3

Development of Weaves from Elementary Bases

PLAIN WEAVE DERIVATIVES

This group of structures comprises varied simple weaves which are all extensions of the plain weave and can be produced on two healds. The extension of the plain weave can proceed, either vertically, grouping together several picks in the same shed and resulting in warp ribs; or, horizontally, with groups of neighbouring ends working in tandem and producing weft ribs; or, in both directions simultaneously, resulting in mat, hopsack and basket weaves.

Warp rib weaves

Simple warp ribs can be produced in ordinary plain weave and their construction is illustrated in *Figure 2.2*. Other, more-pronounced effects result from extending the plain weave vertically, as shown in the examples given at A to F in *Figure 3.1*. A, B, and C produce regular warp ribs in which each end passes alternately over and under 2, 3, and 4 picks respectively, and is brought prominently to the surface on both sides of the cloth. This is shown at G in *Figure 3.1*, which indicates how the ends interlace with the picks in the plan A. Lines or ribs, that are equal in size, are formed running the width of the cloth, as shown in *Figure 3.2*, which represents a fabric produced in the weave given at A in *Figure 3.1*.

D, E, and F in *Figure 3.1* are irregular warp ribs, which produce horizontal lines that are unequal in size. In D and E the odd ends are chiefly on the surface, while the even ends are mostly on the back, as shown at H, which represents the interlacing with the weave E. By using a good class of material for the odd ends, and a cheaper material for the even ends, a cloth with a good appearance may be economically produced in designs such as D and E. In the design F a wide rib alternates with two finer ribs, but in this case all the ends are equally on the surface.

In each of the examples given above the correct formation of the rib is dependent not only on the order of interlacing but also on the respective density of setting of the warp and the weft threads. Best results are obtained with a high warp sett in which the warp ends cover the weft almost entirely.

The ribs can be emphasised even more strongly by the use of alternate coarse and fine ends, slack and tight ends, and thick and fine picks as shown respectively at I, J, and K in *Figure 3.1*. Each of the above three combinations will produce a more prominent rib than that shown at H although there is no difference in the weave itself. Further increase in the prominence of

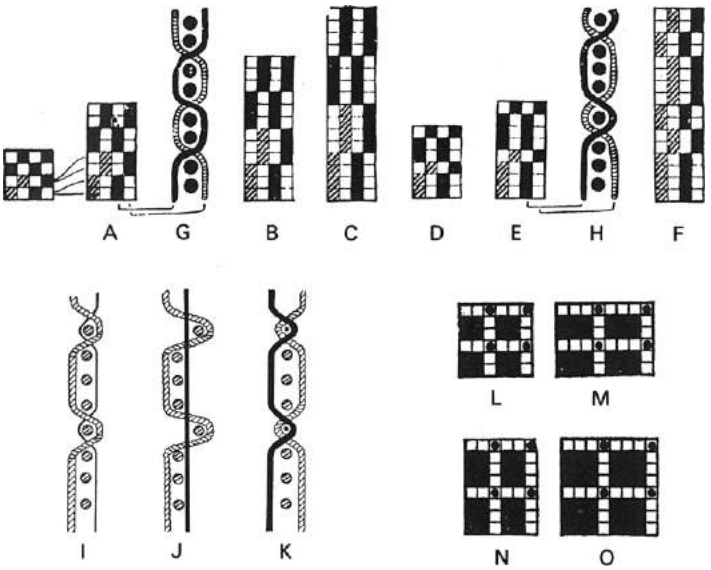


Figure 3.1

warp ribs can be achieved by grouping together several ends which work alike and raising them over a number of coarse picks and then passing them under one fine pick. Using this method with fine warps it is possible to achieve ribs equally prominent to those obtained by the use of alternate coarse and fine ends but of much smarter appearance. This type of construction is shown on design paper at L, M, N, and O in *Figure 3.1*. For looms with changing boxes at one side only, a 2-and-2 order of wefting may be employed for the designs N and O, one of the fine picks going into the same shed as the two thick picks. Many of the weaves illustrated are used extensively in the production of the various *grosgrain* cloths and also form the basis of the *matelasse* fabrics.

Weft rib weaves

These are opposite to warp rib weaves, and result from extending the plain weave horizontally, as shown in the examples A to F in *Figure 3.3*. In A, B, and C, which are regular weft ribs, each pick of weft passes alternately under and over 2, 3, and 4 ends respectively; the weft is brought prominently to the surface and forms lines running the length of the cloth on both sides. D, E, and F are irregular weft ribs, which produce longitudinal lines that are unequal in size. The diagrams G and H respectively correspond with the plans A and F, and show how the picks interlace with the ends. The fabric represented in *Figure 3.2*, if turned one-quarter round, will illustrate the appearance

of a weft rib weave. As in the warp ribs, the appearance of the cloth also depends on the respective thread settings and to achieve good effects it is necessary to weave a weft rib with a high number of picks per inch and a comparatively low number of ends per inch. The prominence of the ribs can

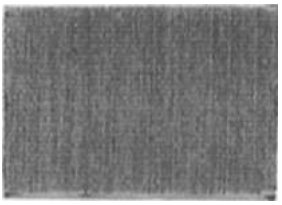


Figure 3.2

be increased by suitable use of coarse and fine yarns as shown in the diagrams I and J in *Figure 3.3*. Construction J, which depends upon a suitable arrangement of coarse and fine ends, is more frequently employed as it does not require the use of a loom with multiple shuttle boxes which is necessary in the production of rib I where alternate coarse and fine picks are introduced. Weaving particulars to produce the weft rib J (also shown on design paper at D) in cotton yarns would be: Warp—2 coarse ends, 40/2 tex; 1 fine end, 15/1 tex; 20 ends per cm; weft—42 picks per cm of 30/1 tex.

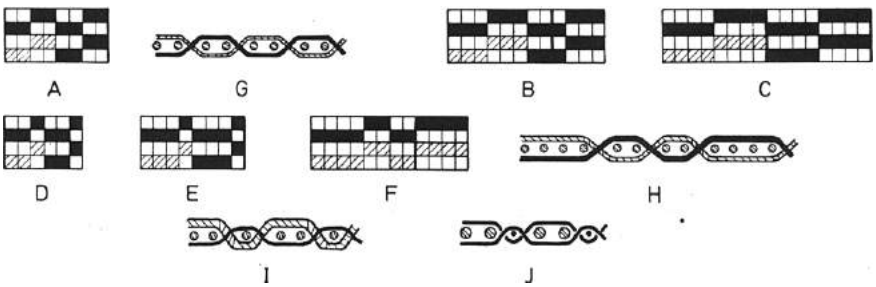


Figure 3.3

The dependence of all rib constructions upon the correct thread settings is very marked and the weave D, which in the circumstances illustrated above produces a distinct weft rib, can also be employed to give a warp rib if the following yarn counts and settings are used: Warp—18/1 tex cotton, 52 ends per cm with the two ends working together slack, and the single end tight; weft—38/1 tex cotton, 16 picks per cm. The warp rib obtained in this manner results in an effect which is similar to that achieved by means of the weave F in *Figure 3.1* but slightly less prominent.

Hopsack, mat, or basket weaves

These are constructed by extending the plain weave both vertically and horizontally, so that in both directions there are two or more threads working together in the same order. A, B, and C in *Figure 3.4* are regular hopsacks arranged respectively 2-and-2, 3-and-3, and 4-and-4; the warp and weft show equally on the surface of both sides of the cloth in the form of small equal-sized squares or rectangles. The interlacing diagram given at M represents the weave A, while a fabric to correspond is illustrated in *Figure*

3.5. D, E, and F in *Figure 3.4* are irregular hopsack weaves, which form unequal spaces in the cloth. On account of the loose method in which the threads interlace in ordinary hopsack weaves, large designs are only employed in fine fabrics. It is possible, however, to obtain well interlaced effects in coarser fabrics by combining hopsacks with warp and weft ribs to form constructions frequently referred to as fancy basket weaves. Some examples of these structures are shown at G to L in *Figure 3.4* and it will be observed

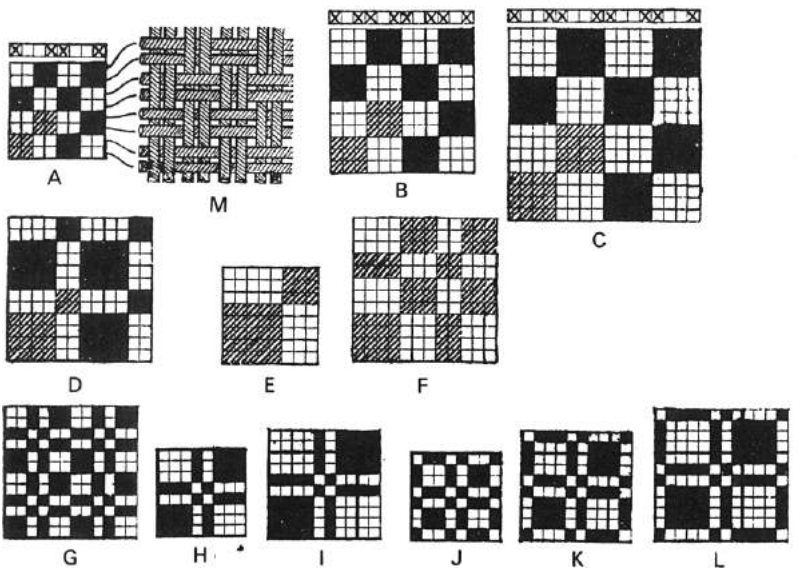
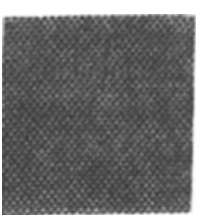


Figure 3.4

that although some repeats are quite large all effects can be produced on only two healds with the use of suitable drafts. The designs G to L are frequently woven with finer yarns for the rib ends and picks than for the hopsack threads. Thus, the design J may be arranged in the following manner: Warp—two double ends of 30/1 tex cotton (hopsack), and two single ends of 15/1 tex cotton (warp rib); Weft—two picks of 60/1 tex cotton (hopsack),

Figure 3.5



and two picks of 15/1 tex cotton (weft rib). All hopsack and basket weaves can be extended further to produce even larger and more prominent effects but, in order to avoid loose construction, it is necessary to modify the weaves considerably. Several examples of such modified hopsacks are given in *Figure 5.1.*

Denting of weft rib and hopsack weaves

The ends which work together tend to twist or roll round each other as the cloth is woven, and if this takes place the cloth suffers in appearance, while the weaving process is made more difficult. The twisting of the ends can be prevented by denting them in such a manner that those which work alike are separated by the wires of the reed. Above each plan A, B, and C in *Figure 3.4* a system of denting is given in which the marks and blanks indicate the order in which the ends are passed together through the reed, the threads of a group being passed through different splits. The same orders of denting are applicable to the weft rib weaves A, B, and C in *Figure 3.3*.

Mock rib effects

Occasionally cloths are produced in ordinary plain weave which resemble the design given at A in *Figure 3.1*. This is achieved by doubling up two threads of weft on a pirn and inserting the double weft in lieu of the two single picks which are necessary in the proper warp rib construction. A special effect is sometimes obtained by having differently coloured threads wound alongside each other on the pirns. The withdrawal of the weft in the direction of the length of the pirn causes the threads to make one twist round each other for every revolution made by them on the pirn or cop. The slight amount of twist thus inserted causes the colours to show intermittently in the cloth producing an irregular or streaky colour effect. Similarly, an imitation weft rib which resembles A in *Figure 3.3* can be obtained in plain weave by placing two ends in each mail, in which case, if they are differently coloured, the rolling of the threads round each other causes the colours to show intermittently in the cloth.

WEAVES CONSTRUCTED ON TWILL BASES

Regular twills are capable of a considerable degree of modification and serve frequently as the bases for the construction of new designs which superficially may appear to possess little in common with the original base.

Waved twills

One of the simplest forms of modified twill is the waved twill achieved by reversing the direction of the twill at suitable intervals. The reversal can occur either upon a warp end, in which case a horizontal wave is produced, or upon a weft pick which results in a vertical wave or a zig-zag effect.

The horizontal wave effects are economically produced in point drafts, and good styles may be woven on a few healds by means of twill tappets. The vertical line effects, however, mostly require a dobby shedding motion, because of the comparatively large number of picks in the lifting plan. *Figure 3.6* illustrates a horizontal wave pattern that corresponds with the weave given at D in *Figure 3.7* while by turning *Figure 3.6* one-quarter round a vertical effect is shown that corresponds with the weave L in *Figure 3.7*.

Figure 3.6

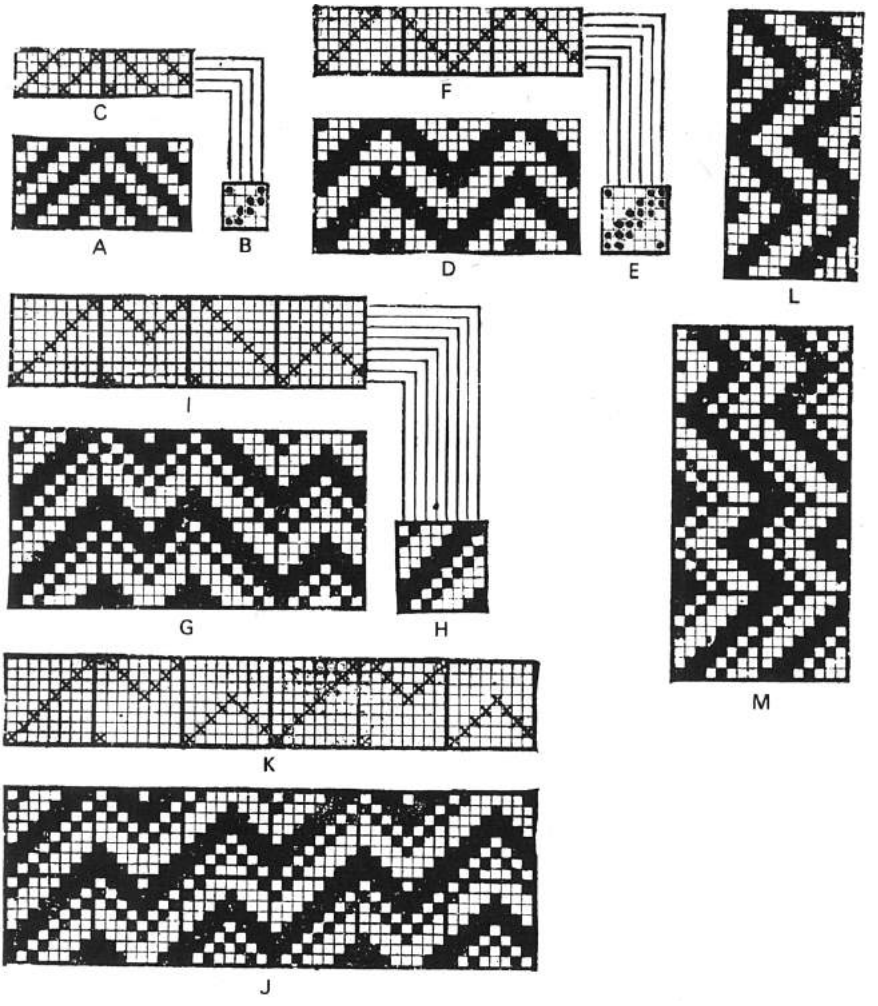


Figure 3.7

A in *Figure 3.7* shows the 2-and-2 twill given at B, arranged 8 ends to right and 8 ends to left, turning on the first and ninth ends, whilst D shows the 3-and-3 twill E running 6 ends to right and 6 ends to left, turning on the first and seventh ends. A more complex arrangement is illustrated at G, in which the 8-thread twill H is turned on the ends 1, 9, 13, 17, 25, and 29. In each case the design is, for convenience, so arranged that an equal number of ends is drawn on each heald, as shown in the point drafts C, F, and I, which respectively correspond with the designs A, D, and G.

In the designs A, D, and G, the twills run for as many threads to the right as to the left, so that each twill line returns to the level at which it commenced.

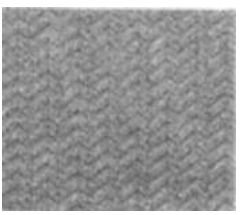


Figure 3.8

In the design J, however, for which K is the draft, the twill H is arranged to run 8 ends to the right and 4 ends to the left alternately, so that the zig-zag line gradually rises and runs at a flat angle from side to side of the cloth, as shown in the corresponding fabric represented in *Figure 3.8*.

The designs L and M in *Figure 3.7*, which correspond with D and G, illustrate the method of producing vertical waves in the cloth. In the former the twill turns on the picks 1 and 7, and in the latter on the picks 1, 9, 13, 17, 25, and 29. A defect of the pointed twill arrangement is the formation of an increased float where the weave turns, the long float occurring in the weft in the horizontal waved effects, and in the warp in the vertical patterns.

Herringbone twills

These twills, although they also depend upon the reversal of the direction to achieve the desired effect, are constructed in a different manner from the ordinary waved twills. Careful study of the designs and drafts in *Figure 3.9* will show the differences in construction. The twill does not come to a point where it changes the direction, but instead one twill line is said to 'cut' into

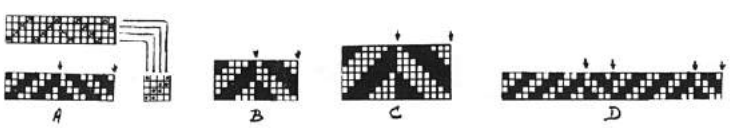


Figure 3.9

the other at the point of reversal. Example A in *Figure 3.9* shows the construction of a 2-and-2 twill herringbone quite clearly. The twill runs from left to right for a desired number of ends—in this case eight—whereupon the reversal of the direction takes place by introducing on the ninth end the marks which are exactly opposite to those of the eighth end, and commencing to run the twill from this point down in the reverse direction. The effect of

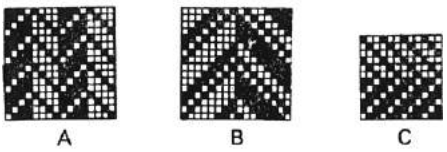


Figure 3.10

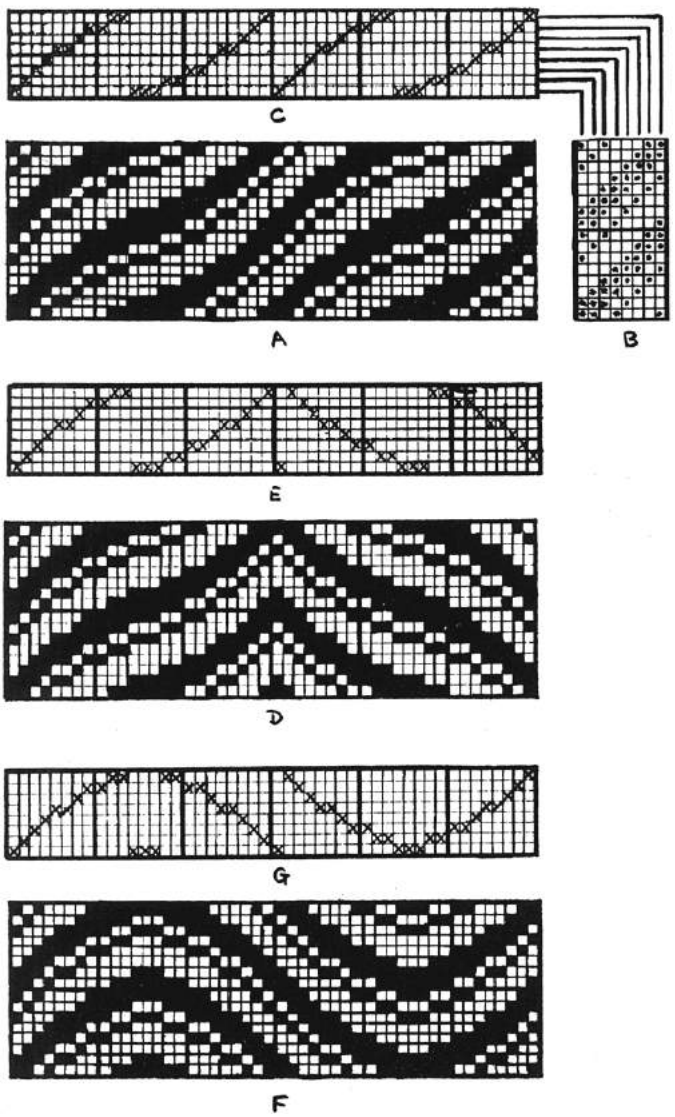


Figure 3.11

the diametrically opposite lifts at the reversal point is to throw the neighbouring ends apart from one another to produce what is commonly known as the 'break' or the 'cut' (indicated in *Figure 3.9* by arrows). This method of joining also tends to produce a distinct stripe effect, and prevents the formation of an extended float where the weave turns, which is an undesirable effect unavoidably occurring in ordinary waved twills. Examples B and C in *Figure 3.9* show the 3-and-3, and 4-and-4 twills arranged on the herringbone basis, whilst D represents a 2-and-2 herringbone twill with unequal width of stripe. All the weaves shown in *Figure 3.9* are extensively used in the manufacture of suitings and overcoatings

Figure 3.10 illustrates the very distinct effects which it is possible to achieve when, instead of even sided twills, use is made of either warp, or weft sided twills as the base for herringbones. Owing to the principle of opposing, on the point of reversal, a warp lift with a weft lift (and vice-versa), any warp faced twill is reconstituted in the form of a weft faced twill running in the reverse direction. A and B in *Figure 3.10* show this effect clearly. Where warp yarn is of different colour to the weft yarn very distinct stripes are formed. As the two twills formed in this manner are quite different a larger number of healds will be necessary to produce these effects than is normally required for the production of the herringbone effects from even-sided twills of similar size. In order to achieve equal degree of prominence in the warp, and in the weft faced stripe, these cloths must be woven in a *square* sett.

The above principle of construction can be used to produce transverse or cross-over stripes if the reversal of the direction is made upon a pick of weft as shown at C in *Figure 3.10*. This type of design is occasionally employed in cloths for hangings and other soft furnishings.

Curved twills

The principle of construction of curved twills will be understood from an examination of the design A in *Figure 3.11*, which is constructed from the 8-thread twill given at B on the basis of the curved draft indicated at C. This class of design is only used to a limited extent, as there is the disadvantage that the length of the weft float and the firmness of the cloth vary in different parts of the twill line.

Curved twills may be reversed in direction so as to form zig-zag effects in which each curve terminates in a point, as shown at D in *Figure 3.11*, and the corresponding draft E; or an undulating wave twill may be made, as indicated at F and the corresponding draft G.

Broken twills

A large variety of attractive effects, generally somewhat similar in appearance to herringbone twills, can be produced by *breaking* a regular twill. The *break* can be achieved in different ways and the designs in *Figure 3.12* illustrate the simplest method in which the continuity of the twill is stopped by frequent reversals of the direction. Designs A to E show the basic twills and side by side their corresponding broken twill counterparts are illustrated. Suitable drafts are indicated by crosses above each group of designs. The designs A_1

to E_1 are derived by stopping the orderly progression of the regular twill half-way through the repeat and running the ends in the second half of the repeat in reverse order. In the case of four shaft twills the new order of drafting is, therefore, 1, 2/4, 3; whilst in the eight thread twills the order is 1, 2, 3, 4/8, 7, 6, 5. The design A_1 represents the very popular 2-and-2 broken twill, and B_1 is the 1-and-3 broken twill which is also known as the satinette. Most even sided twills result in well balanced effects upon 'breaking', but some twills which are not even-sided sometimes give rise to the formation of inconsequential floats when broken half-way through the repeat. This is illustrated at E_1 which does not produce a pleasing effect due to the doubling-up of the floats at each 'break' point of the repeat.

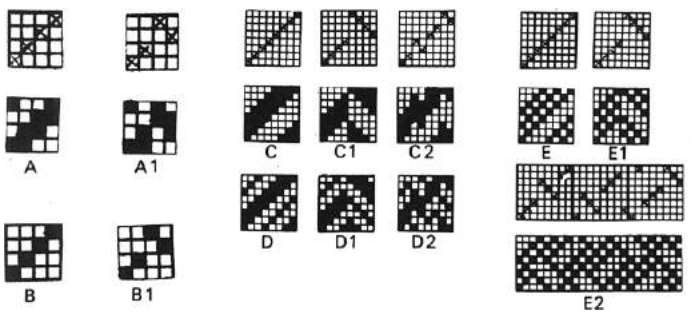


Figure 3.12

In addition to the *break and reversal* half-way through the repeat many other effects can be achieved by breaks of the draft at more frequent intervals and designs C_2 and D_2 show the effect of the draft broken in pairs: 1, 2/4, 3; 5, 6/8, 7—whilst E_2 results from the break and reversal of the design E in groups of 3: 1, 2, 3/6, 5, 4; 7, 8, 1/4, 3, 2; 5, 6, 7/2, 1, 8; 3, 4, 5/8, 7, 6. From the foregoing examples it will be clear that if the 'break' unit is a factor of the repeat of the original weave then the size of the new weave repeat is unaltered; if, however, the 'break' unit is not a factor of the original repeat size, then the new repeat size will be equal to the l.c.m. of the 'break' unit and the original repeat. In the example E_2 the relevant figures are 3 and 8 respectively, and, therefore, in accordance with the rule given above, the new design repeats upon 24 ends. The order of progression in these constructions is well illustrated by the example E_2 and upon studying it the following instructions could be formulated: 1. Run the twill in one direction for the required number of threads (in E_2—1, 2, 3); 2. Add to the number of the last thread the number of threads per 'break' and run the twill in the opposite direction (in E_2—$3 + 3 = 6$ ∴ 6, 5, 4); and so on, until the original starting point is reached again. In trying to reach arithmetical solutions it must be remembered that the number of threads per repeat represents a unit, and, therefore, in an eight thread repeat, thread number 9 is equal to number 1, thread number 10 to number 2, etc.

Another useful system of broken twill construction which is particularly applicable to twills that are composed of equal warp and weft float, consists of 'entering and skipping' the threads of an ordinary twill. Any number of threads may be entered and skipped respectively at a place, but generally the

most suitable number to skip is one less than half the number of threads in the repeat of the twill. If the latter condition is observed in certain equal-sided twills, the warp and weft floats oppose each other, and a fine line or 'cut' is made where the twill is broken. As will be seen from the examples given in *Figure 3.13* the 'broken' portions of the twills are not in this method alternately reversed as in the previous system, but run in the same direction.

The method of entering-and-skipping is illustrated in *Figure 3.13*, in which three repeats of 2-and-2 twill are given at A, while at B the threads of A are shown arranged in the order of 2 entered and 1 skipped. C shows the draft for B, if a normal 2-and-2 twill lifting plan is employed; and it will be noted that the order of drawing in is 2 healds drawn and 1 heald skipped, and thus coincides with the basis upon which B is constructed.

D in *Figure 3.13* shows the 3-and-3 twill arranged in the order of 3 entered and 2 skipped; F the 4-and-4 twill arranged 4 entered and 3 skipped; and H a 10-thread twill arranged 4 entered and 4 skipped; while E, G, and I represent the bases of construction, and the drafts for the respective designs. The number of threads in the repeat of a design can be ascertained by noting the number of squares that corresponding positions of the weave are distant

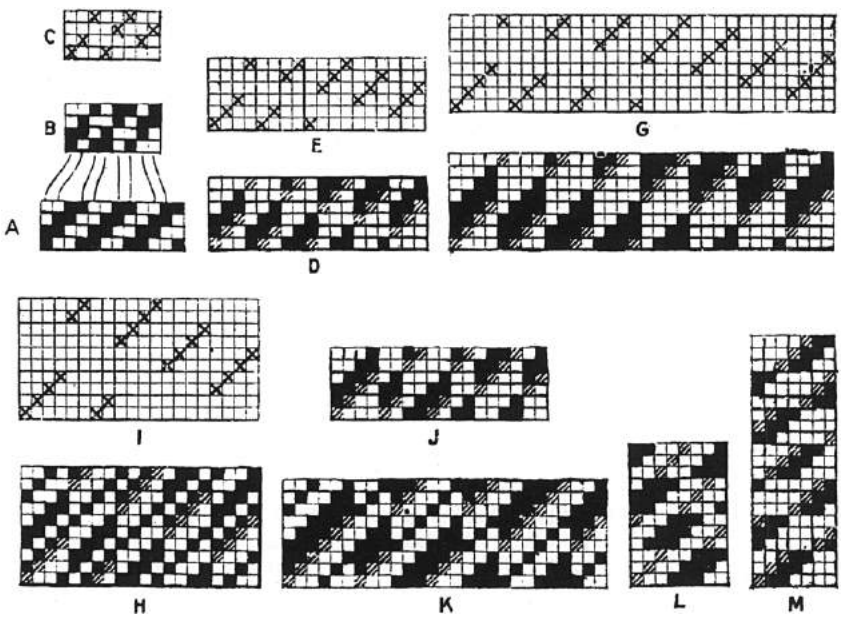


Figure 3.13

from each other. Thus, in F corresponding positions move one square downward and four squares outward each time; and as there are 8 picks in the weave there are: $(8 \div 1) \times 4 = 32$ ends in the repeat. In H there are 10 picks in the weave, and the move is 2 downward and 4 outward; therefore in the repeat there are: $(10 \div 2) \times 4 = 20$ ends.

The designs may be varied by entering unequal numbers of threads, as shown at J in *Figure 3.13*, in which the 3-and-3 twill is arranged 4 entered, 2 skipped, 2 entered, and 2 skipped. In the same manner, K shows a 9-thread twill arranged 6 entered, 3 skipped, 3 entered, and 3 skipped, and this example

also illustrates that the system of construction is by no means limited to twills which are composed of equal warp and weft float, but can be used with good results in re-arranging the threads of almost any type of twill.

Designs can also be constructed by filling and skipping the picks, as shown at L and M in *Figure 3.13*; the former of which consists of an 8-thread twill arranged with 3 picks filled and 3 picks skipped, and the latter of a 7-thread twill arranged 3 picks filled and 2 skipped. Further, in either the warp or weft method, if the base marks are inserted first, as shown by the shaded squares in the designs given in *Figure 3.13*, marks may be added to them in any desired order.

In yet another method of constructing broken twills it is possible to create small mat or cord effects by combining the 'enter-and-skip' system with the repetition of similar lifts side by side, or with the reversal of direction. The

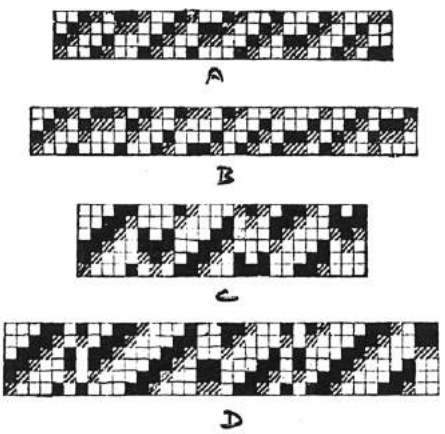


Figure 3.14

mat or cord effects can be made either to cut with the twill, or to join it in continuation, and some of these fancy broken constructions are shown in *Figure 3.14*. Designs A and B are based on the 2-and-2 twill, and designs C and D on the 3-and-3 twill. In A the small mat effect, produced by repetition of like lifts, cuts with the twill at one side, and joins it at the other side. In B four threads of the twill cut with four threads of the modified twill, whilst C and D show broken 3-and-3 twill designs in which the skipping, the repetition and the reversal of the order are arranged in various combinations. Threads which are different in colour or material may be effectively introduced at the places where a weave is broken. Also an advantage of the broken twill system of construction is that variety of design is produced with little or no effect upon the firmness of the structure, so that the yarns and settings which are suitable for an ordinary twill are equally suitable for the same twill broken.

Transposed or re-arranged twills

By means of transposition or re-arrangement of the original order of the threads in a regular twill many new and attractive designs can be created. The transposition results in the interruption of the continuous twill line and

some transposed effects are very similar to broken twill designs. Re-arrangement of both the warp and the weft threads is possible and several systems of transposition are shown in *Figure 3.15*. The base line of a 12-thread ordinary twill is indicated at A, while at B the marks are transposed in groups of 2,

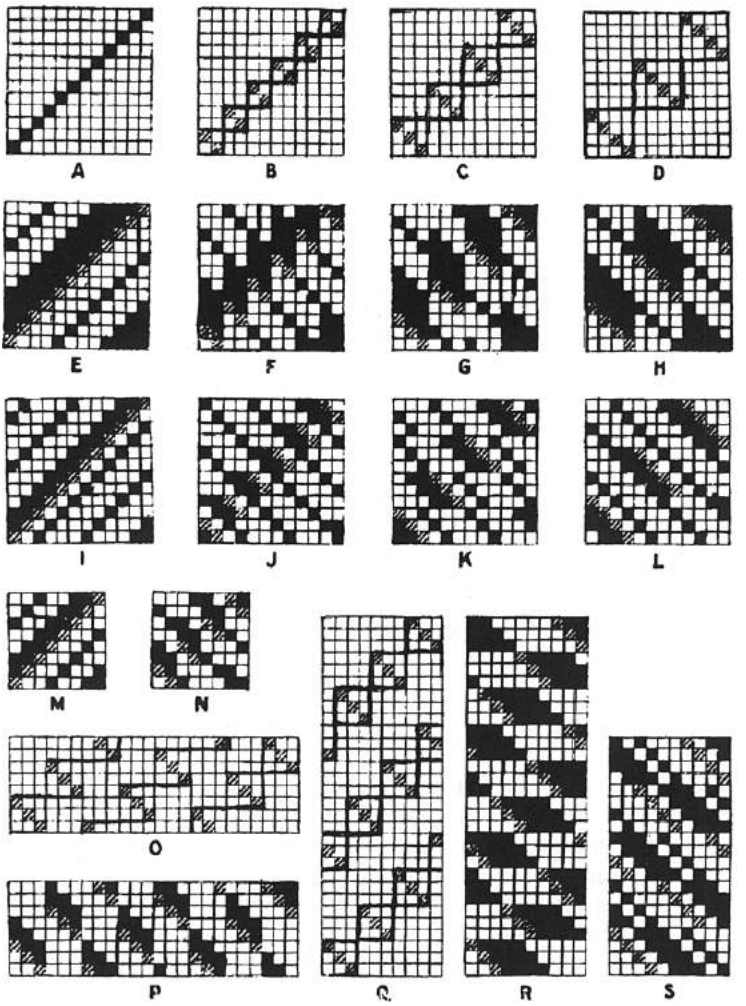


Figure 3.15

at C in groups of 3, and at D in groups of 4. In E, F, G, and H, and in I, J, K, and L, the shaded squares correspond with the base marks indicated in A, B, C, and D, respectively. At F, G, and H respectively the twill E is re-arranged in the warp according to the transposed bases B, C, and D; while J, K, and L similarly show the twill I re-arranged in the weft. A comparison will show that the ends of the ordinary twill E, taken consecutively from 1 to 12, are arranged in F in the order of 2, 1; 4, 3; 6, 5; 8, 7; 10, 9; 12, 11; in G in the order of 3, 2, 1; 6, 5, 4; 9, 8, 7; 12, 11, 10; and in H in the order of, 4, 3, 2, 1; 8, 7, 6, 5; 12, 11, 10, 9. In J, K, and L respectively the picks of the twill I are arranged in corresponding orders.

The design given at N in *Figure 3.15* corresponds with the fabric represented in *Figure 3.16*. The weave is termed the Mayo or Campbell, and is formed by transposing the ends of the 8-thread twill M in 2s. O and P illustrate the transposition of the ends of a 3-and-5 twill in 3s, in which it is necessary to extend the design over a number of ends, which is the l.c.m. of 8 and 3—i.e., 24. The ends of the twill are thus arranged in the order of 3, 2, 1; 6, 5, 4; 1, 8, 7; 4, 3, 2; 7, 6, 5; 2, 1, 8; 5, 4, 3; 8, 7, 6. In the same manner in transposing the picks of a 10-thread twill in 3s, as shown at Q and R, the repeat

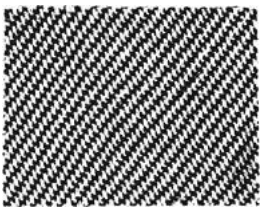


Figure 3.16

extends over 30 picks—the l.c.m. of 10 and 3; while in transposing a 10-thread twill in 4s, as shown at S, the repeat extends over 20 picks—the l.c.m. of 10 and 4.

A variation of the foregoing method consists of arranging the groups of threads in transposed and straight order alternately, as shown at A to D in *Figure 3.17*, and the corresponding designs E to H. The design H coincides

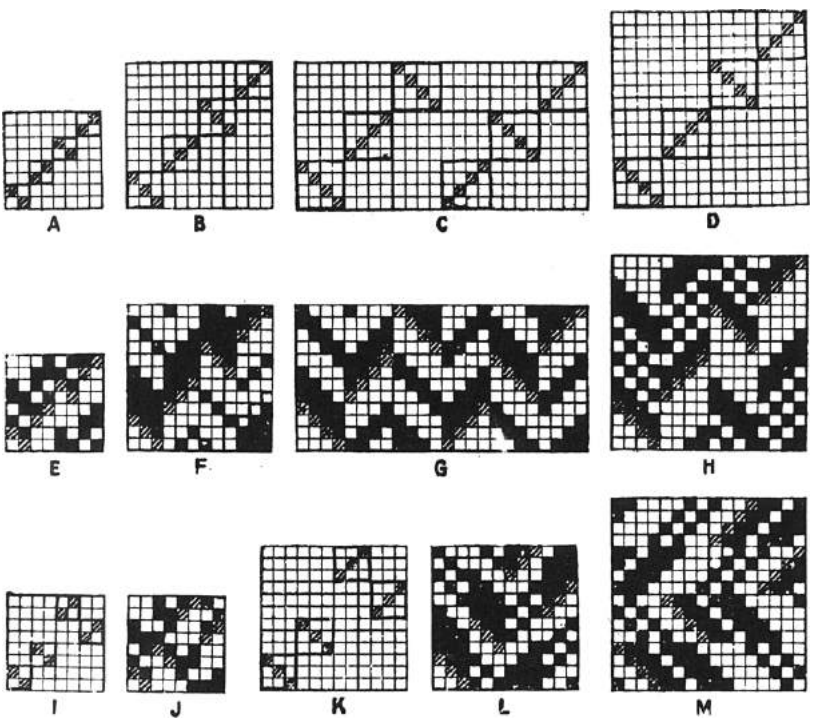


Figure 3.17

with the fabric represented in *Figure 3.18*. Designs J, L, and M in *Figure 3.17* are re-arranged in the order corresponding to the distribution of lifts in a 4 thread satinette and the bases of the first two are shown at I and K respectively. The design M, repeating on 16 threads, is arranged in the same manner except that the threads are in groups of four. It will be readily appreciated that this particular form of transposition is only suitable for such repeats which are divisible by four.

An entirely separate class of re-arranged twills is based on the sateen system of moves and most twills transposed in the sateen order tend to loose the distinctive diagonal line which is their feature in the original form. Both

Figure 3.18

the warp and the weft thread transposition is possible and the only limiting condition in the choice of twill is that it must repeat over the same number of threads as the sateen from which the order of the re-arrangement was derived. The method is illustrated in *Figure 3.19*, in which A and B represent two sateen re-arrangements of the ends, and C and D two similar re-arrangements of the picks, of a 9-thread twill with which they are shown connected by lines. The shaded squares show the bases of the designs. In A the 9-thread sateen base counting 2 outwards is employed, and in B counting 2 upwards, hence the ends, which in the twill are in the order of 1, 2, 3, 4, 5, 6, 7, 8, 9, are arranged in A in the order of 1, 6, 2, 7, 3, 8, 4, 9, 5, and in B in the order of 1, 3, 5, 7, 9, 2, 4, 6, 8. In the same manner, in C the picks of the twill are arranged in the order of 1, 3, 5, 7, 9, 2, 4, 6, 8, and in D in the order of 1, 6, 2, 7, 3, 8, 4, 9, 5.

A convenient method of re-arranging a twill in sateen order is illustrated at E to H in *Figure 3.19*. The sateen base is first inserted, as shown at F, then each sateen mark is taken to be one mark of the twill, and to it the other marks of the twill are added in regular order. In re-arranging the ends of the twill the marks are added above and below the base marks, as shown at G, whereas if the picks are re-arranged the marks are added alongside the base marks, as indicated at H. In each design G and H the marks and blanks are alike; also the weaves appear very similar on paper, but they yield quite different effects in the cloth because in G the principal floats are in the warp, and in H in the weft.

In some cases, a re-arranged weave produces a much looser structure than the original twill, as will be evident from a comparison of the twill I in *Figure*

3.19, and the sateen re-arrangement given at J. G and H, on the other hand, are quite as firm as the original twill E, on account of the manner in which the floats cut with each other. The original twills E and I, however, are similar in firmness, the only difference between them being that the latter contains more marks than the former, but this is sufficient to affect the firmness of the re-arranged weave very considerably. It will, therefore, be evident, from a comparison of the examples E, G, and H with I and J, that the re-arrangement of twills which are equally firm may result in structures being formed that

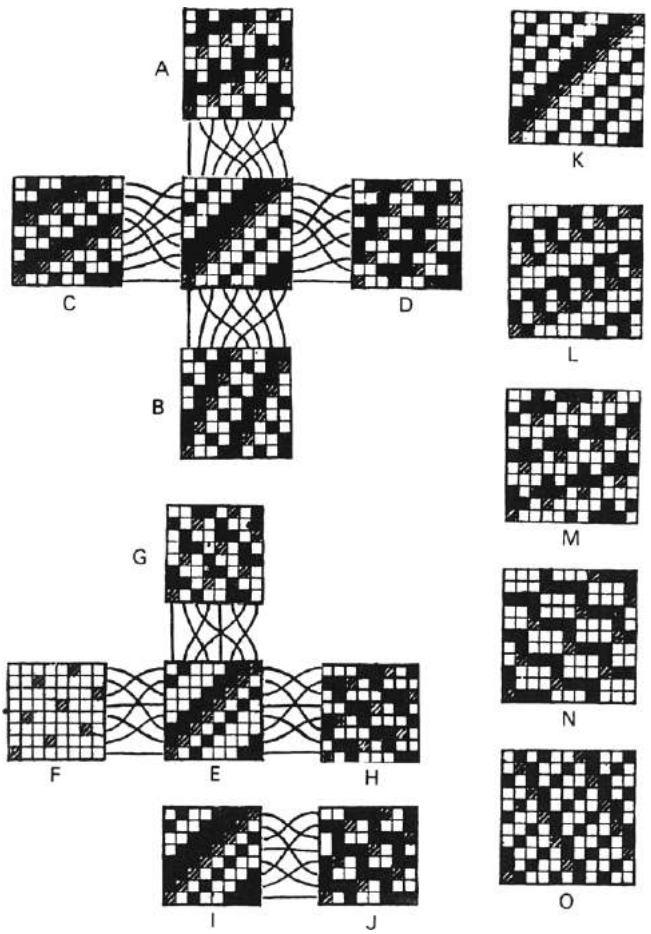


Figure 3.19

differ materially in firmness. Certain twills, of which I in *Figure 3.19* is an example, produce the same design whether they are re-arranged in the warp or in the weft.

Four sateen re-arrangements in the warp of the 11-thread twill K, are given in *Figure 3.19* at L, M, N, and O, in which the count is 2, 3, 4, and 5 respectively; it will be seen that the design O is much firmer than the others. By turning the designs one-quarter round, so that the vertical spaces become horizontal, four re-arrangements in the weft will be obtained. The examples are thus

illustrative of the great variety of weaves that can be produced in the foregoing system, particularly if it be taken into account that a large number of different twills can be made on eleven threads, each of which will produce a different series of effects.

The chief disadvantage of constructing a new design by re-arranging the threads of a *given* twill is that the order of interlacing is governed by the twill, and the resulting design may be quite unsuitable for the cloth for which it is intended. The system, however, is useful, because a twill and a sateen rearrangement in the warp can be woven in the same healds by means of straight and sateen drafting.

Elongated twills

The angle formed in the cloth by a twill weave depends upon: (a) the relative ratio of ends and picks per unit space; and (b) the rate of advance of one interlacing in respect of the following one.

If the ends and the picks per unit space are equal a regular twill advancing in steps of one as shown at A in *Figure 3.20* runs at an angle of 45°. If, however, there are more ends than picks per inch in the cloth, the line of an

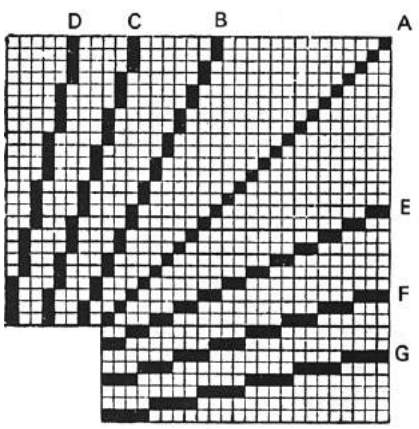


Figure 3.20

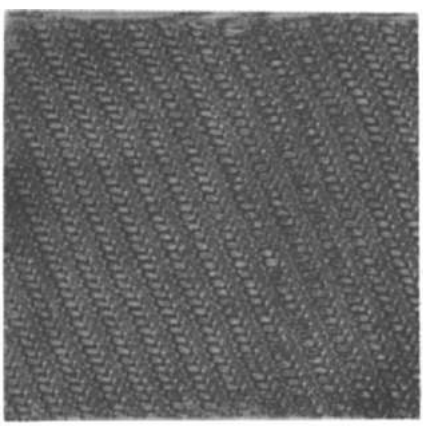


Figure 3.21

ordinary twill more nearly approaches the vertical; while if the picks exceed the ends the line becomes flatter. A fabric in which a steep twill is formed is represented in *Figure 3.21*, which, if turned one-quarter round, will also show the appearance of a flat twill.

Elongated twills, running at various angles, can also be constructed by advancing the points of intersection two or more threads in one direction to one thread in the other direction, as shown at B to G in *Figure 3.20*.

The relationship between the angle formed by a twill and the two sets of factors which determine it may be expressed by the following simple formula:

$$\tan \alpha = \frac{\text{Rate of advancement of twill upwards}}{\text{Rate of advancement of twill outwards}} \times \frac{\text{ends per cm}}{\text{picks per cm}}$$

The angle calculated is that from the horizontal and the following three examples illustrate the application of the formula.

(1) Rate of advancement (or step) of twill—1 in both directions. Square set cloth—24 threads per cm in both directions.

$$\tan \alpha = \frac{1}{1} \times \frac{24}{24} = 1$$

$$\alpha = 45°.$$

(2) Step upwards—2; step outwards—1.
Ends per cm—42; picks per cm—21.

$$\tan \alpha = \frac{2}{1} \times \frac{42}{21} = 4$$

$$\alpha = 76°.$$

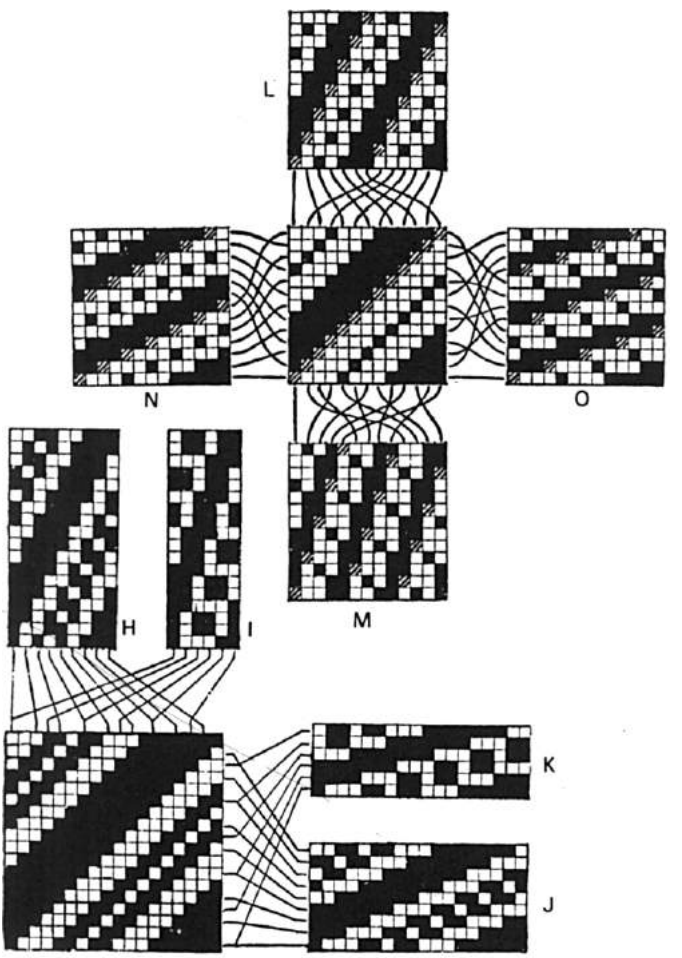


Figure 3.22

(3) Step upwards—1; step outwards—2.
Ends per cm—12; picks per cm—30.

$$\tan \alpha = \frac{1}{2} \times \frac{12}{30} = \frac{1}{5}$$

$$\alpha = 11°.$$

One method of designing elongated twills consists of selecting, or rearranging the threads of a given ordinary twill in certain orders, as illustrated by the examples given in *Figure 3.22*. Each thread in the elongated twills is shown connected by a line with the corresponding thread in the original twill, and the four designs made from each twill correspond with the bases indicated at B, C, E, and F in *Figure 3.20*. Commencing with the first end of the given twill, the steep twill H is constructed by inserting every second end of the twill, and the steep twill I, by inserting every third end. Then, commencing with the first pick, the flat twill J is constructed by inserting every second pick

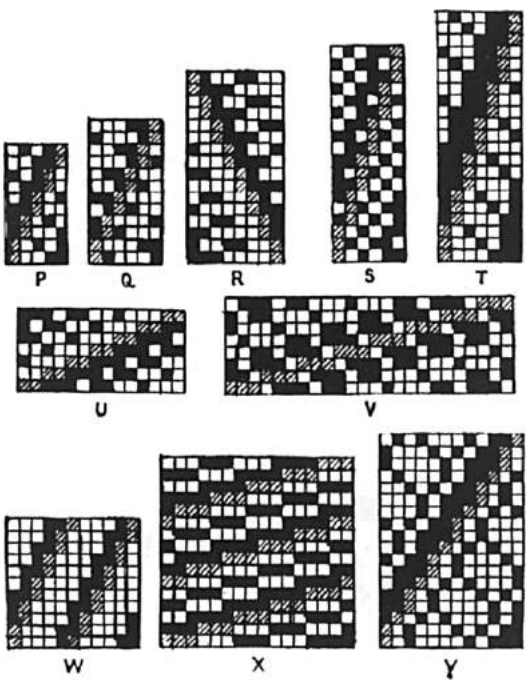


Figure 3.23

of the given twill, and K by inserting every third pick. As the number counted is in each case a factor of the number of threads in the given twill, the repeat of the new design in one direction is proportionally less.

The examples L to O illustrate the method of procedure when the number counted is not a factor of the number of threads in the given twill. The twill repeats on 13 threads, therefore, in counting 2, it is necessary to arrange the threads in the order of 1, 3, 5, 7, 9, 11, 13, 2, 4, 6, 8, 10, 12, as shown at L and N; while in counting 3, the threads are ultimately arranged in the order of 1, 4, 7, 10, 13, 3, 6, 9, 12, 2, 5, 8, 11, as indicated at M and O. It should be noted

that in this case exactly the same designs would result from transposing the twill in sateen order, counting 2 and 3.

The foregoing method, though quite useful, may result in loose fabric, and generally it is preferable to construct elongated twills specifically designed for the purpose, starting with a base line of marks running at the desired angle, and repeating upon the required number of ends and picks. Other marks are then added systematically to the base marks, in the manner illustrated at P to Y in *Figure 3.23*. P, Q, and R are steep twills on 5, 6, and 8 ends respectively, counting 2 upward to 1 outward. The fabric, represented in *Figure 3.21*, corresponds with the design R. S and T are steep twills on 6 and 7 ends respectively, counting 3 upward to 1 outward; while U is a flat twill on 7 picks, counting 2 outward to 1 upward, and V a flat twill on 8 picks, counting 3 outward to 1 upward. W and X illustrate how the base marks are carried

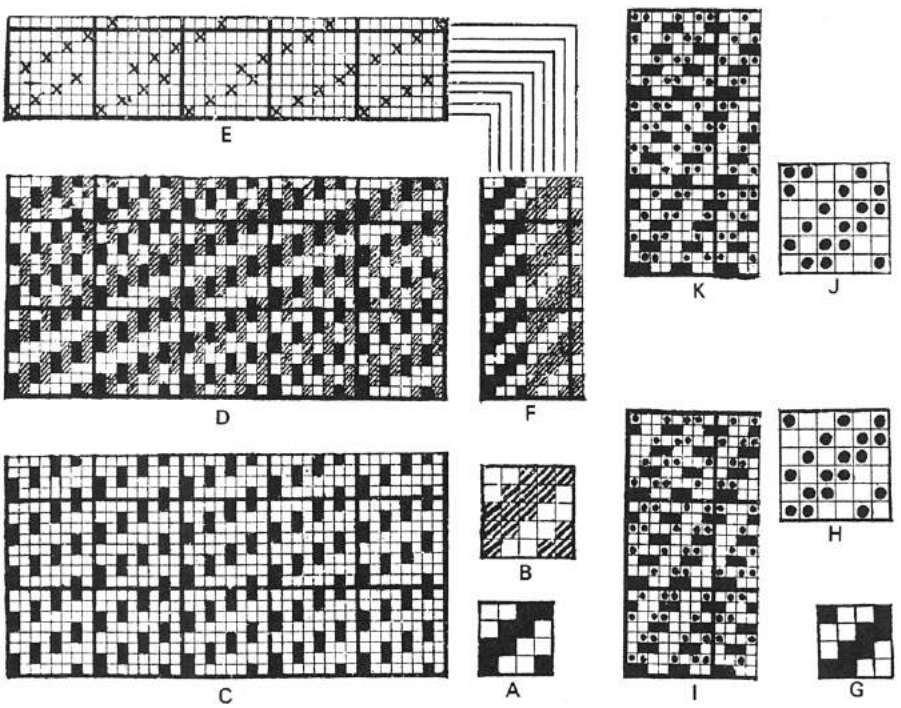


Figure 3.24

through a design, in order to obtain correct repetition, when the number counted is not a factor of the number of threads in the repeat. The design Y, in which the count is 2 and 1 alternately, will serve to illustrate how the angle of the twill line may be still further varied.

In steep twills the warp should, as a rule, show more prominently on the surface than the weft, and vice versa in flat twills. To conform with this rule the weaves U, V, and X in *Figure 3.23* should be regarded as the 'reversed convention' designs in which the marks indicate 'weft-up'. This method of construction is, in the above cases, preferable as it makes it easier to appreciate the development of the effect from the base marks. Steep twills, which produce distinct twill lines of warp in the cloth are termed 'whip cords'. The

addition of marks to the edges of a line of warp float, as shown in Q and R, develops the prominence of the line.

Unless the cloth is firmly set the threads are liable to slip in elongated twill weaves. Firmness of texture can be obtained to some extent by inserting a suitable firm weave between the floating twill lines; thus 2-and-1 twill

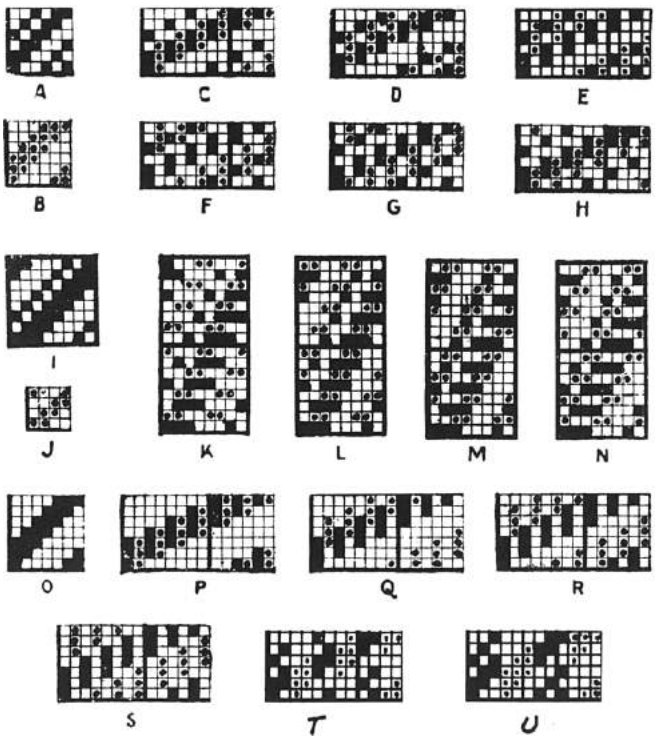


Figure 3.25

naturally fits a weave in which the count is 2, as shown at P in *Figure 3.23*, and plain weave or 1-and-3 twill, when the count is 3, as shown at S and T.

Elongated twills can be also produced by combining various twill weaves and a number of examples of these structures is shown in *Figure 3.24* and *3.25*.

Combination of twill weaves

Different methods of constructing designs by combining small ordinary twill weaves in the order of an end or a pick of each alternately are illustrated in *Figures 3.24*, *3.25*, and *3.26*. In combining the 4 and 5-thread twills, given respectively at A and B in *Figure 3.24*, an end of each alternately, one twill—say A—is first indicated on the odd vertical spaces, as shown at C. Then, to complete the design, twill *B* is indicated on the even vertical spaces, as shown at D. Each twill must be carried out on 20 ends and picks—the l.c.m. of 4 and 5, hence the design D consists of 20 threads of A combined with 20 threads of B, and thus repeats on 40 ends and 20 picks.

The proper method of drafting the design D is illustrated at E in *Figure 3.24*, in which the ends of the 2-and-2 twill are indicated on four healds placed at

the front of the five healds upon which the ends of the 3-and-2 twill are drawn. The arrangement enables the order of drawing in to be readily followed, while the most crowded healds are placed at the front and carry the ends which interweave most frequently. The lifting plan is given at F.

The 4- and 6-thread twills, given respectively at G and H in *Figure 3.24*, are shown combined—a pick of each alternately—at I, the 2-and-2 twill being inserted on the odd horizontal spaces, and the 6-thread twill on the

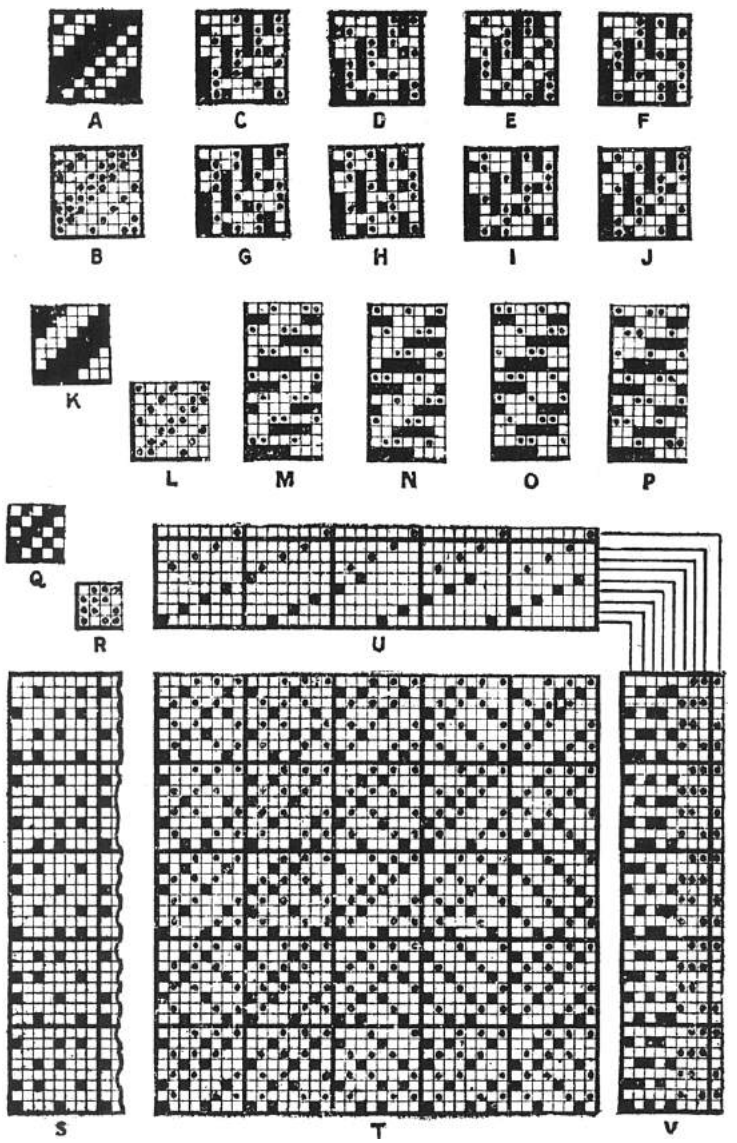


Figure 3.26

even horizontal spaces. In this case, as 12 is the l.c.m. of 4 and 6, each twill is extended over 12 ends and picks so that the design I consists of 12 picks of G combined with 12 picks of H, and repeats on 24 picks and 12 ends.

When the repeats of the twills that are combined have no factor in common only one design results in either the warp or the weft method of combination, as each twill gets into every possible relationship with the other twill. If, however, the repeats have a common factor more than one design can generally be constructed by altering the relative position of the two twills. Thus, 2 will divide into 4 and 6—the respective repeats of G and H in *Figure 3.24*, and it is therefore possible to produce a second design, as shown at K, by commencing the 6-thread twill in the position indicated at J, while retaining the 2-and-2 twill in the original position. It will be found by experiment that any further change in the relative position of the two twills will simply produce a duplicate of either I or K.

The construction of different designs by varying the relative position of two twills can be carried still further if the twills are equal in size or if one is double the size of the other. Thus, in combining the two six-thread twills given at A and B in *Figure 3.25*—an end of each alternately—six designs are obtained, as shown at C, D, E, F, G, and H; and, as 6 ends of one twill are combined with six ends of the other, each design repeats on 12 ends and 6 picks. One twill—say A—is inserted in the same position on the odd vertical spaces of each design, then the twill B is indicated on the even vertical spaces; commencing in the design C with the first end of B; in D with the second end; in E with the third end; in F with the fourth end; in G with the fifth end; and in H with the sixth end. The twills can be combined—a pick of each alternately—in the same manner, and the latter method has the advantage that each design only requires six healds, whereas each design C to H in *Figure 3.25* requires 12 healds.

The twills I and J are shown combined—a pick of each alternately—at K, L, M, and N in *Figure 3.25*, only four changes being possible in this case as J is on four threads. It is necessary, however, to use 8 threads of the weave J to conform with the repeat of I, hence the complete design repeats on 16 picks and 8 ends. The weave I is indicated in the same position on the odd horizontal spaces of K, L, M, and N; then the weave J is inserted on the even horizontal spaces commencing with the picks in turn in succeeding designs.

A still further development, which is illustrated by the examples O to S in *Figure 3.25*, consists of using the same twill for both the odd and the even threads. The weave O is indicated on the odd vertical spaces of the designs P, Q, R, and S, commencing each time with the first end; but in inserting the weave on the even vertical spaces, P commences with the first, Q with the third, R with the fourth, and S with the fifth end of O. In this weave any further change of position will produce a duplicate of one of the preceding. This method has the advantage that only half as many healds are required as there are ends in the repeat.

Further possibilities which exist in this group of structures are shown at T and U where the two original twills, A and B, have been combined by taking alternate pairs of ends from each, as at T, or combining in groups of three ends from each at a time, as at U. The possibilities of achieving novel effects by combination are virtually endless as one, or both, twills used could be first transposed and then used in combination either warp-wise or weft-wise; in single threads, in pairs, or in larger groups of threads.

In the foregoing combinations, flat or steep twills are respectively produced according to whether the ends or the picks are combined. The examples given in *Figure 3.26* illustrate methods of combining twills by which designs—

twilling at the angle of 45°—are formed. The designs C to J are constructed by first indicating *alternate* ends of the twill A on the odd vertical spaces in the same position in each design. Then *alternate* ends of the twill B are inserted on the even vertical spaces, commencing with the following end in each succeeding design. Thus C commences with the first end of B, D with the second end, E with the third end, and so on.

In the same manner, the designs M, N, O, and P in *Figure 3.26*, are constructed by inserting alternate picks of the twill K in the same position on the odd horizontal spaces; then alternate picks of the twill L, commencing each time with a different pick, are inserted on the even horizontal spaces. In this case as each twill repeats on an odd number of picks, all the picks must be combined, and the resulting designs therefore repeat on 14 picks and 7 ends. All the positions in which the twill L can be placed are not shown, as the remaining positions simply produce duplicates of M, N, and P; it will be found that duplicate designs result when the marks of the original twills are arranged symmetrically.

A useful method of employing two small twills in the construction of a large fancy twill running at the angle of 45° is illustrated by the examples Q, R, S, and T in *Figure 3.26*. One twill—say Q—is indicated where the *odd* vertical and horizontal spaces intersect, in the manner represented in the portion given at S, then the design is completed by inserting the second twill (*R*) where the *even* vertical and horizontal spaces intersect, as shown at T. The number of ends and picks in the repeat of the design is equal to twice the l.c.m. of the threads in the repeat of the twills—or $2 \times 5 \times 4 = 40$ ends and picks. Marks should largely predominate over the blanks in the twills that are combined, or the floats in the resulting designs will be too large. A warp or weft surface is produced according to whether the marks are taken to indicate weft or warp. The draft for the design T is given at U, and the lifting plan at V; and an important feature of the arrangement is the small number of healds that is required. In each of the foregoing systems of combination more than two twills can be employed which may be either unequal or equal in size.

WEAVES CONSTRUCTED ON SATIN OR SATEEN BASES

Simple developments

In simple derivatives the new design is built up by using the original satin or sateen as the base, and subtracting or adding marks as required, in the same relative position to each base mark. Thus, the *Venetian* weave, given at A in *Figure 3.27* is produced by indicating an additional weft float above each blank of the original 5-thread satin, while the 'Buckskin' weave shown at B is similarly constructed except that it is based on the 8-thread satin. The newly created additional weft floats are indicated on the design paper by means of dots. Similarly, new designs can be based on the weft sateens but in this case, the design is developed by introducing additional warp floats alongside the original interlacing points as indicated at C and D. These constructions are used in the production of very heavy weft-faced cotton fabrics that are employed as protective clothing in situations in which a

considerable degree of wear is expected. By introducing comparatively few ends per inch a very large number of picks can be inserted, and a compact, strong cloth is produced, which generally has a soft, downy surface, formed by 'raising' the weft. A cloth may be woven with 40 ends per cm of 40/2 tex cotton warp, and from 60 to 80 picks per cm of from 30 to 44 tex cotton weft. The design E in *Figure 3.27* is reversible, and if heavily wefted the cloth has a dense weft surface on both sides. The various structures in this class of fabrics are known by such terms as 'swansdown', 'lambskin', and 'imperial'.

The examples F to J in *Figure 3.27* are constructed on a 10-thread sateen basis. It is usually convenient to commence a design by adding a few marks to each base mark, as shown at F, and to then add other marks in stages (if considered necessary), as indicated in the designs G, H, I, and J.

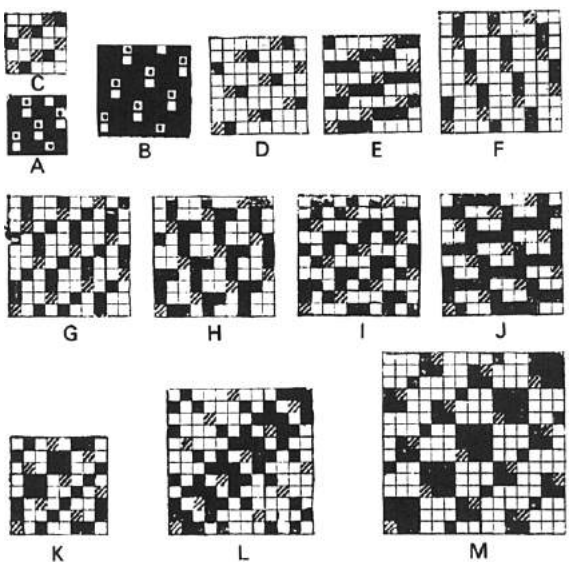


Figure 3.27

As a rule, in constructing small weaves the marks should be added in the same order to the base marks, in the manner represented at C to J in *Figure 3.27*. In the case of a few sateens, however, such as the 8, 12, and 15-thread weaves, in which the sateen marks run in line with each other at 45° angle, and join with each other in succeeding repeats, the method may be deviated from. Thus K, L, and M in *Figure 3.27* show interesting designs which result from the addition of marks in irregular order to the 8, 12, and 15-thread sateens respectively. (Examples of larger and more elaborate sateen derivatives are given in *Figure 4.2*.)

Extension of sateen weaves

Sateen weaves may be extended horizontally, as shown at A and D in *Figure 3.28*; or vertically, as indicated at B and E; or both horizontally and vertically, as represented at C and F; the examples illustrating the system in reference to the 5 and 8-thread sateens. Their chief value, when used in the forms shown

at A to F is that with the same number of healds longer floats are formed on the surface of the cloth than is the case with ordinary sateens. For instance, the design A, which requires five healds, has a weft float of 8, and is a very suitable weave for displaying a lustrous weft stripe prominently on the surface of a cloth.

The extended sateens may be readily employed as bases in the construction of new weaves, which are usually of a bolder character than those produced upon ordinary sateen bases. Marks are added systematically to the base marks, as shown in the designs G to L in *Figure 3.28*, which respectively correspond with the plans A to F. Satin base can, of course, be equally well used, but as the development by 'subtraction' of marks is rather more difficult,

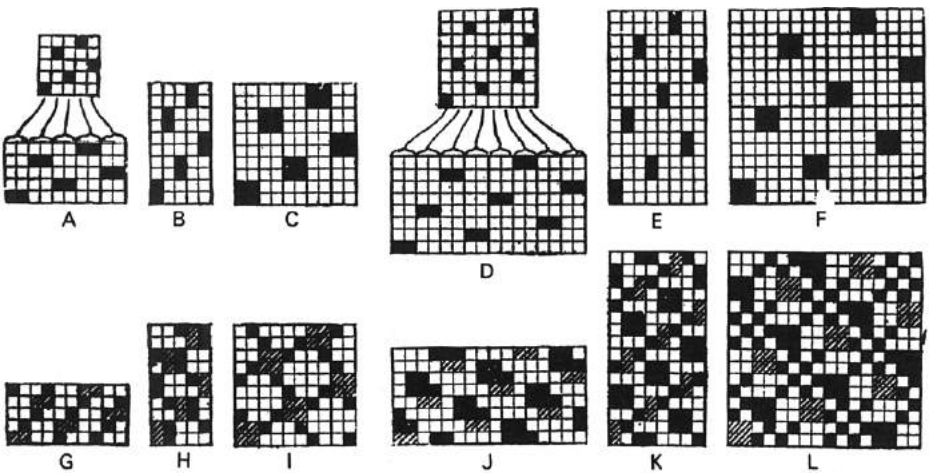


Figure 3.28

the sateens are generally preferred on the grounds of convenience. If desired, a warp faced character of the cloth is easily achieved by the addition of a sufficient number of marks to the original sateen.

Sateen base, or the particular system of moves adopted in a sateen, is also of value as a means of re-arranging certain weave orders. This has already been shown in connection with the transposed twills. In addition the weave serves frequently as the basis for the distribution of figures in isolated spot designs.

4

Fancy Twill, Diamond and Diaper Designs

FANCY TWILLS

Large diagonals

A method of constructing ordinary twills or diagonals by combining two or more small twills in diagonal form is illustrated at A and B in *Figure 4.1*. These diagonals, however, cannot be drafted on to a small number of healds. A is composed of 3-and-1 and 1-and-3 twills, while B is a compound of 3-and-3, 2-and-1, and 1-and-3 twills, the last twilling in the opposite direction to the diagonal. The chief points to note in constructing the weaves are that the twills are joined together in a suitable manner, that they are sufficiently different from each other, and that each is alloted enough space to give the large twill a distinctly diagonal appearance. By reversing one of the twills, as shown in B, the diagonal form is developed very clearly.

Shaded twills

These are designed, as shown at C, D, and E in *Figure 4.1*, by combining a number of small twills in which the floats increase or decrease in size. C is composed of five twills on six threads, which are arranged 5-and-1, 4-and-2, 3-and-3, 2-and-4, and 1-and-5. The term *single-shading* is applied to this style because each kind of float shades in one direction only. D is a *double-shaded* style which is composed of the 1-and-4, 2-and-3, 3-and-2, and 4-and-1 twills, the floats of which are arranged to shade in both directions. E is composed of 5-and-1, 4-and-1, 3-and-1, and 2-and-1 twills, which are so arranged as to form distinct warp and weft sections each of which is single shaded. The last style can be readily modified to produce warp and weft sections which are double-shaded.

Diagonals on sateen bases

These are constructed by combining two or more sateen derivatives, in the method illustrated in *Figure 4.2*. Certain sateens, such as the 8, 10, and 15-thread weaves, can be used in constructing diagonal designs running at 45°

angle. An example is shown at F in *Figure 4.2*, which is based on the 8-thread sateen counting 5. Sateens can also be selected which will yield steep twills, as shown at G, or flat twills, as shown at H. G is based on a 10-thread sateen counting 3, and H on a 7-thread sateen counting 2. According to the angle in

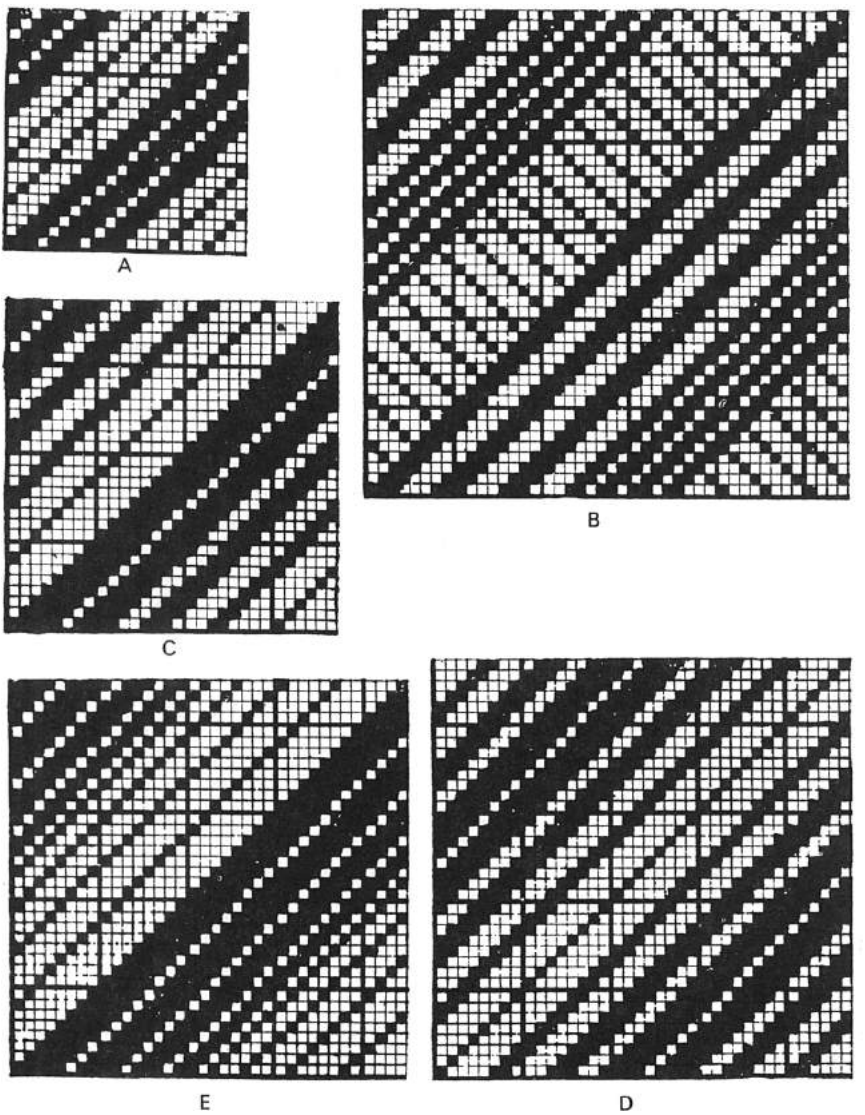


Figure 4.1

which the diagonal is required to run the sateen base is inserted over an equal or an unequal number of ends and picks; thus in F the ends and picks are equal; G is on three times as many picks as ends; and H on twice as many ends as picks. The number of ends and picks in a design must be a multiple of the number of threads in the repeat of the sateen. In adding marks to the sateen marks the weaves in the respective sections should be made sufficiently

different from each other to show clearly, except when a shaded diagonal effect is formed, as shown at H, in which the weave is changed very gradually. Diagonal lines may be arranged to run at different angles in a design as shown at I, which is constructed on the 8-thread sateen basis. The development of

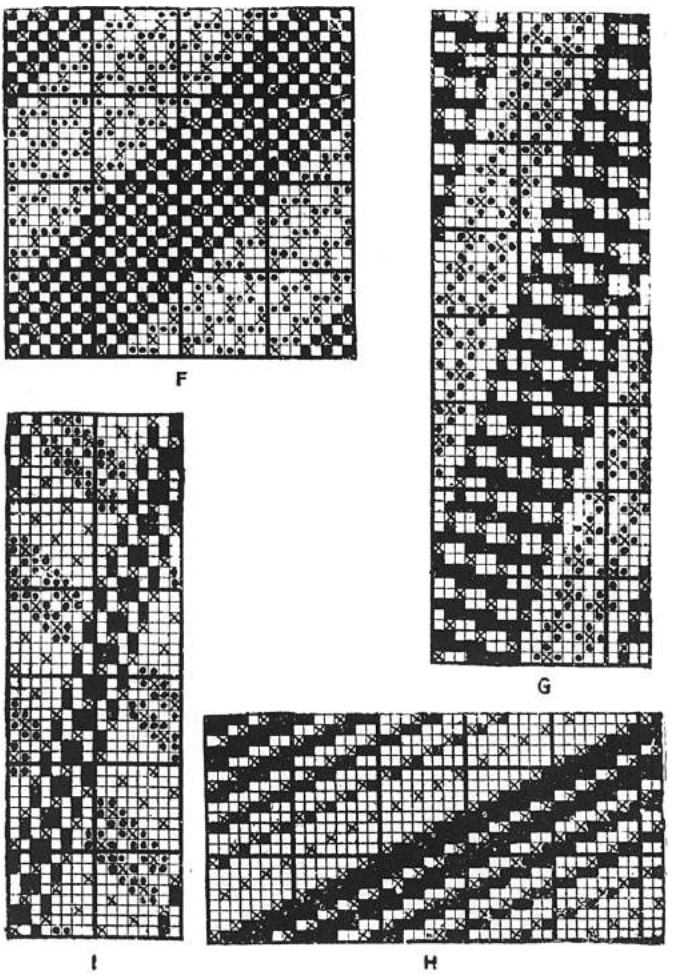


Figure 4.2

these constructions can be easily traced from the designs as the original sateen base marks are shown in the form of crosses, whilst the second stage extensions are indicated by the solid marks and the third stage work is represented by the dotted marks.

Figured twills

The examples, given at A, B, C, and D in *Figure 4.3*, illustrate the arrangement of small spots or figures in conjunction with, and running at the same angle, as ordinary twills. A spot may be repeated diagonally one or more

times in each repeat of the twill lines; and in finding the repeat of a spot it is necessary to count the spaces diagonally. For example, in the design A the crosses, which indicate corresponding positions of the spots, occur on every third space—counted diagonally, and in order to show this clearly, dots are indicated between the crosses. The complete repeat of the twill is upon 12 threads or diagonal spaces, and the spot is therefore repeated four times. A representation of the design A, in the woven fabric, is given in *Figure 4.4*.

The twill in the design B in *Figure 4.3* repeats on 16 threads, and as the figure repeats on 8 diagonal spaces, as indicated by the crosses and dots, it is inserted twice in the complete design. In C the twill lines repeat upon 16 threads, but in this case the spot repeats on 6 spaces—counted diagonally, hence the complete repeat extends over 48 picks—the l.c.m. of 16 and 6. The design C could be arranged similarly to repeat upon 48 ends and 16 picks

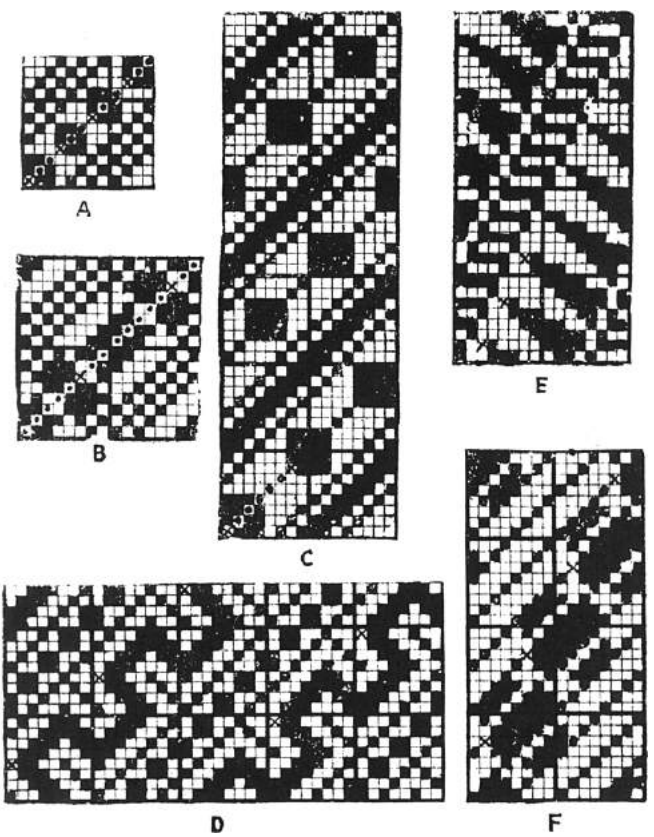


Figure 4.3

by extending the weave horizontally, and in the design D a figured twill is shown thus arranged. The twill repeats upon 20 threads, and the figure on 8 diagonal spaces, hence the complete design occupies 20 picks and 40 ends, the latter number being the l.c.m. of 20 and 8. In dobby shedding it is necessary to extend the designs vertically, but in jacquard weaving the horizontal method has the advantage that a saving of cards is effected. In

designing figured twills it is convenient to first insert lightly a diagonal line of marks as a basis; the spaces occupied by the figure and the twill then require to be adjusted to the size of the repeat, or vice versa.

Small figures may be arranged in combination with steep or flat twills, and an example is given at E in *Figure 4.3* in which the twill repeats on 16 ends and 32 picks, while the distance between corresponding parts of the figure is

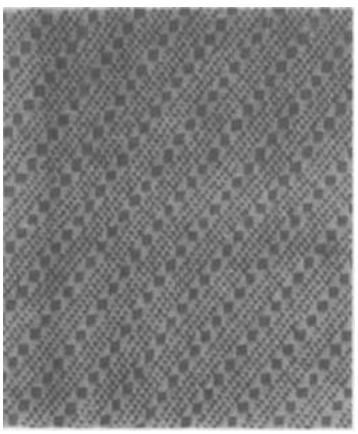


Figure 4.4

two spaces outward, and four spaces upward. The design F is inclined at the same angle as E, the distance between corresponding parts of the figure being four outward and eight upward, but in this case the space between the figures is simply filled in with 1-and-3 ordinary twill.

DIAMONDS AND DIAPERS

These designs, from the point of view of their construction, can be regarded as a further development of the twill weaves. Two different types can be distinguished: those that are symmetrical about their vertical and horizontal axes which can be produced with the aid of the point draft; and those that are not pointed which are symmetrical about their diagonal axes. The first type, in its simplest form, is a development of the waved twill, whilst many effects in the second group are based on the herringbone twill. The terms diamond or diaper are used somewhat indiscriminately, but it is more correct to apply the term diamond with reference to the first type, and the term diaper in respect of the second type.

Construction of diamond designs

True diamond shapes converge into a vertix and for this reason most designs of this type can be constructed economically on the point draft basis. The structure may be developed in the following two ways: (1) By employing a vertical waved twill or zig-zag as the lifting plan in conjunction with the point draft; (2) By indicating a diamond base and building up the design symmetrically on each side of the centre thread. The first method is illustrated at A, B,

C, and D in *Figure 4.5* in which A shows a 1-and-3 twill that is arranged at B as a horizontal waved twill in the order of 1, 2, 3, 4, 3, 2, while C represents the same twill arranged to zig-zag vertically in the order of 1, 2, 3, 4, 3, 2 (two repeats are given in each direction). If B be taken as a draft with C as the lifting plan, the small diamond design given at D will result.

In the same manner E, F, and G in *Figure 4.5*, illustrate the construction of a diamond design based upon 2-and-2 twill. The draft E turns on the first and ninth ends, and the lifting plan F, which, as shown by the crosses, runs in the

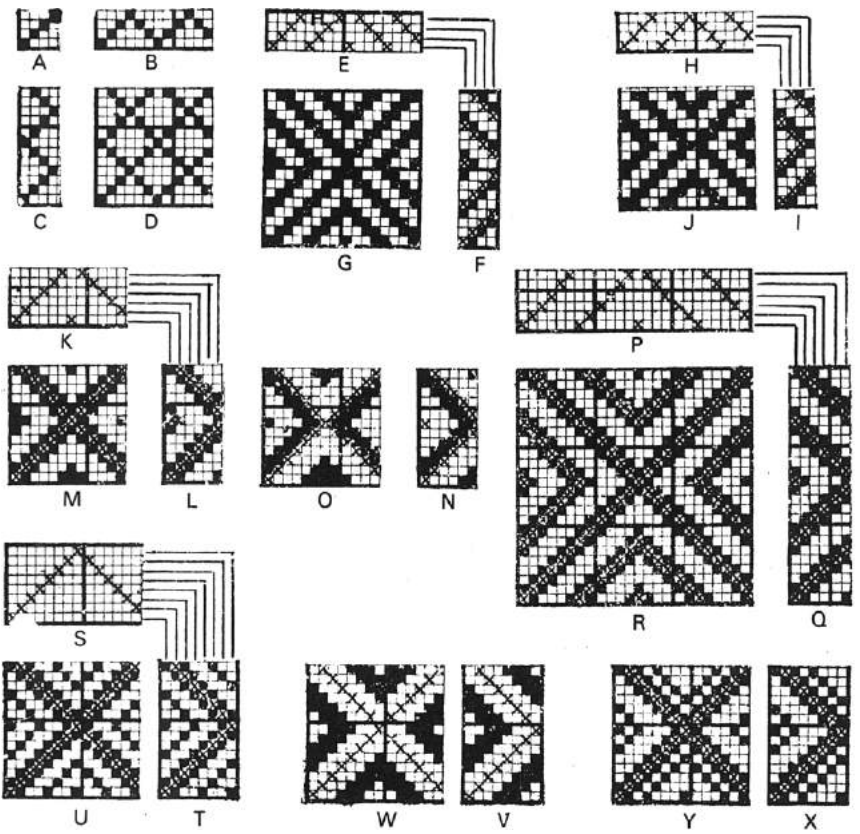


Figure 4.5

same order vertically as the draft is arranged horizontally, turns on the first and ninth picks. The combination of E and F produces the diamond design given at G, in which, however, it will be noted that the diamond spaces are not alike. This is due to the additional mark of the 2-and-2 twill being necessarily placed at one side of the base marks in the lifting plan. It is possible, however, to produce similar diamond spaces in the 2-and-2 twill by making the repeat two threads larger in one direction than in the other, as shown at H, I, and J. The design J corresponds with the woven pattern represented in *Figure 4.6*.

The construction of three diamond designs, based upon 3-and-3 twill weave, is illustrated at K to R in *Figure 4.5*. The draft K turns upon the first and seventh ends, and the corresponding lifting plan L upon the first and seventh picks. In the latter the base line (indicated by the crosses) forms the

centre of the float of three, and the arrangement results in the formation of a perfectly symmetrical diamond design, as shown at M. A lifting plan for the draft K is given at N, however, in which the base line does not form the centre of the 3-and-3 twill weave, and this results in the production of a design, as represented at O, in which the diamond spaces are not alike. By employing more than one repeat of the twill in each direction, as shown at P, Q, and R in *Figure 4.5*, a larger diamond design is produced. If the base line of the lifting plan forms the centre of the marks of the twill weave, a continuous line of marks in each direction is formed which enclose the diamond spaces.

The drafts E, K, and P in *Figure 4.5* turn on the same heald (the first) each time, and the arrangement has the advantage that the same number of ends is drawn upon each heald. Pointed drafts, however, are frequently made to

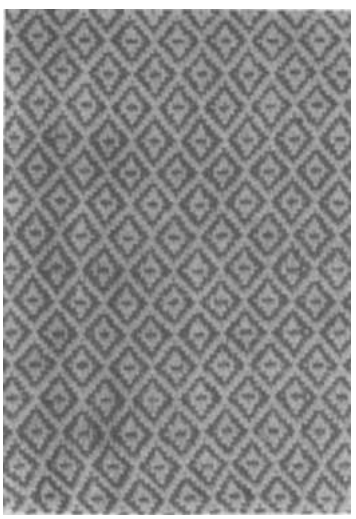


Figure 4.6

turn on the first and last healds, which thus require half as many mails as the centre healds, as shown at S in *Figure 4.5*. In order to illustrate certain features in the designs, three lifting plans are given at T, V, and X, in each of which an 8-thread twill weave is reversed in the same order as the draft S, while the corresponding designs are indicated at U, W, and Y. The same twill weave is used in both T and V, and in both cases the base line of marks forms the centre of the twill. In the plan T, however, the base line is in the centre of the float of three, whereas in V it coincides with the single line of marks. The difference in the position of the twill results in the formation of two quite different designs, as will be seen from a comparison of U and W. In the lifting plan X the base line of marks is in the centre of the float of three, but the single line of marks is not in the centre of the space between, hence in the resulting design, given at Y, the two diamond spaces are dissimilar. This, however, is not necessarily a disadvantage.

Figure 4.7 shows the construction of a more elaborate diamond design than any of the foregoing, and also illustrates a method of using straight and waved twills in the production of bordered fabrics. A shows a straight draft, and B a fancy point draft on 8 healds, while C and D represent straight and waved twill lifting plans to correspond. The straight twill given at E results

from the combination of A and C; the horizontal waved twill F from the combination of B and C; the vertical zig-zag twill G from the combination of A and D; and the diamond design H from the combination of B and D. By suitably repeating the respective sections a number of times a bordered fabric may be formed in which E forms the corners, F the cross-borders, G the side-borders, and H the centre.

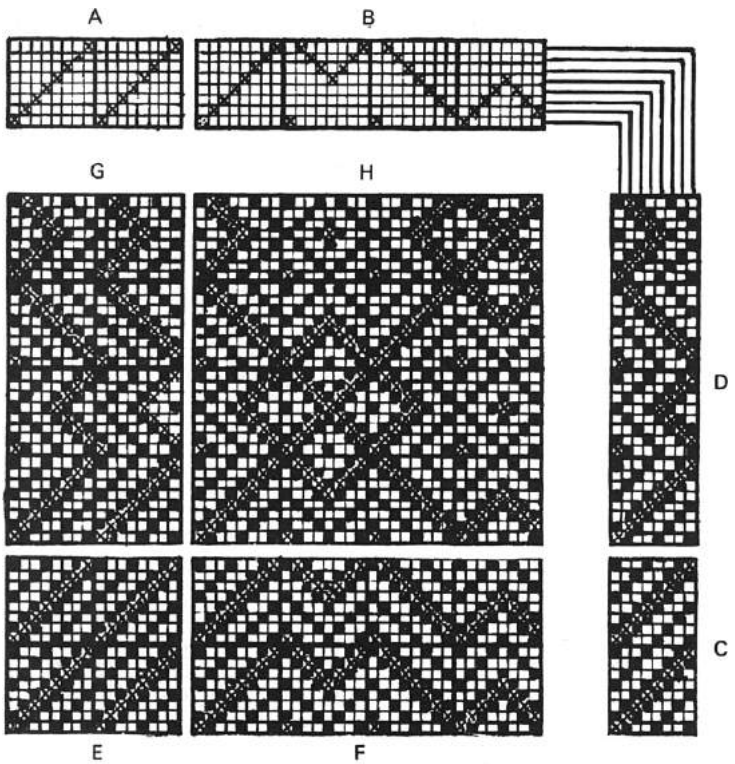


Figure 4.7

Figure 4.8 shows another form of diamond figure which repeats upon 90 ends and picks, and can be woven in 18 healds. The order of drafting is indicated by the black squares on the first 18 horizontal spaces of the design. The lifting plan, which is based on the weave given at A in *Figure 4.9*, is indicated on the first 18 vertical spaces of *Figure 4.8*; and, as shown by the solid marks, the order of reversing is the same as in the draft. A method of preventing the formation of an increased float where the twill reverses (which is common to pointed twills) is illustrated by the example. The draft is arranged to turn always on the first or the tenth heald, and the lifting plan on the first or the tenth vertical space. The squares where the first and tenth ends and picks intersect in the weave A in *Figure 4.9*, are therefore taken as centres, and the twill line of float is cut across as shown. Therefore, instead of the floats joining together small spots are formed at each place where the twill lines cross one another in *Figure 4.8*. In order that the general effect may be clearly seen the complete weave is shown only on the first 18 ends and picks of the design.

It is very necessary for the weave, which is used as the basis of the lifting plan, to be systematically constructed in order to ensure that a symmetrical design will result. For the purpose of further illustrating this point two fancy twill weaves are given at B and C in *Figure 4.9* which are suitable for the draft of *Figure 4.8*. A single line of marks is first inserted diagonally, as shown by the dotted squares in B and C, then the first and tenth threads (on which the

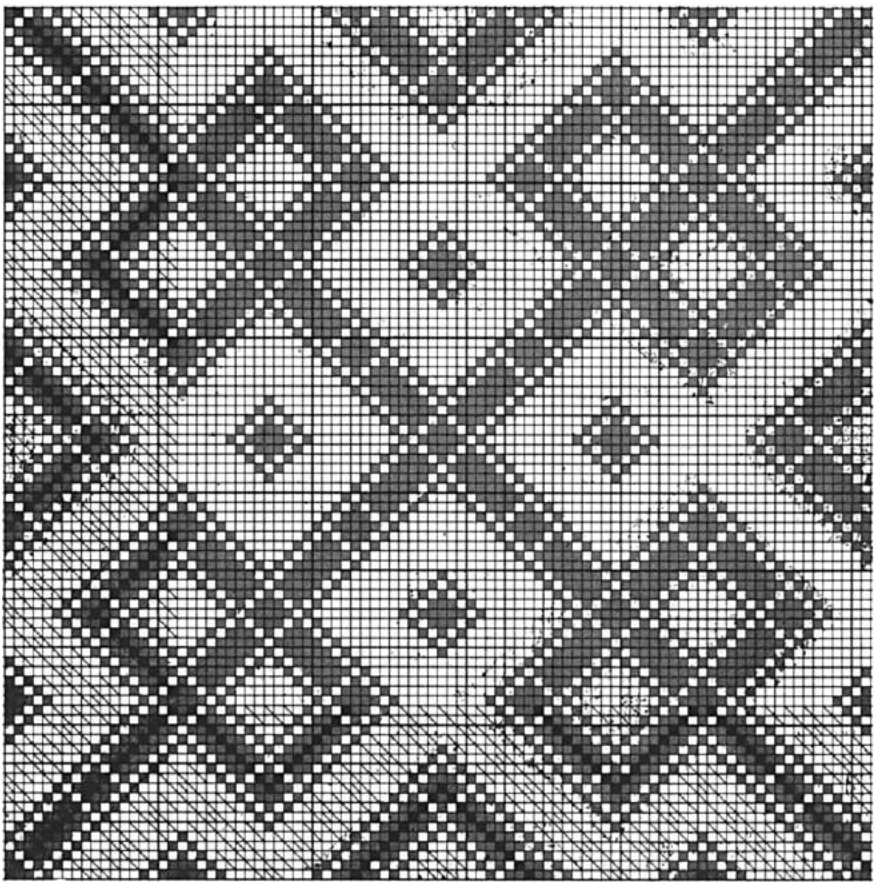


Figure 4.8

draft reverses) are taken as centres, and a weave is built up which will reverse either in the direction of the warp or the weft without forming an increase in the float. Also the remainder of the weave is constructed in the same manner on each side of the centre line of marks.

In the second method of constructing point-drafted diamond designs a pointed draft is first indicated on the required number of healds, as shown at A or B in *Figure 4.10*, which are arranged on nine healds. Marks are then inserted in reverse order, as shown at C or D, and the repeat, which is on two threads less than twice the number of healds in the draft, is thus divided by the base marks into two diamond spaces. The base marks, which serve as a guide in building up the design, may be converted into distinct lines that cross one another, as shown at E; or a weave may be indicated only in the diamond

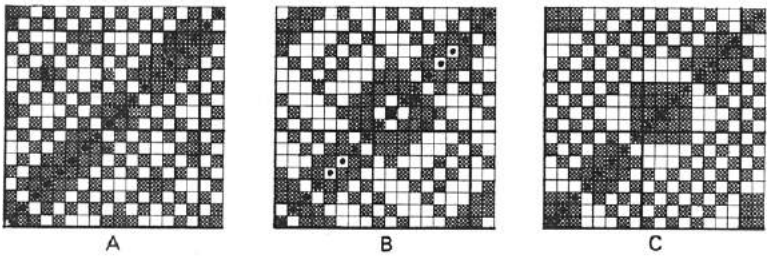


Figure 4.9

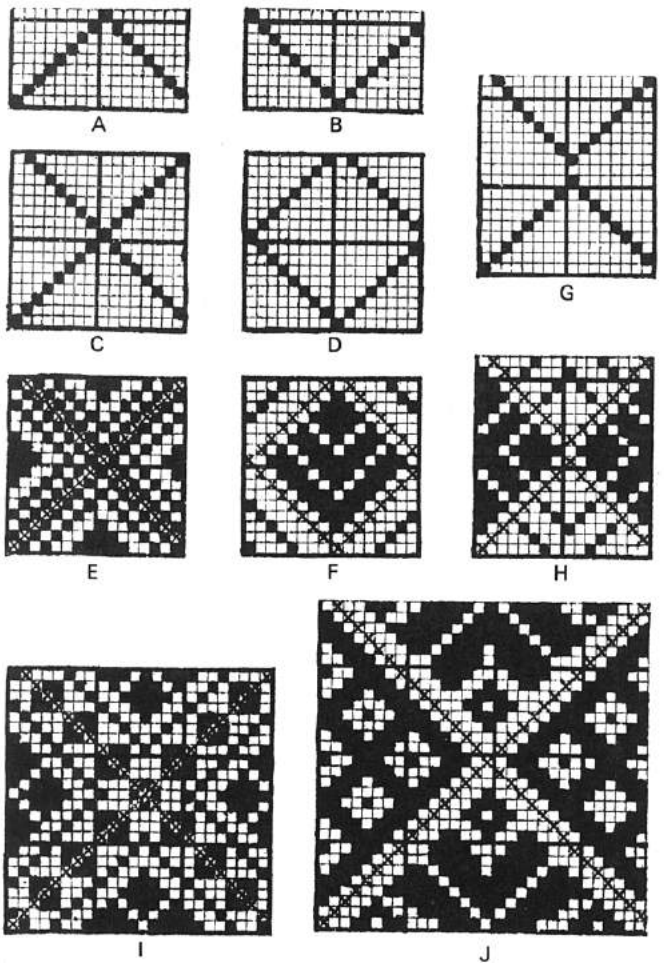


Figure 4.10

spaces, as represented at F. The two diamond spaces may be filled in in the same manner, as shown in E, or different effects may be inserted, as indicated in F, which shows one diamond space in weft float, and the other in warp float. In each case, however, it is necessary for the threads to work alike on each side of the centre ends.

In constructing diamond designs in which the sections are equal in size and exactly the reverse of each other, the repeat should be made two threads larger in one direction than the other. The method is illustrated at G and H in *Figure 4.10*; G showing how the diamond base is arranged, and H a design in which the warp float in one space exactly corresponds with the weft float in the other space.

If a hopsack weave is employed, the small squares should be arranged to reverse properly from the centre, as shown in the design given at I in *Figure 4.10*, which is constructed on the basis of a point draft on 13 healds.

The design J shows an elaborate style that is weavable on a 16-heald point draft.

Construction of diaper designs

The simplest weaves of this type are produced as a further development of the herringbone twill, in which the principle of opposing a warp float on one side of the design by a weft float on the other, is extended in both directions, i.e. horizontally and vertically. In this manner a design is formed in which the typical herringbone *cut* splits the design into four quarters, the diagonally opposite quarters being similar. Simple, even-sided twills such as the 2-and-2, or 3-and-3 produce well balanced diaper effects as shown at A and D in *Figure 4.11*. These structures are frequently employed as they are capable of forming large design repeats with considerable economy in the number of healds that need to be used. This is indicated at B and E where typical herringbone drafts are employed, using in the production of the diaper a number of healds which is no greater than the minimum required for a basic 2-and-2, or 3-and-3 twill. More elaborate diapers, such as that shown at F, can also be constructed on the herringbone draft basis provided that the twills from which they were originated fall into a certain specific category. The characteristics of such twills are: (1) That they are even-sided; (2) That their repeat splits into two halves each of which is symmetrical within itself; and (3) That the lifts in each of the two halves are diametrically opposite. The twill used as the base for the diaper F satisfies all three conditions stated above, which is shown graphically at H in *Figure 4.11* where the dotted line 'd' indicates that the twill splits up in the required manner. Other twills to conform with the above requirements can be easily constructed and the following two will produce good diapers with herringbone drafts on 16 and 12 healds respectively $\frac{2\cdot2\cdot:\cdot4\cdot}{\cdot4\cdot:\cdot2\cdot2\cdot}$; $\frac{1\cdot2\cdot1\cdot:\cdot1\cdot1\cdot}{\cdot1\cdot1\cdot:\cdot1\cdot2\cdot1\cdot}$. Even sided twills containing more than two lines of floats which do not split in the manner indicated above cannot be woven with the economical herringbone draft. This is shown at I and J where the base is the $\frac{3}{1}\frac{1}{3}$ twill. Although this twill is even-sided each half of the repeat is not symmetrical and, as a result, upon herringbone reversal the succession of the warp and the weft floats is reversed. Therefore, though the twill itself requires only 8 healds its herringbone or diaper version must be constructed on 16 healds.

Warp and weft faced twills can also be used to produce diapers on the herringbone reversal as shown at K, L, and M in *Figure 4.11*, but owing to the very prominent *quartering* of the repeat a distinct check effect is produced and for this reason such effects are frequently termed *dice checks*.

In addition to the herringbone based diapers many other diaper forms can be constructed without a preconceived base. These offer greater freedom to

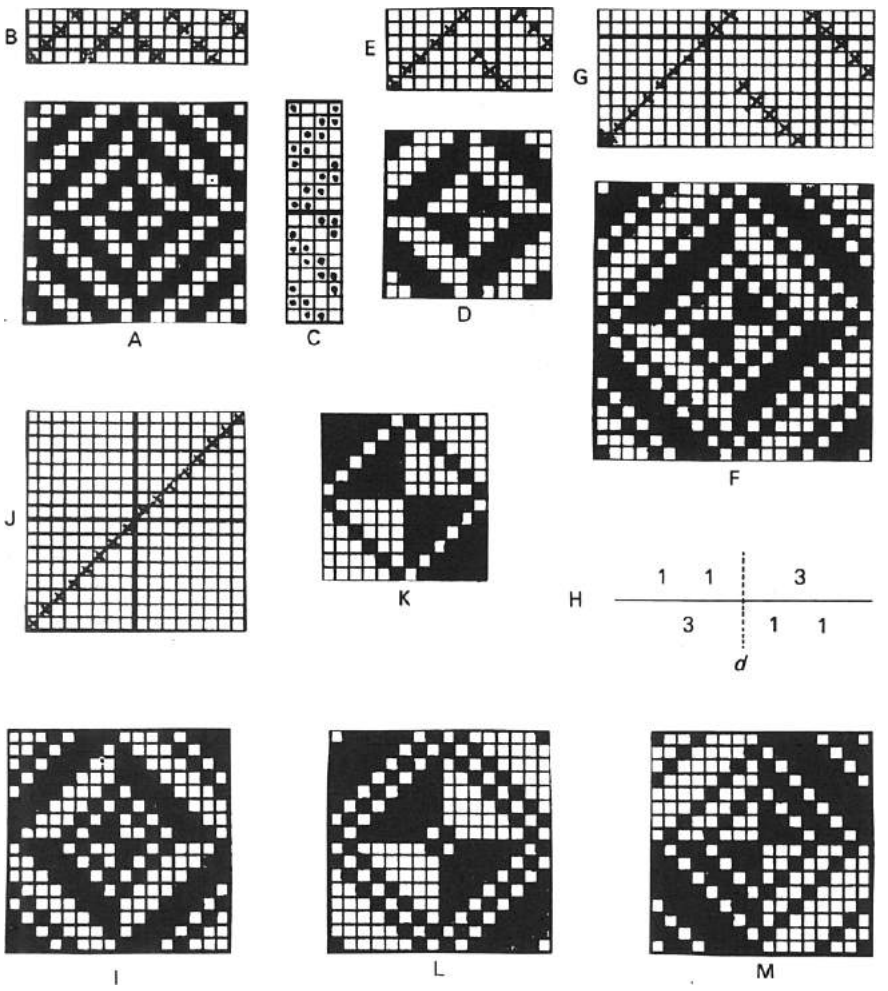


Figure 4.11

the designer, but in dobby shedding the size of their repeat is more limited as they normally cannot be woven with the same economy in the number of healds as the point or herringbone drafted designs. In this class of structures, to retain an idea of the required form, the diamond base marks may be for convenience indicated in the same manner as in the construction of pointed designs. Very interesting interlacing twill designs are produced in this system, and a convenient method of working is illustrated at A and B in *Figure 4.12*. From the centres where the diamond base lines intersect, lines of marks are inserted running to right and left alternately, as indicated by the solid squares

in A. Marks are then added to the base lines to give the required length of float, as shown at B, but blank squares are left where the twills cross one another in order to break the continuity of the lines.

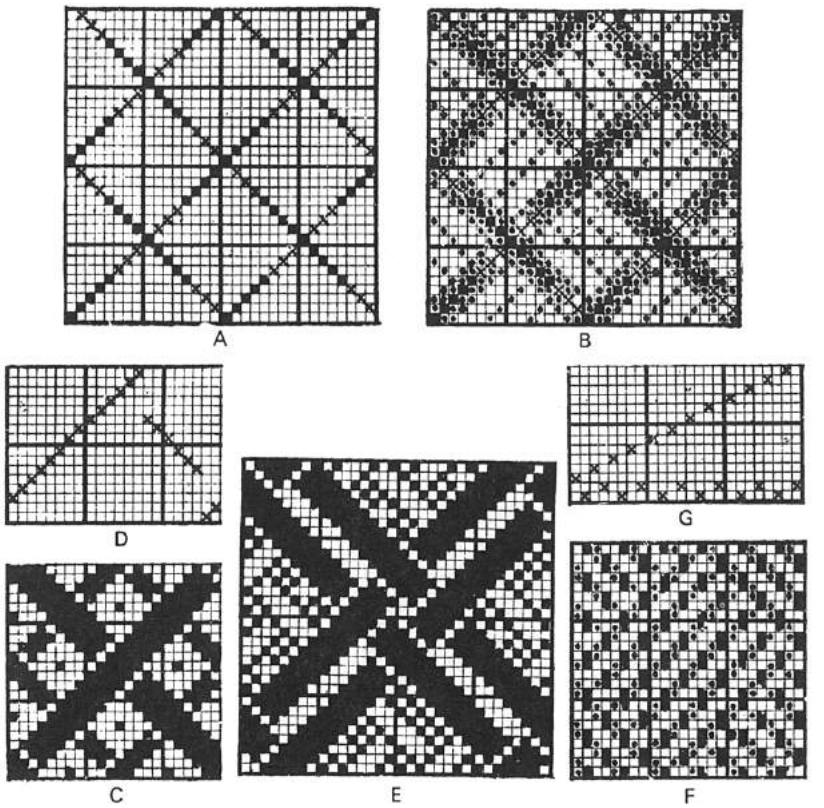


Figure 4.12

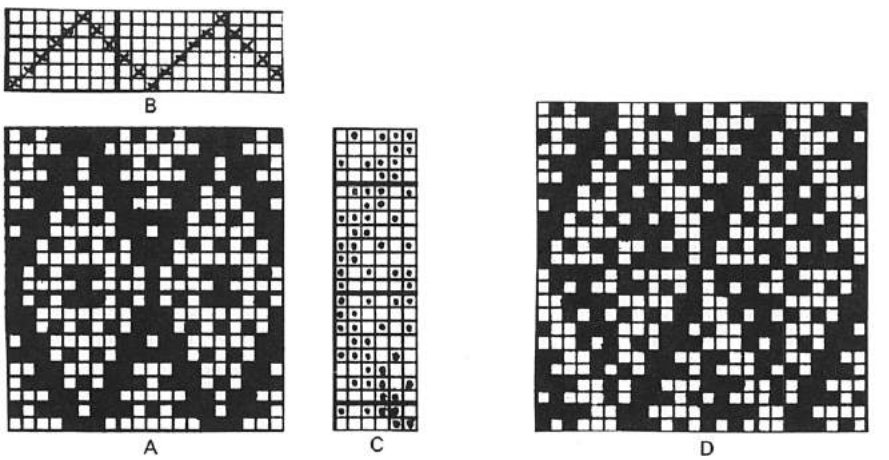


Figure 4.13

In dobby shedding, in order to obtain a larger number of threads in the repeat than the number of healds employed, an interlacing twill design may be arranged to suit a modified form of point drafting. An example is given at C in *Figure 4.12*, which repeats on 22 threads but can be drafted on 16 healds, as indicated at D.

The design E illustrates a method of interlacing the twills when two or more lines are introduced; this design cannot be drafted on to less than 29 healds, and is therefore beyond the capacity of the ordinary type of dobby.

The diamond design given at F illustrates a principle by which comparatively large effects can be woven on a small number of healds. The even ends work continuously in 2-and-2 order, as indicated by the solid marks, and can be drawn upon two healds, as shown in the draft G. The 2-and-2 twill weave is caused to run to left or to right in the design according to the position in which the marks are inserted upon the odd ends. Effects can be produced in 1-and-3 twill weave in the same manner.

Elongated and flattened diamonds and diapers

Good designs can be often obtained by extending steep and shallow twills into diamond or diaper designs. Depending upon the original twill base the resulting figure will be either elongated or flattened in appearance. Careful selection of the twills is necessary to avoid the formation of excessive length of float and some modification may on occasions be required. Both the point draft and the herringbone principle may be applied, the first method being illustrated at A, and the second at D in *Figure 4.13*, the same steep twill (shown shaded) being used as the base in each case. B shows the advantage of the point draft in dobby designing as A, which requires only 6 healds is almost as big in the area of repeat as D which needs 12 healds. Designs A and D when turned at 90° show the appearance of the flattened twills. For best effects, elongated diamonds, in common with the steep twills, should show more warp than weft on the face, whilst weft float should predominate in the flat diamonds, close setting of the threads being necessary in both to obtain sufficient firmness in the interlacing.

More elaborate diamond or diaper forms can be produced on the shaded and figured twill bases and some large diamonds suitable for jacquard designs are shown in *Figures 10.11* and *12.40* to *12.42*.