . = 56

Pattern threads 2216

Leaving 2430 − 2216 = 214 threads for satin, etc.

In both cases the average is approximately 74 rows of 30 hooks per row.

Now this number—thirty hooks per row—could be obtained exactly with the same machine, provided the 5-leaf twill were to be used; and 32-row machines are often specially filled 3, 2, 3 hooks per needle, four times repeated, so that they may be quickly and economically changed to 30-row machines for the 5-thread twill by removing the first and last hook of each row. This arrangement causes four twos to come in succession, but it is found to be, on the whole, satisfactory. The 5-thread sateen weave is, however, seldom used for linen fabrics containing over 80 threads per inch, particularly where the cloth is shotted half over square. It is used in square sett linen cloths up to about 80 threads per inch, and in lower sett union, as well as in cotton damasks of both square and over square sett.

Again, a 500's machine (51 rows of 10 needles) with 40 hooks per row—4 hooks to each needle—might be used. If one row be left aside for satins there would be 50 rows of 40, or 2000 hooks available for pattern. This would

leave 2430 − 2000 = 430 threads for satins, *i.e.* nearly 5 or $2\frac{1}{2}$ in. at each selvage. Such a width of plain cloth by no means improves the appearance of the napkin, but the method of having a good breadth of plain satin at the selvage is sometimes adopted because it affords a simple and ready means of making small alterations in the width—by reducing the satins alone—without requiring to touch the mounting of the pattern proper.

Of the above three methods the first is the most expensive, but it would produce the most satisfactory result, since no needle controls more than two successive threads of warp. The second method is cheaper than No. 1 in respect of the first cost of machines, and also in designing and card-cutting, but it would result in a distinctly inferior outline in the pattern, since half of the needles of the machine would each control three successive warp threads. Method No. 3 would be the cheapest of all, but since each needle in such a machine controls four hooks, and therefore four successive warp threads, the outline of the pattern would be very ragged and most unsatisfactory.

A further method which might be employed, and one which would utilise to the full the available needles of the two machines referred to in the first method, besides giving the most satisfactory results, would be to reduce these machines by the process of "fileying" or casting-out of superfluous hooks to an average of 22 hooks per row instead of 24 hooks. It is impossible to fill the machines with 22 hooks per row and still preserve the sequence of the ground and figure twills, but they may be filled with two rows of 20 hooks each, alternating with two rows of 24 hooks each, and so give an average of 22 hooks per row over all. Since it is an essential feature of the principle that every needle must be employed, it is evident that where 12 needles control 20 hooks, 8 needles of the row will have 2 hooks each, and 4 needles only 1 hook each; the arrangement generally adopted being 2, 2, 1, four times repeated. In this way 50 rows of each machine, or 100 rows in all, equalling 2000 hooks, would be utilised for the pattern, while two full rows of 24 hooks each would be available for the 230 satin threads. The filling of the machines in this special manner might be a little troublesome on account of the necessity of making special needles for the "fileyed" rows, but the result would be most certainly worth the trouble, since no needle would control more than two threads of the warp, while only one each would be controlled by a certain number of needles.

Other and less expensive harness mountings than the above are, however, generally adopted, the most usual being that in which about one-third to two-fifths of the pattern nearest each selvage is doubled or turned over, while the remaining portion in the centre is single. In other cases a perfect centre tie is adopted. With the latter mounting it is clear that the total number of hooks necessary will be equal to half the number of the pattern threads, and that the designs resulting from such a mounting will be perfectly symmetrical. With the former mounting the portion of single in the centre permits of designs of a perfectly symmetrical nature being woven, but it is more directly intended for those of a semi-symmetrical character, and for others where it is necessary to introduce words, initials, monograms, or other distinctive features which demand a single mount. If the napkin referred to were produced with a purely centred tie, one 600's needle jacquard with an average of 22 hooks per row, or $50 \times 22 = 1100$ pattern hooks, would be sufficient; but if the part single tie were introduced for the same size and sett of

napkin a machine of larger capacity would be necessary. Suppose the total number of threads equals 2200, then

$$\frac{2200}{3} = 733 \text{ threads in the doubled portion, but}$$

$$2200 - 733 = 1467 \text{ single threads or hooks necessary.}$$

$$\text{But } \frac{1467 \text{ hooks}}{50 \text{ rows}} = 29\tfrac{17}{50} \text{ hooks per row.}$$

Now, by the process of casting-out or "fileying" already referred to, it is possible to fill the jacquard so that practically any average number of hooks per row may be obtained. It is not desirable, however, to complicate the machine by filling it in such an unusual manner, unless very special circumstances arise to demand it. In the case under consideration it would be much simpler and more satisfactory to fill the machine for an average of 30 hooks per row, and modify the mounting to correspond. A 32-row machine could be used with advantage, provided it were filled with two rows of 32 hooks alternating with two rows of 28 hooks for 48 rows—then one row with 32 hooks and one with 28, thus giving an all-over average of 30 hooks per row. The last or fifty-first row would have the full 32 hooks for side satins. The full mount might be arranged thus :—

24 rows double : border	$\left\{\begin{array}{l}12 \times 32 \text{ hooks} \\ 12 \times 28 \quad ,,\end{array}\right\}$	= 720 hooks	× 2 = 1440 threads.
26 rows single : centre	$\left\{\begin{array}{l}13 \times 32 \quad ,, \\ 13 \times 28 \quad ,,\end{array}\right\}$	= 780 ,,	× 1 = 780 ,,
1 row side satins (1st row of machine)		= 32 ,,	= 210 ,,
		1532 ,,	2430 ,,

210 threads would give little more than an inch of satin at each selvage, but, should this be considered too small, it could easily be increased when painting the design. The

figure portion can be kept in a little from the extreme edge of the double portion of the harness.

It is, in general, an essential feature in the use of self-twilling jacquards that the complete number of hooks per row in the machine, or in a repeat of the sequence of the "fileying" arrangement, must be a multiple of the binding twill employed—in this case the 8-thread twill; and in the above mounting this condition is strictly observed until the last row of the single portion of the machine is reached. Since this row is an odd one of 28 hooks, it is clear that it will contain $3\frac{1}{2}$ repeats of the weave, and that in consequence of this ending the last thread of the single portion will be the fourth thread of the weave. If the last row of the single portion formed a multiple of the weave, there would be a maximum float of fourteen where this part of the cloth joins the doubled-over portion; on the other hand, when the arrangement is as described—that is, with the single part finishing on the fourth thread of the weave,—the maximum float at the junction of the two parts of the harness will be ten instead of seven as under normal conditions. But since the cloth is fairly fine in quality, this float of ten will not detrimentally affect the appearance of the cloth. In all cases of a similar kind, no matter what twill is used, the best results are obtained by ending the single portion on half, or approximately half, a repeat of the twill.

Harness mounts for common harness cloths are arranged on the same general lines as those for napkins of the same class. In some few instances the harness may be centre-tied, as has already been pointed out, but in the majority of cases a portion of the pattern in the centre of the cloth is single—usually about one-fifth of the total pattern in eight-quarter wide cloths, or one-third of the needle

capacity employed. The pure centre mounting is suitable only for perfectly symmetrical designs, whereas the other type of mounting is adaptable for designs both symmetrical and semi-symmetrical in character.

Two machines of 900 needles each, or their equivalent, three 600-needle machines, are employed for the finer qualities: in either case there are approximately 150 rows of hooks. If three 60-design machines were employed for the work, and two of them, or 100 rows of hooks, were mounted with double cords, and the other machine, or 50 rows of hooks, with single cords, the figuring capacity of the whole mount would, with 32 hooks per row, be sufficient for 8000 threads. Thus :—

$$\left.\begin{array}{l}100 \text{ rows double} = 200\\ \;\;50 \;\;\;,, \;\;\;\text{single} = \;\;50\end{array}\right\} = 250 \times 32 = 8000 \text{ threads.}$$

With 40 hooks per row the capacity would be proportionately greater, but in extreme cases, and for certain patterns of the finer qualities—as, *e.g.*, in 90 in. and 108 in. widths,—four 600-needle machines of 48 hooks per row may be employed.

In the napkin examples already referred to we have indicated that one full row of the machine would be set aside for satins, but in practice a full row is seldom used for this purpose. Sometimes 16 hooks only are utilised for satins, at other times only 8, while in many cases the full 51 rows of needles and hooks are employed for the pattern alone, the side satins being worked from eight or sixteen special hooks (five or ten in the case of the 5-thread twill) attached underneath to the twilling bars of the machine. Where two or more "fileyed" or broken row jacquards are employed on one mount, it is of course imperative that the twills of the different machines should be continuous—in other words, that the twill of No. 2 machine should begin where the twill of No. 1 leaves off, and so on. This arrangement is obtained automatically with full-row machines, but with fileyed machines, and particularly where the full 51 rows have been utilised for pattern, great care must be taken when filling the machines to arrange the hooks so as to secure this essentially important feature in the cloth. Even under such circumstances it is quite possible that the double portion of the harness may not end on a complete twill; but this is immaterial provided the single portion begins on the succeeding thread and ends with a thread of the twill which will form a satisfactory juncture with the first thread of the doubled portion of the pattern.

To determine the actual number of hooks per row necessary for any particular case, let us assume that an eight-quarter cloth is required to count 105 threads per inch finished, with approximately 68 in. of pattern and 4 in. of satin (2 in. at each selvage) in the width: in all $105 \times 72 = 7560$ threads. If three machines be used—two mounted double and one single, as previously indicated—then

$$105 \text{ threads} \times 68 \text{ in.} = 7140 \text{ threads, and}$$
$$\frac{7140 \text{ threads}}{250 \text{ rows}} = 28\tfrac{14}{25} \text{ hooks per row.}$$

Now, while this number could be easily approximated to by filling the machine with a few rows of 32 hooks among the rows of 28 hooks—as, *e.g.*,

$$8 \times 32 + 42 \times 28 = 1432 \text{ hooks,}$$
$$\text{and } \frac{1432 \text{ hooks}}{50 \text{ rows}} = 28\tfrac{16}{25} \text{ hooks per row,}$$

—the filling of the machine would be unnecessarily

complicated, and a much better and more practicable proceeding would be to fill the machines with 28 hooks per row all over, and to use every row in each machine for pattern purposes. Two machines at 51 rows each double and one machine with 51 rows single are equivalent to 255 rows, and 255 rows $\times$ 28 hooks per row $= 7140$ threads exactly.

The number of hooks in two rows of 28 is a multiple of the 8-thread twill, so that with the above arrangement the double portion of the design would end on the last thread of the twill and the single portion on the fourth thread, while the satins would be worked by special hooks as indicated. In a mount of this character, No. 1 machine, or that one taking the outer portion of the border, would be placed, not at the outside, but between machines Nos. 2 and 3, in order to avoid undesirable angles in any portion of the harness. The exact order in which the machines are placed is of little importance provided the cords are arranged in their proper order and with due regard to the proper slope, and, of course, that each machine is provided with the right cards.

If a pattern containing the above number of threads (7560) were to be treated for a centre tie or pattern, it is probable that, for economical reasons, only two 600-needle machines, with 102 rows of hooks in all, would be used. But in this case half the pattern, or approximately 105 threads $\times$ 34 in. $= 3570$ threads, must be controlled by, say, 100 rows. Evidently, then, a 40-row machine would be required, but filled with 36 hooks per row :—

$$100 \text{ rows} \times 36 \text{ hooks per row} = 3600,$$
$$\text{and } 3600 \times 2 = 7200 \text{ pattern threads.}$$

This would still leave $7560 - 7200 = 360$ threads for side satins, or a little more than $1\frac{1}{2}$ in. at each selvage. It is true that if desired three machines could be mounted for the centre tie, but such a proceeding, besides limiting the mount to strictly symmetrical patterns, would cost as much in designing and in cards as the mount containing the single tie. Three machines would, therefore, be seldom or never adopted in practice.

All mounts of a similar character may be treated in a similar manner, and mounts for different widths of the same quality may be treated either directly as fresh cases or by proportion. It regularly happens that a certain pattern is required in different widths of the same sett, and if it is intended to weave the cloth from the same cards, or a repeat of them, it is, of course, imperative that the same number of needles and rows of hooks be employed. Thus, if a ten-quarter or 90-in. cloth were required to match the above eight-quarter, then we should have $\frac{28 \text{ hooks} \times 10}{8} = 35$ hooks per row for the new width. This number could be obtained on the average by filling a 40-row machine with 4 rows of 36 hooks alternating with 4 rows of 34 hooks, and so obtaining $255 \times 35 = 8925$ pattern threads. But the total number of threads must equal 105×90 in. $= 9450$; $\therefore 9450 - 8925 = 525$ threads for satins, or $2\frac{1}{2}$ in. at each selvage. Or the machine might be filled all over with 36 hooks per row, in which case it is clear that 255 fewer threads, or only 270 threads in all, would be available for side satins. This would give only $1\frac{1}{4}$ in. at each selvage: rather little perhaps for a 90-in. cloth, but still sometimes found in practice.

In making alterations such as these it is clear that when the pattern is increased in width it must also be equally increased in length, in order that the true

proportions of the ornament may be maintained. This is simply done. For example, we shall suppose that in both widths of above pattern the cloth is shotted to finish half over square, and that a correspondingly ruled paper (12 by 18) has been used for the design. In the case of the eight-quarter cloth, since there are $28 \div 12 = 2\frac{1}{3}$ hooks per needle, the same average number of picks must be given to each card, or 7 picks to 3 cards; and for the ten-quarter cloth, with $36 \div 12 = 3$ hooks per needle, three picks per card should be given. In the latter case fewer satin cards might require to be used at the end of the cloth, since the side satins have not been increased in proportion to those of the eight-quarter cloth; or the same number of cards could be retained and the shots per card reduced slightly under three to compensate. The former method would be the simpler. The correct proportions would, of course, be maintained if the machines were used giving an average of 35 hooks per row, and the shotting motion arranged to give $35 \div 12 = 2\frac{11}{12}$ picks per card, or 35 picks on 12 cards. Since this number might involve a rather large shotting disc, a smaller one might be used, say one giving 20 picks on 7 cards, or about $2\frac{1}{2}$ per cent fewer picks per card than with 35 on 12. But since the proper length of the cloth must be obtained, a few extra cards might be added to the end satins, and the picks per inch slightly reduced to give the required length.

Where it is necessary to make alterations in the dimensions of the cloth in one direction only, as, for instance, when making an eight-quarter cloth in three different lengths—8/4, 10/4, and 12/4,—it is necessary to introduce extra cards in proportion to the extra length required. These cards are cut for each machine, and for some symmetrical designs from an 18-in. extension-piece specially designed to fit into the centre of the 8/4 cloth. At other times this piece is designed in keeping with the character of the original design, and intended to join on, as a repeat, to the end of the single portion. In other cases the single portion of the design, or that part of it which, in practically symmetrical designs, is treated as single, is utilised for the above purpose with a small extra piece specially designed to bring it up to the requisite dimensions.

While designs prepared for the common harness system are, in general, used only for different widths of the same quality, they are to some extent also available for other qualities provided the harness mount is the same in both cases; but for business reasons the same pattern is seldom woven on two or more qualities of linen damask. Should one pattern be desired, however, in another quality, and the width of the cloth be alike in both cases, then it is only necessary to reduce or increase the number of hooks per row in proportion to the different warp setts. Thus, given that a 28-row machine is suitable for 105 threads per inch, and that a change is desired to 80 threads per inch, then

$$\frac{28 \text{ hooks} \times 80 \text{ threads}}{105 \text{ threads}} = 21\tfrac{1}{3} \text{ hooks per row.}$$

A 24-row machine might be used filled 2 rows of 24 hooks alternately with 2 rows of 20 hooks (average 22 hooks per row), but should this leave too few threads for side satins the machine could be filled as follows: 1 row with 24 hooks, and 2 rows of 20 hooks alternately, giving $(1 \times 24) + (2 \times 20) = 64$; and $64 \div 3 = 21\frac{1}{3}$ hooks per row (average). Should width and sett both be different, the change is still one of proportion, and may be calculated on the approximate number of pattern threads available in each case.

When making such changes it is, of course, a practical question whether the detail of the design suitable for one quality would be equally suitable for the other, but that is a question which can only be decided at the time. The effects of such changes are always apparent, although perhaps in a modified degree, even when the quality or sett of the cloth is retained and a reduction of width only is made. In cases where one needle controls less than two hooks—and it frequently happens that 12 needles control only 16 hooks, and sometimes less,—it is evident that at many points of the design one needle will control only one warp thread. When this occurs, or is likely to occur, the designer should be careful not to paint single cords to any great extent on the design paper, because, should these cords coincide with needles which control only single threads in the warp, the effect in the cloth will likely prove most unsatisfactory. To be safe, painting on single cords should only be practised in the finer qualities where each needle is certain to operate two or more hooks.

Designs prepared for eight-quarter cloths are usually utilised for all widths from 6/4 to 12/4, but where napkins are required to match, another but similar painting is made on a much smaller number of needles—usually about half that occupied by the design for the cloth.

Designs for these fine damasks are usually of a floral nature with free and flowing stems, tendrils, and leaves, although those of a stiffer and more strictly ornamental character are sometimes chosen. These latter, an excellent specimen of which, entitled "Autumn," we reproduce in Fig. 130, do not, however, always specially lend themselves for reproduction by the common harness system of weaving. The perfectly horizontal and vertical lines which often form features in such designs cannot, with this type of weaving, be properly bound at both sides of each line. When straight lines are introduced in designs intended for this type of weaving, their direction should be more or less diagonal; indeed, the same remark applies to the general direction of most of the ornament.

Fig. 130.

The above design, by Mr. Henry Drummond, Dunfermline, was awarded a silver medal by the South Kensington authorities in 1903; but, while recognising the artistic qualities of the design, and the ability with which the

subject has been treated generally, we are afraid that the above-mentioned practical difficulties in regard to sharp and distinct reproduction would prevent its adoption in practice. It is true that the design could, at considerable expense, be perfectly woven by the full harness system, but it is somewhat defective in the respect alluded to when intended for the common harness method of weaving—the method which is almost invariably employed for large designs. Otherwise, although not strictly symmetrical at all points, the design is an excellent example of the symmetrical type, and might easily be adapted to a centre-tied harness. A part single tie would, however, be preferable, and would most probably be adopted; nevertheless, several economies could be effected by treating it as strictly symmetrical, more especially if it were to be painted on 12 by 12 paper. Under such conditions much painting of the design might be saved, since part of the side border cards could be cut from part of the end border painting; and, besides, it would only be necessary to cut cards for half the cloth, the other half being produced by working the cards backwards. Where a single portion is introduced into the cards, it is necessary, after this single part in the way of the weft has been woven, to reel or turn back the cards, with the loom standing, until the last card of the double portion is brought round; the loom is then restarted, but the cards now work backwards. If non-square paper were used—as, *e.g.*, 12 by 18—it would be necessary to paint the design full out, since with such paper the side border cards cannot be cut from the end border painting of the design. Assuming, however, that the design is to be treated as strictly symmetrical, and is yet to be woven with a mounting in which part of it is single, we shall endeavour to show the painting of the design necessary if square paper were used. We must first determine the extent of the single mounting in the harness, and, while the design could be adapted to any usual amount, we shall assume that the single part is to be one-third of the total needles employed, or one out of the three machines already supposed to be mounted. Now it is clear that the centre of the single portion of the mount must coincide with the centre of the cloth, or, with reference to the design in Fig. 130, with the centre of the heart-shaped space in the end or cross-border. But since the whole of the single mount occupies exactly half as many needles as the double mount, it follows that half of the single part of the design will be equal to one-fourth of the double part of the design at one side of the cloth; consequently, if we divide the design for half the complete width into five equal portions, four of these will represent one side of the double, and the fifth portion will represent half the single, while a precisely similar portion on the other side of the cloth centre will give the remaining part of the single. This is shown clearly in Fig. 131, in which the leading lines of the design have been reproduced. From this figure it is evident that the design in Fig. 130 shows slightly more of the ornament than it would be necessary to paint for the card-cutter. Fig. 131 also shows diagrammatically that nine sheets of design paper, A to J, each 50 or 51 blocks square, would be necessary for the complete design if 12 by 18 or any other non-square paper were used, and if that part of the design contained by sheets A, B, and C were all single. But since the design is to be treated as strictly symmetrical it would be necessary to design and cut cards only as far as the centre of the cloth indicated by the line K L. The second half of the cloth in the way of the length would be

produced by reversing the working of the cards from this point. By symmetrical treatment alone, therefore, three half sheets of designing would be saved. A much greater saving results if 12 by 12 paper be used, for it would be

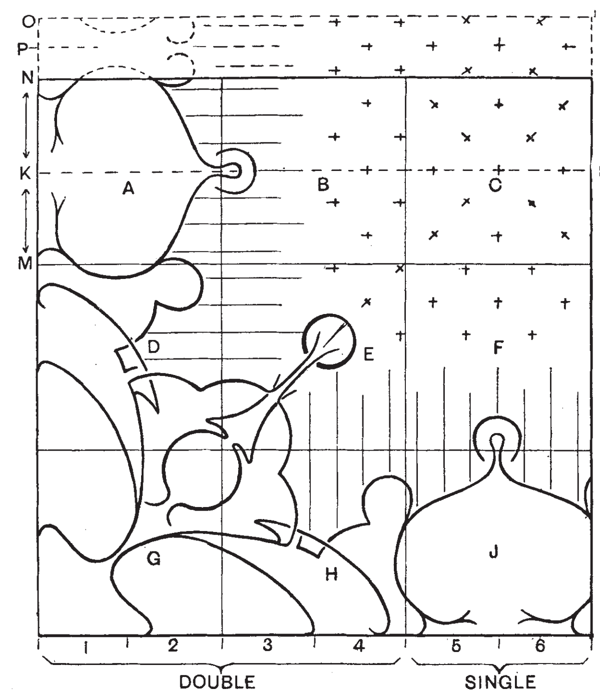


Fig. 131.

possible to utilise sheet H for sheet D by turning the former through 90 degrees, and either lacing or cutting the cards backwards, while half of sheets J and F, by similar treatment, would fulfil similar functions for A and B. With symmetrical treatment, therefore, and the use of 12 by 12 paper, only $5\frac{1}{2}$ sheets of design paper (G, H, J, E, F, and $\frac{1}{2}$ C) would be required as compared with 9 sheets for 12 by 18 paper and full single treatment. At a very modest estimate this represents a saving of about £15 in the cost of designing alone.

Extension pieces of designs which contain animate forms, as in Fig. 130, are often more difficult to manipulate than are those which are intended as complements to purely floral sketches. If the design under consideration were required to be adapted for a cloth ten quarters in length, part of the extra cards required would be obtained by repeating those already in use for section K M, and lacing them backwards to produce section K N (see Fig. 131). In addition, it would be necessary to design a special piece for each machine to form half of the section N O. Since the design is being treated symmetrically, cards for only half this extra section would be required. The whole set of cards would work forwards to the new centre of the cloth at P and then reverse. To be correct, all the cards thus added from K to P should increase the length of the cloth by 9 in., and this, when duplicated by reversing, increase the length by 18 in. Now M to N is one-fifth of the pattern length of the 8/4 cloth, 68 in. $\div 5 = 13 \cdot 6$ in.; K N is therefore $13 \cdot 6 \div 2 = 6 \cdot 8$ in. K P = 9 in., and K N = 6·8 in., therefore N P must equal $9 - 6 \cdot 8 = 2 \cdot 2$ in. in order to give the correct length.

If M N or 13·6 in. is produced by 600 cards, then N P or 2·2 in. will require

$$\frac{600 \text{ cards} \times 2 \cdot 2}{13 \cdot 6} = 97 \text{ cards.}$$

96 cards would probably be cut from a painted design of the same number of lines. For a further extension to twelve quarters long it would only be necessary to repeat

the cards from K to P and to lace them backwards. In designs where the treatment is not symmetrical the extra piece N O would be fully painted, and extra cards would be cut for the full 18 in. from M to O.

Figs. 132 and 133 illustrate the types of design which are usually submitted for the common harness method of weaving. Part A, Fig. 132, shows one quarter of the sketch as it would be prepared (except perhaps that the figure would be black on a white ground) ready for transference to the design paper, while part B is the complete design as it would appear on the cloth. This particular example is perfectly symmetrical about the centre. The complete design, D, Fig. 133, is, however, very similar in its proportions to Fig. 130—about one-fifth in the centre being single tie. A little more than one-quarter of the sketch is shown at C. Both figures illustrate the free and flowing nature of such designs, the general trend of the ornament towards the centre, and the entire absence of stiff horizontal or vertical lines—a very desirable feature. Design D, Fig. 133, is, perhaps, a little too heavy or full of figure, but it must be remembered that in the illustration it has been reduced to a very small scale. The quarter design at C in the same figure appears more open, and the woven article would appear even more so. Assuming that the single part is one-half of the double part in sketch C, the design might be mounted on two medium pitch machines, each having 57 rows of 16 needles by 2 hooks per needle, or 32 hooks per row if the warp sett were, say, 90 threads per inch finished.

$$57 \text{ rows} \times 2 \text{ machines} = 114 \text{ rows.}$$

$$\frac{114 \text{ rows}}{3 \text{ parts}} = 38 \text{ rows per part—}i.e.,\ 76 \text{ rows for the double portion and } 38 \text{ rows for the single.}$$

A

B

FIG. 132.

C

D

FIG. 133.

$$\left.\begin{array}{l}76 \text{ rows double} = 152 \\ 38 \quad ,, \quad \text{single} \;\; = \;\; 38\end{array}\right\} = 190 \text{ rows} \times 32 \text{ hooks each} = 6080 \text{ pattern threads.}$$

$$\frac{6080 \text{ threads}}{90 \text{ threads per inch}} = 67\tfrac{5}{9} \text{ in. of pattern.}$$

This would leave 72 in. $-$ $67\frac{5}{9}$ in. $= 4\frac{4}{9}$ in. of satin, or $2\frac{2}{9}$ in. at each selvage in an 8/4 cloth.

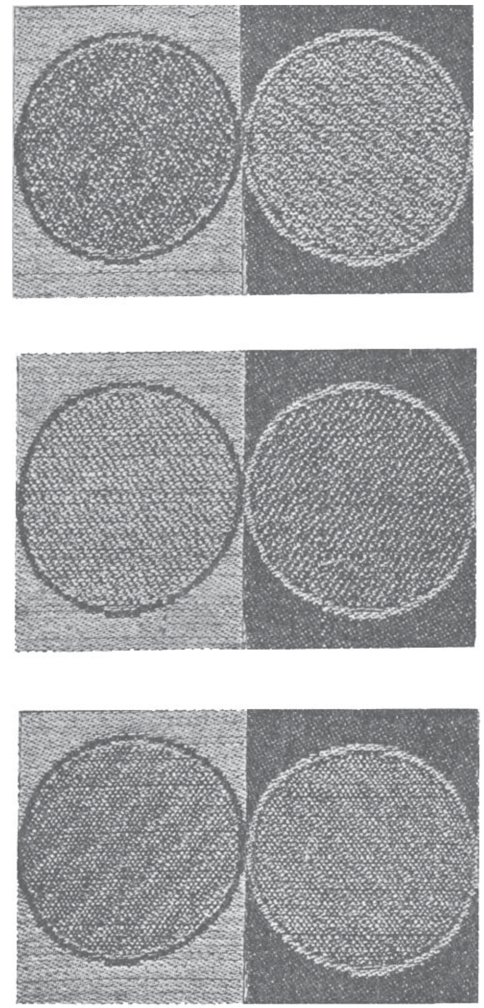
The benefits derived from mounting on two such machines instead of on three 600-needle ordinary machines would be :—

1st. The saving of 33 per cent of cards.

2nd. The outline of the figure would still be kept very fine, since no needle would control more than two hooks or more than two contiguous warp threads.

The enlargement of a common harness design from the sketch to design paper proceeds on exactly the same principle as in the case of a full harness design, but when using 12 by 18, or similarly proportioned paper, it must always be remembered that vertical and horizontal lines of the same breadth, while covering equal linear spaces on the design paper, will cover an unequal number of cords in proportion to the ruling of the paper. Thus a float of two warp cords must be equalled by three weft cords, and so on. Although as a general rule detail may be painted to a much finer degree than in full harness, still, it is always essential that great care should be taken to round off the curves very gradually, since a step of two warp or weft cords on the design paper may mean a step of anything between four and eight threads or picks in the cloth.

Under ordinary circumstances it is not desirable to introduce into the design any shading effect, or other variation from the perfectly flat sateen treatment, since the automatic insertion of the twills makes it impossible to



C

B

A

Fig. 134.

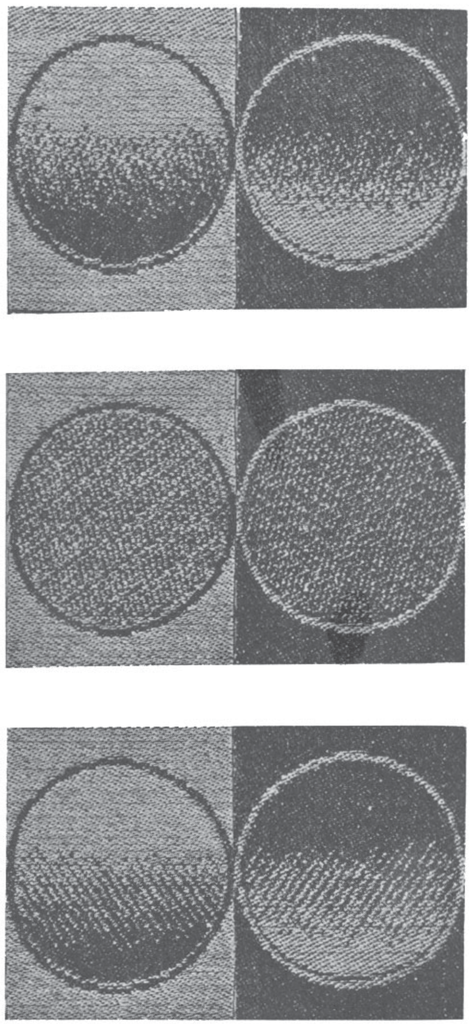


Fig. 135.

reproduce such shading accurately in the cloth. Modified effects of light and shade between those obtained by the sateen extremes are sometimes produced by the introduction of several simple weaves—as, *e.g.*, $\frac{1}{1}$ plain; $\frac{1}{2}$ and $\frac{2}{1}$ twills, separately or combined; the 4-thread straight twills graduated from $\frac{3}{1}$ to $\frac{1}{3}$; the $\frac{2}{2}$ twill arranged in broken order—1, 2, 4, 3; the 5-thread

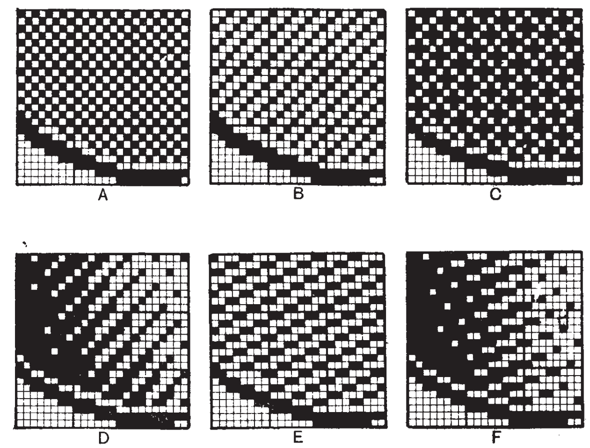


Fig. 136.

sateen $\frac{2}{3}$ arranged warp way or weft way; some 8-thread twills arranged in sateen order, and the 8-thread sateen regular shading. Six of these effects showing both sides of the cloth in each example are illustrated in Figs. 134 and 135, while the corresponding weaves are given in the sectional designs in Fig. 136. In four of these examples, A, B, C, and E, the circles are filled with all-over effects, while in D and F shading is attempted with the 4-thread graduated twills and the 8-thread sateen shading respectively. The cloth contains about 85 threads by 125 picks per inch, and was woven on a 28-hooks per row jacquard—arranged 2, 2, 3 hooks per needle, and with 2, 2, 2, 3 = 9 picks on 4 cards, or $\frac{9}{4} = 2\frac{1}{4}$ picks per card. 12 by 18 design paper was used, and the machine was necessarily arranged for the 8-thread twill. Where the plain weave is used for shading, as in A, care must be taken not to extend it over a large surface of the cloth, since on account of its high interlacing value it is inclined to make the cloth too firm and hard.

Fig. 137 is introduced chiefly to illustrate the application of several different methods of obtaining shaded or half-tone effects in common harness designs. The following varieties may be traced in the design :—

1. $\frac{1}{1}$ plain.
2. $\frac{1}{2}$ twill, graded into the $\frac{2}{1}$ twill.
3. The smallest possible diamond effect in which alternate threads are plain. (This effect is exactly the reverse of Fig. 84, p. 109.)
4. A 7-thread sateen arrangement of the order $\frac{2}{2}\frac{2}{1}$ moving two picks at a time. A similar weave in the way of the weft is also used.
5. A novel effect which is obtained by painting all odd picks solid, and even picks in $\frac{2}{1}$ twill order.

The design, which was evidently painted for a 10-row machine to be used in conjunction with a pressure harness hand-loom, also illustrates a somewhat conventional, but perhaps on this account a more truly artistic treatment of buds and foliage. The pattern was made about seventy years ago, and it is interesting to know that the designer of this example was the father of the celebrated artist—the late Sir Noel Paton.

In fine fabrics of the foregoing character both ground and figure portions of the design are usually developed in the 8-thread sateen weaves; the 5-thread weaves are,

Fig. 137.

however, sometimes used in medium and lower grade qualities of damask. In connection with full harness designing it is stated that the figure in some designs is developed in the 8-thread weave, and the 5-thread weave used for the ground. This decrease of binding points or of structural value in the figure portion results generally in a greater prominence of that part of the pattern. It is impossible, however, to give effect to this combination of weaves with the ordinary twilling jacquard, but on different occasions during the past few years mechanical parts have been added and electrical additions made to the machine whereby this combination becomes possible. These arrangements are generally very ingenious, and while some place restrictions upon the type of machine and are therefore of limited application, others are of general application. All are clever attempts to deal with a difficult problem, but, apart altogether from the question as to whether such a combination of weaves is generally desirable in damasks, the extra mechanism essential involves additional expense and adds further complications to an already sufficiently complex machine.

Where the combination is applied in full harness weaving, the edging of the figure is defective, since the sudden change from a 5 to an 8-thread weave permits the weft to close together to a greater degree at that point than at places where no change takes place. A similar, but opposite effect results where the change is made from figure to ground. Twilling jacquards have also been introduced in which the twills of ground and figure are arranged to run in opposite directions with the object of producing automatic binding at the edges of the figure, but this innovation complicates the mechanism and restricts the work of the designer. Other attempts

have been made, and are still being made, to produce automatic binding by means of additional parts in the machine without changing the direction of the twill, but so far without commercial success. Such binding is undoubtedly desirable in all damasks, but if the method by which it is obtained is to be of any commercial value, little or no restriction must be placed upon the designer or upon the type of machine. In addition, the extra mechanism required should be simple and inexpensive, while, to be effective, it should bind transverse as well as longitudinal lines.

When a longitudinal line is continuous throughout the piece or pattern it can easily be effectively bound. The automatic action of the twilling jacquard binds one side or edge, while the other side is bound by redrawing the first thread of the ground portion through a mail which is controlled by any hook working in opposition to the last thread of the stripe or figure portion. Transverse straight lines cannot, however, be so treated, and isolated portions of lines in the longitudinal direction of the piece should not be, since there is the risk of marring the appearance of the design at some other part.

The method indicated above may also be used with advantage in full harness designs at those points where a straight portion of the harness meets a turned-over portion —as, *e.g.*, where the first or inside thread of the turned-over side border meets the last thread of the last repeat of the filling or centre portion of the design. In cases such as the above—and they are numerous—it will often be found that both the threads indicated normally rise and fall alike, particularly when weaving the ground. This gives rise to what is technically termed a "flat," and is, usually, unsightly. It can be avoided in practically every case by suitably redrawing either of the threads; and, in general, it will be found that by actuating, say, the last thread of the repeat from the hook controlling the first thread of the repeat, a much more satisfactory result will be obtained. Similar faults in the way of the weft cannot be treated except by introducing a special card, but they may be made less apparent by beginning to work the border cards backwards from the second last card instead of from the last.

CHAPTER X

CHECKS AND SMALL EFFECTS

On more than one occasion we have emphasised the fact that the appearance of many fabrics is distinctly enhanced by carefully joining up the various parts of the design or weave. In many cases the method adopted is that of employing weaves which work in opposition to each other in the different portions of the fabric, and so join up perfectly by cutting where they meet. In other cases, where weaves are used which gradually merge into each other, this feature is undesirable; but again, in others, where a sharp distinction between the various portions of the design may be desired, the weaves employed may be of such a nature as to render it impossible to obtain a clear and distinct joining without the introduction of specially arranged cutting threads. To unite satisfactorily the various weaves forming a design is a work which often calls for very careful and judicious treatment, since, in many instances, it is a matter of very great difficulty to keep the floats at the points of junction

within reasonable limits without impairing the appearance of some part of the design. No satisfactory rules can be given for this work, since each design of this kind requires special treatment. The particular way of checking the long floats is largely influenced by the relative lengths of float, and by the relative numbers of threads and picks per inch. For rectangular figures the value of special cutting threads, in whole or in part, is considerable.

No cutting by special threads or otherwise appears in Figs. 82 to 102, but in these designs the necessity for cutting does not arise; nevertheless, the long floats caused by the mode of construction often injure the general effect of the design. From Figs. 103 to 110 the cutting effect is essential; indeed, the smartness of the fabric depends largely on this feature. A similar effect, not necessarily continuous, is desirable in many designs formed by two or more distinct weaves.

If the line of movement of all parts of a design could be made to coincide with that of the twill or outline of the weave used, the operation of joining the several parts would be considerably simplified; but, unfortunately, or fortunately, this seldom happens. Fig. 138 will explain, to some extent, the meaning of the first part of this statement. Here the direction of the weave, although it is plain, may be considered as moving diagonally to left and to right at an angle of 45°, and the figures, which are placed on it, also move diagonally and at the same inclination. Any straight, zigzag, or diamond figure, with perfect contours, may be thus introduced on a plain ground, provided the floats cover odd numbers of threads or picks; indeed, a great variety of continuous as well as detached figures may be arranged on this principle, and, with skilful treatment, very few shafts need be used. The longest float in the figure is five, but it is easy to see from the outline of the central part of the figure that a design may be made where no float exceeds three. The design is complete on 48 threads and 48 picks, the heavy bands and the central figure forming jointly a kind of diamond pattern, while the narrower bands form a check of smaller diamonds, the whole appearing on a plain ground.

Some very pretty effects may be obtained by using

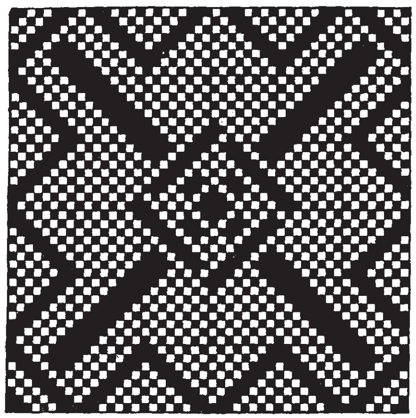


FIG. 138.

the plain weave in conjunction with warp and weft floats, and Fig. 139, which shows two repeats in the way of the warp, is a typical example. Here, again, the floats of both warp and weft conform with the direction of the marks of the plain weave, and no difficulty is experienced in joining the parts. It is, of course, only in special cases where such a satisfactory joining can be obtained by these three units. The general appearance of the design is unique, and the woven fabric is equally effective—the long floats resembling interlacing ribbons.

Fig. 140 is a stripe design, the first part of which is made on the same principle as Fig. 139, but with shorter floats, while the second part consists of straight twills. Fig. 141

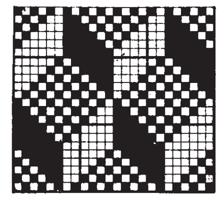


FIG. 139.

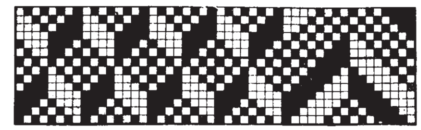
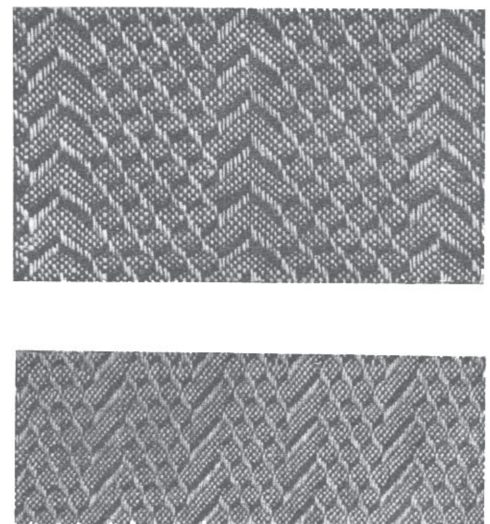


FIG. 140.

A



B

FIG. 141.

A is a photographic reproduction of the woven fabric, while 141 B is of a similar type. The sett and counts of the latter are more suitable for this weave than are those used in A.

When the direction of the main twill or figure does not run in line with the groundwork it is not always an easy matter to join the several portions. Thus, Fig. 142 is also composed of warp and weft floats upon a plain ground, but here the joinings appear very irregular. The effect in the cloth, however, is not irregular, but rather attractive. The long floats of warp and weft are the main features; they form a heavy corded effect, and enclose two areas, one large and one small, developed in plain weave. When woven in a medium to fine sett with suitable yarns the cord is so prominent that it closely resembles some type of embroidery.

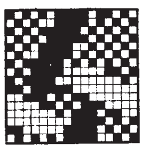


FIG. 142.

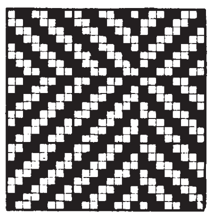


FIG. 143.

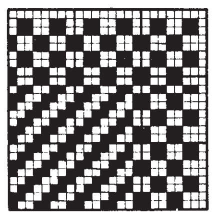


FIG. 144.

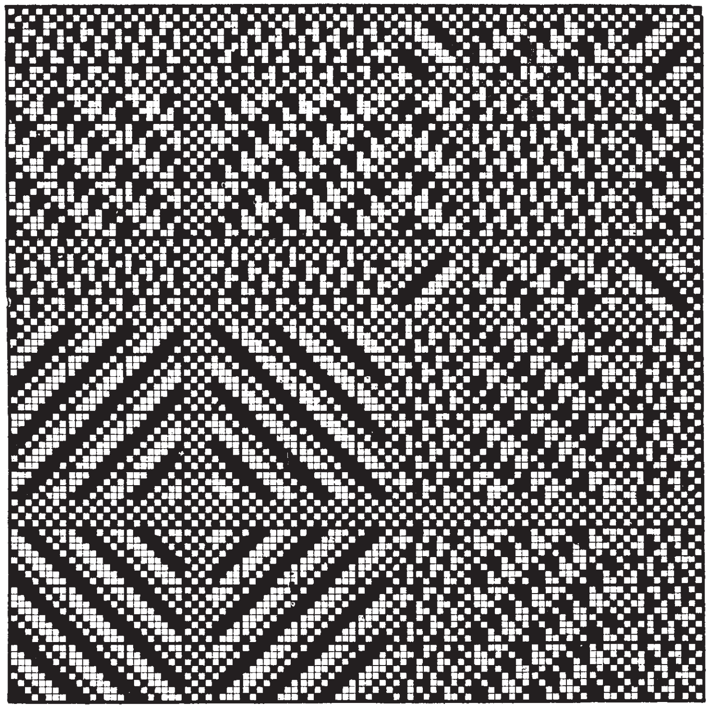
It is often impossible to arrange the weaves in perfect order, but slight imperfections in the design are occasionally imperceptible in the cloth; while, on the other hand, an elegant design on paper may be quite worthless when reproduced as a texture. This is particularly the case where there is a great diversity in the lengths of the float in small areas.

One is always quite safe to predict the effect which would be obtained by such designs as Figs. 143 and 144. Both are made in the form of checks (they are made on a small scale simply to illustrate a principle), and in both cases the checking part cuts at all junctions with the

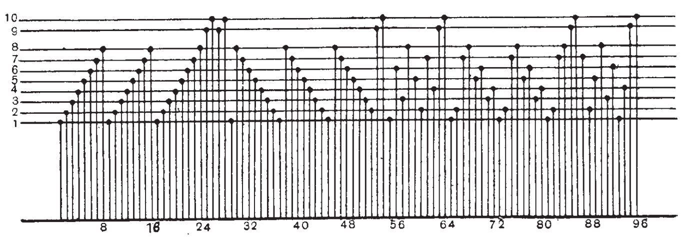
ground part. It is quite an easy matter to give effect to this cutting in Fig. 143, and in all such designs where each separate part occupies a multiple of the unit weave, for it is only necessary to reverse the parts, or a certain portion of each, as illustrated in the figure. It is different, however, with Fig. 144. The basket weave contains only two different kinds of threads and picks, consequently it can cut with only two threads or two picks of the $\frac{2}{2}$ twill. The central part of the check must, therefore, finish on an odd number of threads and picks, and even then it is impossible to arrange the parts as perfectly as those in Fig. 143.

A check design of a larger size is illustrated in Fig. 145. It is introduced chiefly as an example of what may be done by the rearrangement of a simple twill, although it must be remembered that the variations shown do not by any means represent the total number possible. As a matter of fact there are only six arrangements of the $\frac{3\ \ 1}{1\ \ 3}$ twill used in conjunction with the plain weave; these six appear at 1, 2, 3, 4, 5, and 6, in Fig. 146. From what has been already shown, the reader will easily follow the draft in Fig. 145 and the corresponding weaving plan in Fig. 146; but, in this respect, we may add that the shafts which operate the plain weave would be better at the front than at the back. Although there are many fabrics in which certain threads weave plain throughout, as in this example, still there may be some difficulty in the work unless these threads are on a separate beam. In the design under notice one-twelfth of the threads weave plain, and it will be seen that the introduction of these special cutting threads and picks limits the floats to three.

The rearrangements of one weave or a number of



Design.

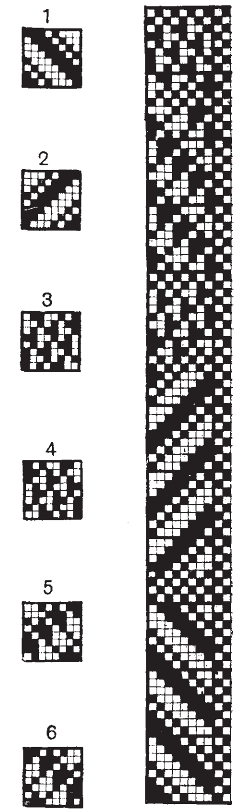


Healding in Draft.

Fig. 145.

different weaves may be employed in developing any kind of floral or geometrical figure. These weaves usually consist of the plain, simple twills, sateens, oatmeals, crêpes, etc., and one of the chief considerations for a designer, after the primary one of the figure itself, is to choose such weaves for the several parts of the design as will develop each part to the best advantage. The various parts must then be joined up so as to prevent any unsatisfactory or lengthy float.

When a single cloth is developed in a variety of weaves or textures as indicated above, the fabric often receives the name of "brocade," although a true brocade is essentially different. Such designs are usually prepared for, and woven by means of, an ordinary jacquard, in which each hook works independently of any mechanism other than the ordinary card, needle, and knife. It will thus be seen that a so-called "brocade harness" is the same as what we have invariably termed a "full harness."



Weaving Plan.

Fig. 146.

CHAPTER XI

COMPOUND FABRICS

DOUBLE WARP-FACED FABRICS

In the manufacture of practically all textile fabrics the utilitarian point of view is of prime importance. Design and ornament, when applied to textiles, must generally be subsidiary to the purpose for which the fabric is intended; more especially is this true when considering design from the technical side—or, in other words, from the point of view of fabric build or structure. In the consideration of such cases the means by which the weight of the fabric may be materially increased forms an important, if it be not the controlling, element. Elsewhere we have shown (see *Jute and Linen Weaving*, Part II., "Calculations") that for given sizes of yarns there is a limit to the number of threads and picks per inch which may be introduced into what is termed a perfectly balanced cloth; this maximum number per inch is, for the said type of cloth, coincident with the maximum weight for any particular size or count of yarns. It is easy to see that, in a range of such cloths, the weight will increase or decrease as the cloth becomes coarser or finer respectively, because while the width remains constant, the thickness of the cloth is a varying quantity, and is approximately equal to the combined diameters of one warp thread and one weft thread. Such being the case, an increase of weight in a simple or single make of the above type of cloth can be obtained only by the use of heavier yarns in a coarser sett. If the same

yarns be used in a finer sett, the result will be an alteration in the structure of the fabric.

Fig. 147 has been prepared to show what would happen

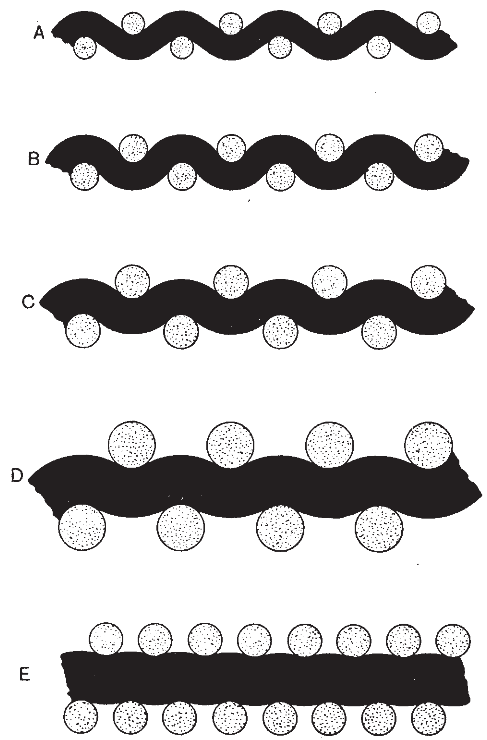


Fig. 147.

if an attempt were made to retain the sett, and at the same time to increase the weight by employing thicker yarns; the weft in each diagram is shown in solid black. Intersection A represents a good make of plain cloth, but not a maximum one; so that if this particular cloth were required heavier, an increase of weight, within limits, could easily be obtained without sensibly altering the structure. This is illustrated at B, in which the maximum is attained. It will be seen that if horizontal lines were drawn above and below each of these figures, each line would touch warp and weft, since they both rise and fall to the same horizontal planes.

Although the threads and picks in C and D are much thicker than those in A and B, the number per inch is the same. Fabrics C and D are, however, considerably heavier than the first two; but it will be observed that the structure is entirely changed. Indeed, as the yarns are increased in diameter, the disposition of the weft yarn approaches more and more closely to a straight line. The fabric is, in reality, approaching the structure shown at E, which, for want of a better definition, may be termed a 3-layer cloth (two layers of warp and one of weft), as distinct from A and B, which are 2-layer cloths (one of warp and one of weft). Some difficulty is experienced in finding correct definitions for these two types, but we think that the words "simple" and "compound" are fairly satisfactory ones to denote makes of two layers and three or more layers respectively. We are well aware that the ordinary warp and weft ribs may be woven with two shafts: still, these fabrics have all the characteristics of a compound structure. On the other hand, many fabrics which would fall under the class termed "simple," are made from elaborate designs.

It is possible, however, to increase the weight and at the same time to retain apparently the structure of any fabric; but this can be done only by the addition of an extra layer of warp, or of weft, or of one or more of each. We now purpose describing and illustrating the different ways of adding such extra layers to the various kinds of fabrics.

Briefly stated, there are two chief reasons for modifying the structure of a fabric:—

1. To increase the weight of the cloth, and so impart desirable properties—*e.g.*, heat retention and durability.
2. To beautify the fabric.

Perhaps the simplest and most natural way of increasing the thickness, and therefore the weight, of an ordinary cloth, is by increasing the number of threads of warp per inch, since economic production results when the number of picks per inch is less than the number of threads. There are many fabrics of this type, generally termed double warp-faced fabrics—*e.g.*, repps, double-warp tapestries, etc. Flax and cotton sailcloth or canvas is a particular example of this type, and the structure of this fabric resembles closely that at E, Fig. 147, except that the warp threads usually run in pairs. These sailcloth and other similar fabrics probably represent the extreme limit of plain cloth weave; but they can hardly be considered as of single or simple structure, since their thickness consists of three layers of yarns.

Besides increasing the weight of the fabric, we secure, under certain conditions, other important results when the threads of the warp are closely set; we refer to the effects produced by the use of coloured threads in the warp. Diagram E in Fig. 147 shows clearly that when the maximum number of warp threads is employed, the weft is almost completely covered. It is also clear that if the warp threads were alternately

1 thread dark,
1 „ light,

the present disposition of the yarns would result in a practically solid dark line from selvage to selvage on the underside of the fabric; while a similar but light coloured line would appear on the surface. Any change in the shedding would reverse these effects, and, when repeated, would produce alternate light and dark ribs across the fabric, even with the plain weave.

Design A, Fig. 148, shows the 8-pick rib weave. Such weaves always require a large number of threads per inch, because similar floats of any pair of consecutive threads are capable of appearing almost in the same longitudinal line in the cloth; the only resistance to this lateral movement being the point where the threads change positions. The greatest facility for this action of closing together is, therefore, in such weaves; but any weave which tends to this style requires, for the same reason, a much greater number of threads per unit space than do the ordinary twills. Consider designs B and C in the same figure: each thread in B keeps the neighbouring threads in their relative positions, as shown on the paper; but in C a lateral movement is possible, and necessary to the proper effect in the fabric. It is in virtue of the natural tendency of threads, as well as of other bodies, to move in the line of least resistance, that such movement takes place; and, although the above two weaves are composed of the same seven threads, it is clear that, while the common intersection theory of cloth structure

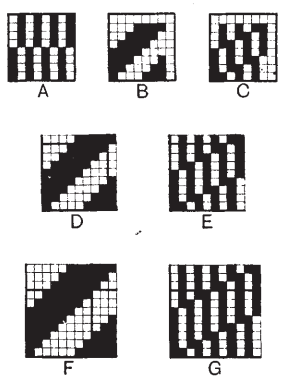


Fig. 148.

may hold good in regard to B, it is absolutely valueless for design C.

Designs B, D, and F, Fig. 148, are respectively the $\frac{4}{3}$, $\frac{5}{4}$, and the $\frac{6}{5}$ straight twills, while plans C, E, and G are the well-known corkscrews made from these weaves. The method of construction for any of these ordinary corkscrews, which were used extensively a few years ago in the manufacture of worsted coatings, is the same. It will be seen that the threads of the straight twill are taken in regular succession, and introduced on alternate threads for the formation of the corkscrew. They may also be made from certain sateen bases, but perhaps the simplest mode of construction is to make the design on $2n+1$ threads and picks, with a float and also a step of $n+1$ on successive threads.

Since the warp threads in these corkscrew weaves practically conceal the weft, it is evident that a thread-and-thread arrangement of colouring will result in two parallel and adjacent twills of distinct colours. This principle of colouring, and the elaboration of the weaves, are extensively adopted in the fancy carpet trade, and in other branches of weaving.

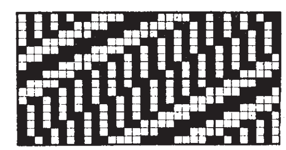


Fig. 149.

Fig. 149 illustrates a method of obtaining differently-coloured diagonals. The main or central part of the weave is identical with design E, Fig. 148, and would, consequently, form two bands representing the colours of the warp. Each band of coloured warp is bounded by a weft diagonal, which, to be effective, would naturally be of a different colour from either of the warp threads; while the solid black band in the design would be represented in