7

Stitched Double Cloths

Double cloths are fabrics in which there are at least two series of warp and weft threads each of which is engaged primarily in producing its own layer of cloth, thus forming a separate face cloth and a separate back cloth. The two layers may be only loosely connected together in which case each may be readily identified as a different entity or they may be so intricately stitched or tied together that they appear to form a complex single structure. The purpose of the construction may be entirely utilitarian, such as the improvement of the thermal insulation value of a fabric in which a fine, smart face appearance is necessary; or, it may be aesthetic in intention for which purpose the existence of two series of threads in each direction improves the capacity for producing intricate effects dependent upon either colour, or structural changes.

Classification of double cloths

Most of the double cloths can be classified under well defined headings and the following list gives the principal structural types with the simple schematic diagrams in *Figure 7.1* illustrating the basic principle of each construction.

(1) Self-stitched double cloths. These fabrics contain only the two series of threads in both directions and the stitching of the face cloth layer to the back layer is accomplished by occasionally dropping a face end under a back pick, or, by lifting a back end over a face pick, or, by utilising both of the above systems in different portions of the cloth. This type of structure and the three different methods of stitching are illustrated at A, B and C in *Figure 17.1.*

(2) Centre-stitched double cloths. In these fabrics a third series of threads is introduced either in the warp or in the weft direction whose entire function is to stitch the two otherwise separate layers of cloth together. The centre threads lie between the face and the back cloth and for the purpose of stitching oscillate at regular intervals between the face and the back thus achieving the required inter-layer cohesion as shown at D in *Figure 7.1.*

(3) Double cloths stitched by thread interchange. These structures are similar to the first category inasmuch as they do not contain an additional

series of stitching threads. However, they are distinguished from the self-stitched fabrics by the fact that the stitching of the face and the back cloth is achieved by frequent and continuous interchange of some thread

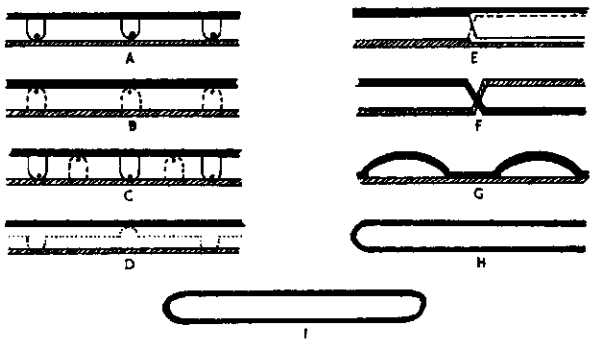

Figure 7.1

elements between the two cloth layers. Thus, in some portions of the cloth the face ends may be made to interweave with the back picks and the back ends with the face picks as illustrated schematically at E in *Figure 7.1.* The point at which the threads interchange represents the stitch point.

(4) Double cloths stitched by cloth interchange. In this class of constructions the principle of the interchange is taken one stage further than in the third category and complete cloth layers are made to change places as shown at F in *Figure 7.1.* As stitching between the two fabrics occurs only at the point of cloth interchange the degree of cohesion in this type of cloth depends on the frequency of the interchange.

(5) Alternate single-ply and double-ply construction. In some fabrics the constituent thread components are occasionally merged together into a heavily set single cloth and occasionally are separated into distinct layers to form figure areas of open double cloth on the firm single cloth ground. Usually, the effect depends upon a degree of distortion as the crammed single cloth areas tend to spread out, thus affecting the appearance of the double cloth 'pockets'. A cloth of this type is illustrated at G in *Figure 7.1.*

In addition some cloths are produced on the double cloth principle of construction but due to the deliberate absence of stitching between the layers become single cloths upon their removal from the loom. Two such constructions, the double width and the tubular cloth are shown respectively at H and I in *Figure 7.1.*

SELF-STITCHED DOUBLE CLOTHS

The self-stitched double cloth is composed of two series of weft and two series of warp threads; one series of each kind forming an upper or face fabric, and the other, an under or back fabric. It is necessary for the face picks to be arranged in definite order with the back picks, and the face ends with the back ends. The two series of ends require to be drawn through the healds or harness in such a manner that one series may be operated quite independently of the other series.

Separate weaves are required for the two fabrics, which may be either alike or different from each other. Then by interweaving the face picks only with the face ends according to the face weave, and the back picks only with the back ends according to the back weave, two distinct fabrics are formed one above the other. The method in which this is accomplished is illustrated in *Figure 7.2.*

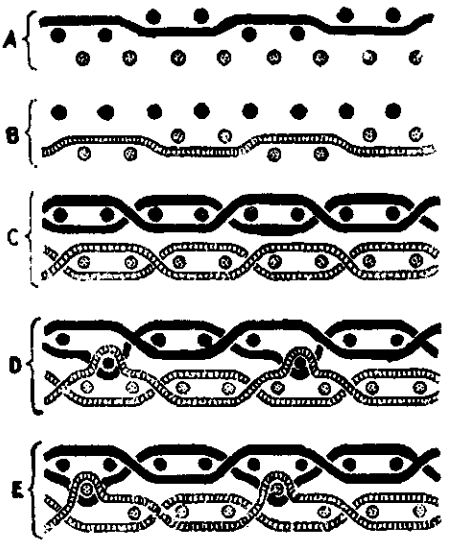

Figure 7.2

The threads are arranged 1 face, 1 back in warp and weft, and a 2-and-2 weft rib weave is employed for both the face and back textures. A represents the position of the warp threads when the first face pick is inserted. All the back ends are left down in order that they will be out of the way of the face weft, and half the face ends are raised in forming the face weave. B shows the position of the warp threads when the first back pick is inserted. In this instance all the face ends are raised in order that they will be clear of the back weft; also half the back ends are raised in forming the backing weave. By allowing each series of weft picks thus to interweave only with its own series of warp threads, two fabrics are produced which are quite separate and detached from each other, as shown at C. If, however, a proportion of the face warp threads be left down when a back pick is inserted, as shown at D in *Figure 7.2,* or if a proportion of the back warp threads be raised when a face pick is inserted, as indicated at E, the threads of one fabric interweave with the threads of the other fabric; and although there are still two distinct fabrics formed one above the other, they may be so closely united that separation of the two layers is impossible. The tying or stitching together of the two fabrics forms one of the principal features of double cloth construction. If a cloth is not soundly stitched, the two fabrics are liable to become separated from each other during wear, particularly if the back fabric is heavier than the face. Diversity of design and colouring can be applied to both sides of a double cloth, and a more perfect structure is obtained than in the case of single fancy cloths or backed cloths.

Relative proportions and thicknesses of the face and back threads

These are decided mainly by the weight to be added to the face texture, but the order of arrangement of the weft threads is determined partly by the weft insertion of the loom. The most common varieties of double cloths are arranged in warp and weft 1 face, 1 back, as shown at F in *Figure 7.3*, and 2 face, 1 back, as shown at G. For looms with boxes at one side only, and when the back weft is different from the face weft, similar effects may be obtained in many weaves by changing the wefting to 2 face, 2 back and 4 face, 2 back, respectively, as shown at H and I. Cloths which require a very fine face are sometimes arranged 3 face, 1 back in warp and weft, as shown at J. The threads may also be arranged in a mixed order, as, for example, 1 face, 1 back in the warp, and 2 face, 1 back in the weft, and *vice versa*, as shown at K and L respectively, or 2 face, 1 back in the warp, and 2 face, 2 back in the weft, as shown at M. Irregular arrangements such as 5 face to 4 back (shown at N), and 7 face to 5 back (shown at O), are also employed, and these are occasionally useful as they admit of relative proportions of face and backing threads being used which cannot be obtained in any of the regular bases.

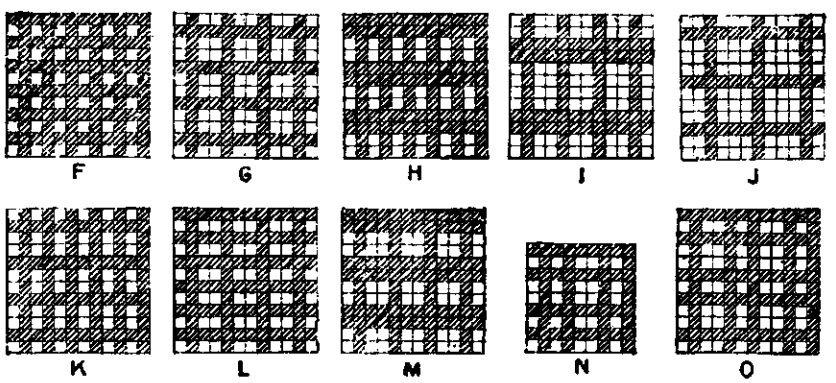

Figure 7.3

In deciding on the relative thicknesses of the face and back yarns, a good rule to follow is to have the relative counts about proportionate to the relative numbers of the threads per unit space. Thus, in a 1 face, 1 back double cloth the back yarn should be similar to, or not much thicker than the face yarn; the finest qualities of the structures being usually made with the same weave and counts for both fabrics. If arranged 2 face to 1 back, the back yarn may be proportionately thicker, or say, from two-thirds to one-half thicker than the face yarn; the back being made coarser than the face, particularly when worsted yarns are used for the latter, and woollen yarns for the former. The proportionate counts of the threads, however, depend upon the relative firmness of the face and back weaves, and the preceding proportions apply to the 2-and-1 arrangement when the back weave is firmer than the face weave, as described in the next paragraph. If the same weave is used on both sides of the cloth the back threads may be three or four times as heavy as the face threads in the 2-and-1 arrangement, especially when centre threads are employed for stitching.

Selection of the face and back weaves

When the threads are arranged in equal proportions the back weave is usually the same as the face weave, or contains about the same relative number of intersections, as, for instance, the 2-and-2 twill is suitable for backing the 3 up, 2 down, 1 up, 2 down twill. In other arrangements the backing weave is, as a rule, made with a relatively greater number of intersections than the face weave in order to compensate for the reduced number of threads. Thus, in the 2 face, 1 back arrangement, the plain weave is suitable for backing the 2-and-2 twill and the 2-and-2 hopsack; the 2-and-1 twill for backing the 3-and-3 twill; and the 2-and-2 twill for backing the 4-and-4 twill. However, in the making of cloths with a fine, smart face and soft back, the same weave may be used, in the 2-and-1 arrangement, for both the face and back textures; while for a similar type of cloth in a 1-and-1 arrangement of the threads, a looser back than face weave may be employed. The most regular effect is obtained by having the repeats of the face and back weaves equal, or one a multiple of the other. For example, the 1-and-3 twill is unsuitable for backing the 2-and-3 twill unless the threads are arranged irregularly in the proportion of 5 face to 4 back threads.

Tying or stitching

In double cloths the stitches joining the two fabrics together, if correctly placed, have no effect on the appearance of either the face or the underside of the cloth. When the method of stitching involves raising the back warp over the face picks then the back end can be used for tying only when it is away from the underside of the back cloth and the pick over which the tie is made must be away from the face of the top cloth. A stitch made in conformity with the above two conditions is invisible on either side of the double cloth as shown at D in *Figure 7.2.* Similarly, if the stitching is achieved by dropping a face end under a back pick both these elements must be away from their respective surfaces, as shown at E in *Figure 7.2.* The method of tying which is the more suitable is, in some cases, determined by the character of the face weave. If a warp satin, or a warp-faced twill weave is employed for the face fabric, tying by lifting the back warp only is suitable; while in the case of a weft sateen or a weft-faced twill weave, it is only advantageous to tie by dropping the face ends. When there is a choice of the two methods, other things being equal, the former method is usually preferable, as the back warp is less liable to show on the face than the back weft, which in the latter system is pulled upwards. This is because the back warp, as a rule, is a finer and smarter yarn than the back weft; during weaving the warp is under greater tension than the weft, and woollen and worsted cloths usually contract in finishing more in width than in length. In some cases both methods of tying are employed in combination, as previously explained, the object of double stitching being to obtain increased firmness of structure and also when other things are equal, so that both face and back warps will be at the same tension and only one warp beam will be necessary.

Construction of squared paper designs

Various factors, which require to be considered before a double weave is commenced, are fully dealt with in reference to subsequent examples. It is sufficient at this stage to assume that in each example the face weave, the back weave, and the ties, are placed in such positions relative to one another as will ensure that the ties are covered on each side of the cloth as effectively as possible by the adjacent floats.

In order to prevent confusion the different stages in working out a double cloth design should be represented by different kinds of marks, as shown in *Figure 7.4,* which illustrates, step by step, the construction of a double 4-and-4 twill structure in which the ends and picks are arranged 1 face, 1 back.

A and B represent the face and the back weave respectively which are marked using the normal convention in which a mark equals warp up. Altogether, the normal convention is preferred in designing for double cloths it being more positive and easier to interpret. At C an area equal to one repeat of the double weave is marked out with the order of arrangement of the face ends and picks and the back ends and picks indicated clearly at the margins. In the example given, lines around the repeat area indicate the back ends; in some of the subsequent designs back ends are indicated by the shaded lines as already shown in *Figure 7.3.* In practice it is easier to denote the order of arrangement by using the letters f and b for the face and the back elements respectively. D shows the first stage of actual double cloth construction which may be defined as: Insert the face weave on the face ends and face picks only, according to the original design. The second stage is similar except that it refers to the back weave: Insert the back weave on the back ends and picks only, according to the original design. E shows the appearance of the design after the completion of the second stage. F shows the marks for the separating lifts which ensure that each series of yarns weaves only with its own kind and this may be stated as: Lift all face ends and back picks. Similarly, to complete the sequence, all back ends must be left down on all face picks which means an absence of marks, i.e. all back ends down on face picks. These lifts, in fact, determine which series becomes the face cloth and which the back and by lifting the face ends out of the way when the back picks are inserted separation of the two fabrics is achieved.

F represents a stage in which two separate fabrics are produced one above the other. As there is no particular reason for producing two disconnected cloths in this manner, it will be realised that this stage is the intermediate point in the construction reached prior to the insertion of stitches or ties to bind the two cloths together. Before the stitch marks are inserted it must be decided which method of stitching is to be used and how frequently the cloths are to be stitched. Assuming that it is required to stitch by lifting the back ends on the face picks and that each back end is to stitch once in the repeat, the correct positions of the ties are shown by the circles at G and by the black marks at K. It will be observed that the rules outlined earlier for correct selection of stitch points are obeyed, viz. (a) the back end is raised to make a stitch when it is absent from the underside, i.e. the visible side of the back cloth; (b) it stitches over the face weft when that weft is absent from the surface of the face cloth, and (c) when it emerges near the surface of the face cloth it is covered by two adjacent long floats of the face warp. In a construction in which both cloths are

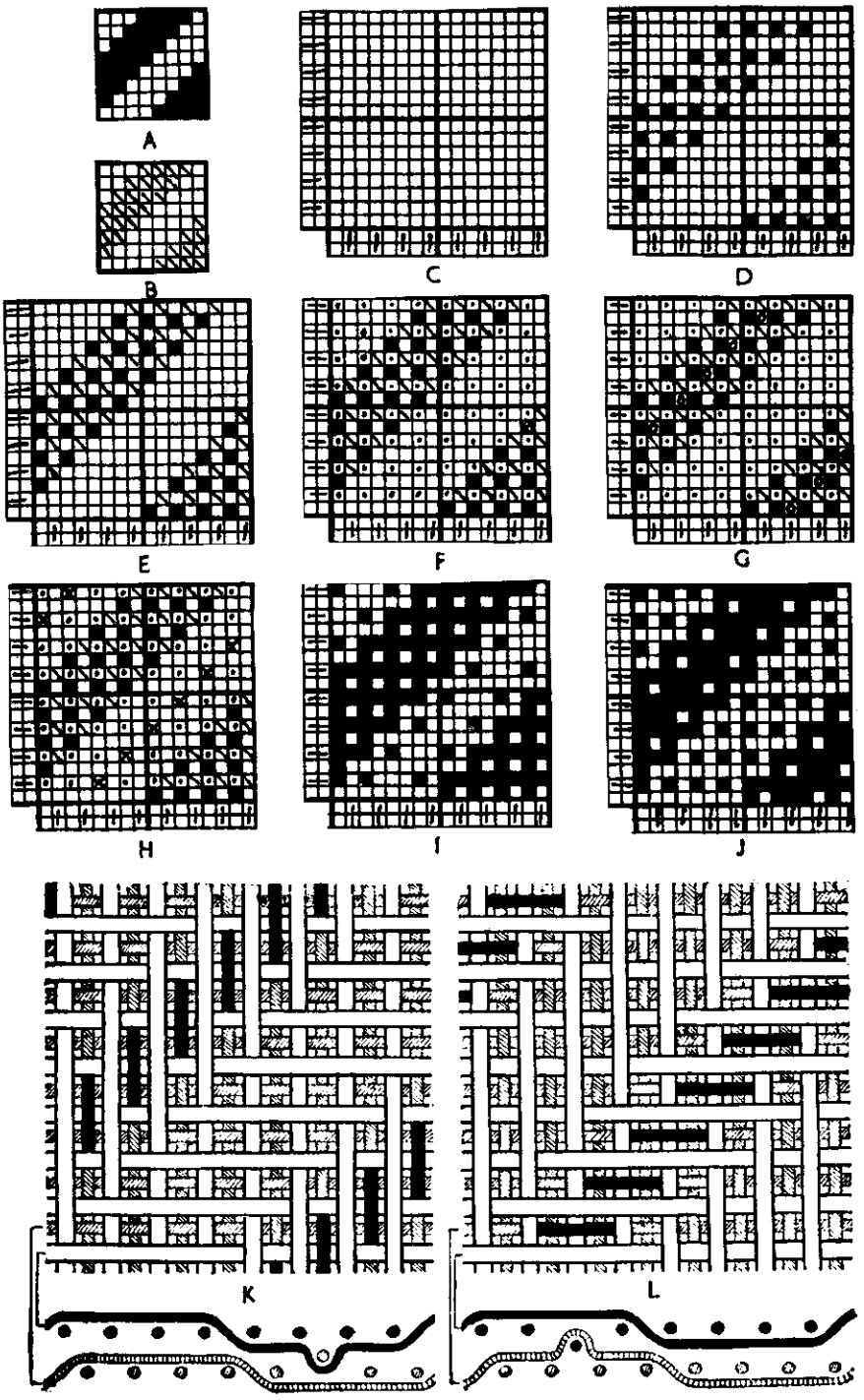

Figure 7.4

produced in a weave containing long floats it is usually easy to find suitable stitch points and in the example given an equally well-concealed tie could be achieved by lifting the back ends on a face pick either above or below the one actually selected. In some fabrics, however, the selection of suitable stitch points may be more restricted.

J shows the appearance of the construction G when only one colour of marks is used. Normally it is not necessary to prepare solid marked designs if it is stated along a design prepared in stages as at G how each type of mark is to be interpreted. In the case of G each mark means warp up. The design G corresponds with the interlacing diagram K in which the back threads are shown shaded. The positioning of the stitch points is emphasised by the black markings which show distinctly how the back warp stitching lifts are concealed by the adjacent long floats of the face warp. The warp cross-section given below K which refers to the interlacing of the first face and back pick also helps to visualise the manner in which a double cloth can be efficiently tied without disturbing either of the two visible surfaces.

The design H in *Figure 7.4* shows the second method of stitching, i.e. stitching by dropping the face ends on back picks. As in the previous system, one stitch per repeat is made, only in this case the face ends and not the back ends are used for the purpose. Using the second method stitching consists, in effect, of cancelling some of the separating lifts made in F and these are indicated by the crosses in design H. As a result, the instructions given in respect of the design H will be: Peg or cut all marks with the exception of the crosses. Otherwise, the design could be re-done by using only one type of mark, as shown at I, in which all marks indicate warp lifts. The design H corresponds with the interlacing diagram L and both indicate clearly the manner in which the ties are concealed, viz. the face end is dropped when it is absent from the surface of the face cloth, it stitches under a back pick which is absent from the underside of the back cloth, and the back pick which at the stitching point tends to be pulled up towards the surface is covered by two long adjacent floats of the face weft. This last point is particularly clearly shown by the diagram L in which the ties are shown by the black markings, and by the warp cross-section under L.

It will be noted from *Figure 7.4* that in both methods of stitching each end of the set used for the tying operates under or over each pick of the opposite set of weft in a regularly distributed order. The regularity of the distribution of ties should be attempted whenever possible as it aids the even distribution of crimp and yarn tension throughout the cloth and thus helps to produce a better fabric.

The method of constructing a double cloth in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft is shown in *Figure 7.5*. This arrangement is suitable for fine face cloths woven with thicker yarns on the underside. The 10-thread fancy weave given at A in *Figure 7.5* is used for the face fabric, and the 5-thread sateen (with weft surface on the underside), given at B, for the back fabric. Both methods of tying are shown, the first being formed by raising the back ends in 5-sateen order over alternate face picks, as indicated at C, and the second by dropping the alternate face ends in a similar order under the back picks as represented at D.

In *Figure 7.5* the different stages of working are indicated separately in a similar manner to *Figure 7.4* but the back ends and picks are in this case denoted by the shaded squares. E shows the arrangement of the face and back threads;

the face weave is inserted at F; the circles in G indicate the positions of the ties using the first, and the crosses in H the positions of the ties using the second method of stitching; the back weave is inserted at I; while the complete design for each system of tying is given at J, and at K.

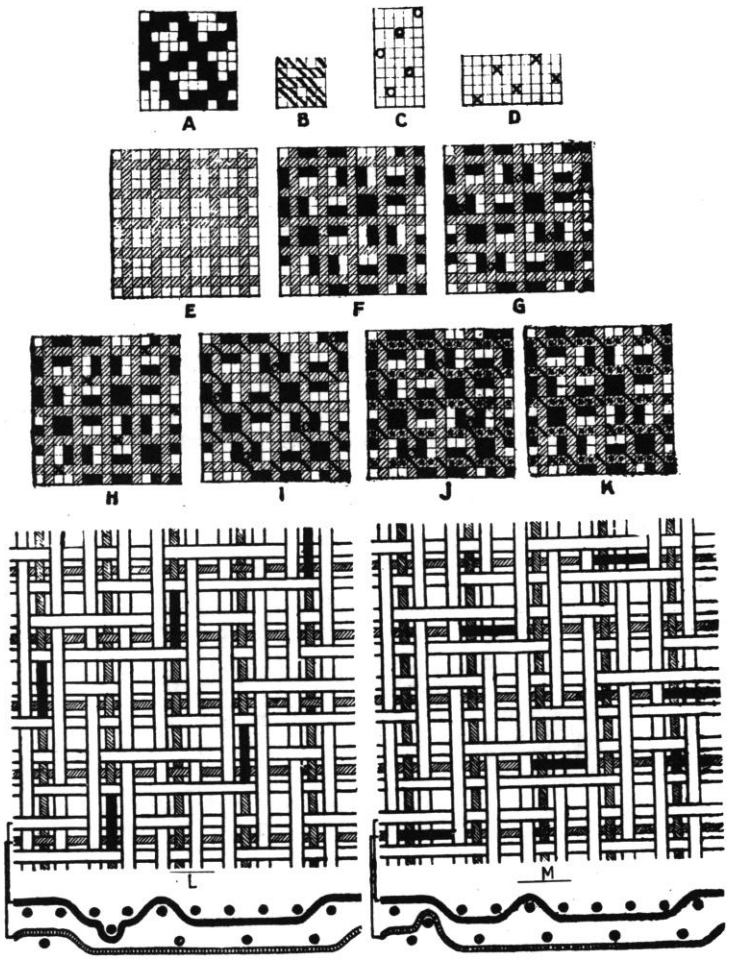

Figure 7.5

The interlacing diagram given at L in *Figure 7.5* corresponds with the weave shown at J, while the warp section below it shows the interlacing of the first back pick and the second face pick of L. Where the back warp enters the face cloth for tying it will be concealed by the face warp floats; also, as each back end (where raised for tying) is also raised on the backing pick which precedes and succeeds the tie, the face weft will be covered on the underside of the cloth by the back weft floats.

M in *Figure 7.5* shows the interlacing diagram corresponding with the weave given at K, with the appropriate warp section below. The ties will be concealed

on the face of the cloth by the face picks which precede and succeed them, but on the back of the cloth the lowered face ends will be covered by the back warp on one side only. This cannot be avoided, because, on the underside there is only a warp float of one at a place in the backing weave. Thus in this construction stitching by lifting the back ends on the face picks is preferable.

In *Figure 7.6* the design is shown for a double cloth, in which the threads are arranged in a mixed order, the proportion being 2 face to 1 back in the warp, and 1 face to 1 back in the weft. This order of arrangement is specially applicable to face weaves which repeat on twice as many ends as picks. The broken 2-and-2 twill, given at A, is employed for the face fabric, ordinary 2-and-2 twill, B, for the back fabric, and the tying is effected in 4-thread twill order, given at C for one method of stitching and at D for the other. This is an example in which the back weave is looser than the face weave, taking into account that there are fewer ends on the underside than on the face. In order to enable positions to be selected for tying by lifting the back ends, the face weave is so placed that a backing end comes between the two ends which twill with each other, and not between two which cut. In this system of tying the ties are effectively covered on both sides of the cloth by the adjacent floats, but in tying by dropping the face ends to ensure that the ties will be perfectly covered on the back of the cloth as well as on the face, it has been necessary to change the positions of the back weave to that shown at M in *Figure 7.6*. E, F, G and H show the appearance

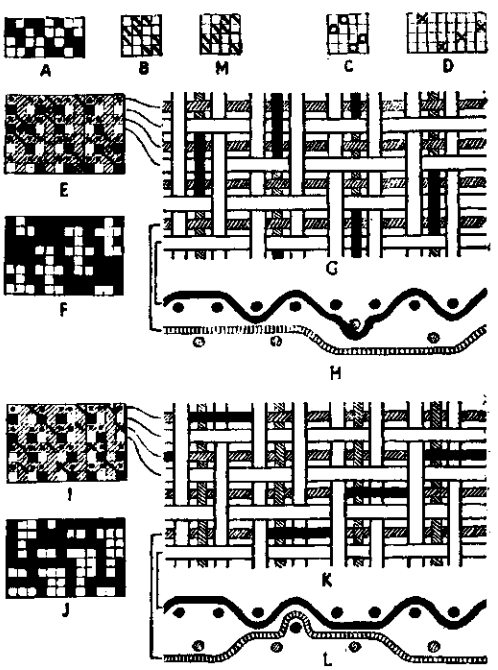

Figure 7.6

of the structure using the former method of tying whilst I, J, K and L show the corresponding views of the same structure stitched by the latter method. All marks indicate warp lifts with the exception of crosses in I.

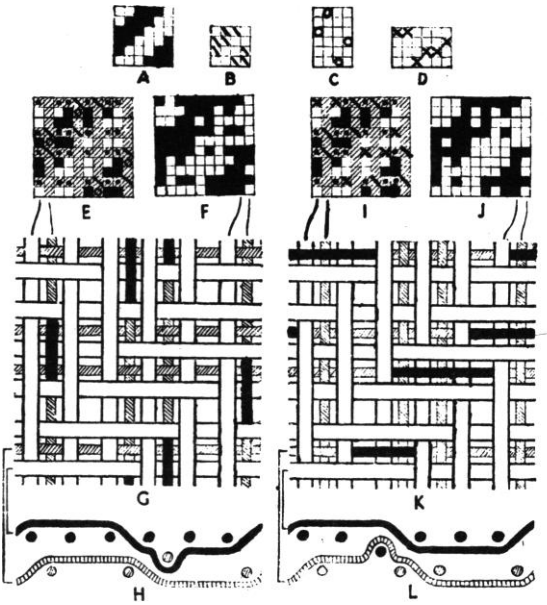

Figure 7.7

Figure 7.7 shows the design of a double cloth, in which the threads are arranged irregularly in the proportion of 6 face ends and picks to 4 back ends and picks. In this type of arrangement the face fabric may be made finer than the back fabric in almost any required proportion. The chief point to note is that suitable weaves are selected for the face and back fabrics respectively. Thus, if the threads are arranged 5 face to 4 back, a 5-shaft face weave should be combined with a 4-shaft back weave; if 4 face to 3 back, a 4-shaft weave with a 3-shaft weave, etc. In the example 3-and-3 twill is employed for the face fabric and 2-and-2 twill for the back fabric, and as the face fabric is finer than the back fabric in the proportion of 6 threads to 4, the 3-and-3 twill face will be similar in appearance to the 2-and-2 twill back. The cloth will therefore have the semblance of a double 2-and-2 twill, but its wearing property will be superior on account of the greater fineness of the face fabric. In the method of tying illustrated in *Figure 7.7,* no tie is placed on the second and fifth face pick, but in the method given at I a slight deviation from the ordinary system is illustrated. On the even back picks two face ends are dropped while on the odd backing picks only one is lowered. They are arranged in this way in order that all the face ends will be intersected by the backing picks, and to show one method of obviating the difficulty which frequently arises in weaving when only a portion of one series of ends is employed for tying. If, however, there is any possibility of the ties showing on the surface of the cloth, such a method should not be employed.

Construction of double cloth designs for looms with changing boxes at one end only

If the same kind of weft yarn is used for both the face and back fabrics, the method of constructing the design is not affected by the limitation in the

boxing capacity of the loom, even though, as is sometimes the case, two or more shuttles are employed for the purpose of weft mixing. If, however, the back weft is different from the face weft, it is necessary for the face and back picks to be arranged on the design paper to alternate with each other in even numbers according to the relative proportions required. The arrangement of the face and back ends may be the same as in ordinary double cloths, and it is better that it should be the same, for if the back warp be employed for tying, the placing of the ties is then not influenced by the order in which the picks are inserted, so far as the face of the cloth is concerned. The covering of the corresponding face weft floats on the underside of the cloth is, however, not so easily effected when the picks are arranged in even numbers. The face warp should only be employed for tying when absolutely necessary, as the insertion of the picks in even numbers not only renders it more difficult for suitable tying positions to be selected in the majority of face weaves, but the interweaving of the backing weft with the face warp at intervals of 2 or 4 face picks, increases the tendency of the latter to group in 2's or 4's.

The system of construction is exactly the same as in the foregoing designs. In *Figure 7.8* the face and back threads are arranged in equal proportions, the

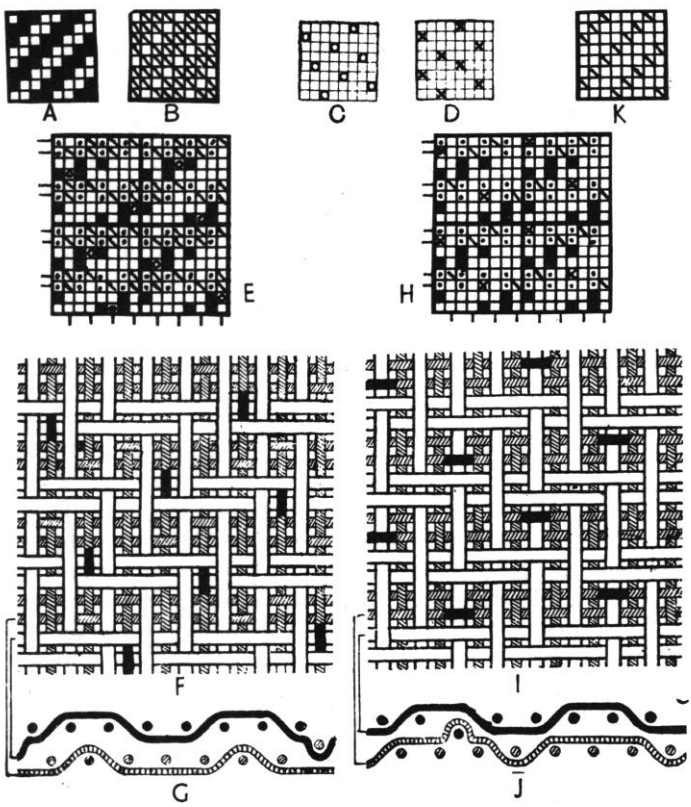

Figure 7.8

ends in the order of 1 face, 1 back and the picks in the order of 2 face, 2 back. The weave marks in *Figure 7.8* indicate warp up with the exception of the crosses which represent the face warp down for stitching. The 2-and-2 twill weave is employed for the face fabric, but for the back fabric the 3-and-1 warp twill, shown at B, is used when the back warp is raised for tying, and the 1-and-3 weft twill, shown at K, when the face warp is lowered for tying. Hence with the design E or F the underside of the cloth will have a weft surface, and with the design H or I a warp surface.

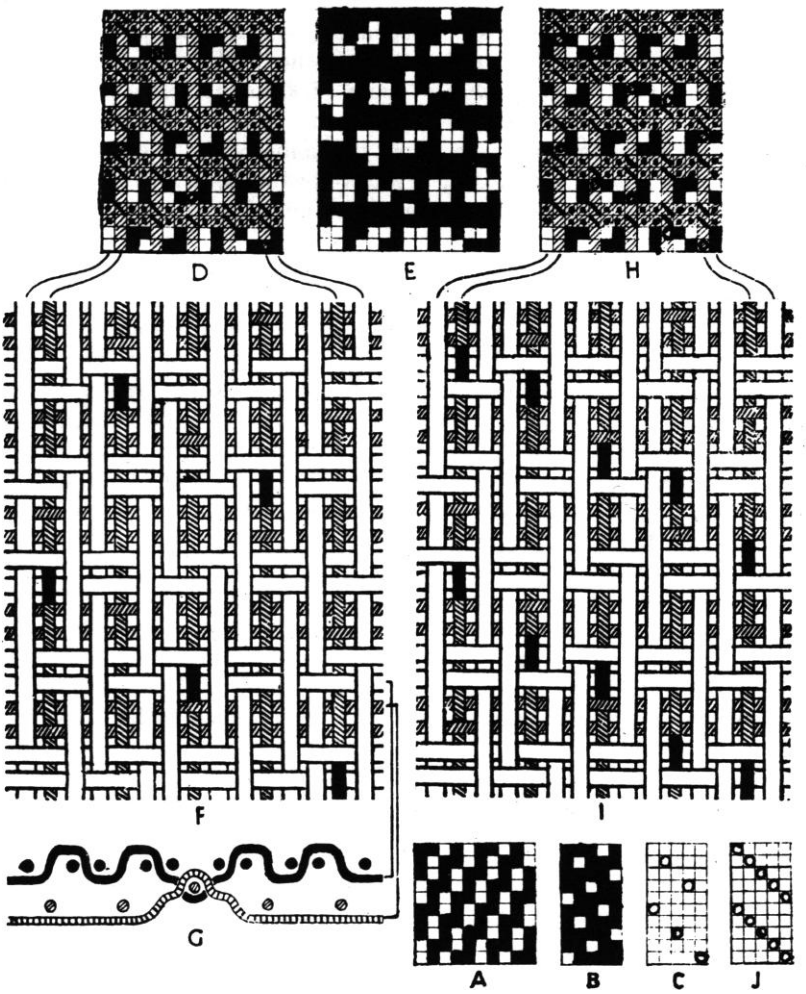

Figure 7.9

In the interlacing diagram given at F the warp ties are shown and arranged in 8-thread sateen order, as indicated at C, and it will be observed that on the face side of the cloth each tie is placed between two face warp floats. Also each back end is raised on the back picks which precede and succeed a tie, hence on the underside of the cloth each face weft tie occurs between two back weft

floats. G in *Figure 7.8* represents the interlacing of the second face pick and the first back pick, from which it will be seen that the face ends and the back picks are quite separate and distinct from each other, while the face picks interweave at intervals with the back ends (in this case the eighth back end) for the purpose of uniting the two fabrics.

In the alternative stitching method illustrated at I in *Figure 7.8* no suitable positions for tying exist on which the even face ends could be dropped. The ties can therefore only be placed on the odd face ends, and though they are equally as well covered on both sides of the cloth a comparison with F will show that the distribution is less perfect in this system than when the back warp is employed for tying. Because of the difference in the arrangement of the ties the design E repeats upon twice as many picks as the design H, of which two repeats are shown. In the section given at J the face picks and the back ends are shown quite separate from each other, the union of the two fabrics being effected by the back weft interweaving at intervals with the face ends.

In *Figure 7.9* the threads are arranged in a mixed order, the proportions being 2 face to 1 back in the warp, and 2 face to 2 back in the weft. The 5-thread warp-face Venetian weave A is employed for the face fabric, and the 5-thread satin, with the weft on the underside, for the back fabric. Tying by dropping face ends on back picks is not illustrated in the figure, but two methods of distributing the back warp ties are given at C and J. The corresponding complete designs are shown at D and H, while the solid design given at E corresponds with D. With the ties distributed as shown at C and D, the alternate face picks only are passed over by the back ends, and although this is a standard method of distributing the ties for cloths in which the face and back ends are in the proportion of 2 to 1, in many cases it is found that a more even cloth is formed if all the face picks are employed for tying, as then the crimp of each is the same. The diagrams F and G correspond with the design D.

The diagram I in *Figure 7.9* corresponds with the design H and is similar to F except that in this case all the face picks are passed over by the backing ends. With the latter order of tying the two fabrics will not only be more firmly united, but the shrinkage of the weft picks will be uniform. The distribution of the ties in this order will, however, be liable to produce an indistinct twill running in the opposite direction to the face warp twill, which, by detracting from the clarity of the latter, may be a source of defect.

Reversible double weaves

The correct placing of the back weave in relation to the ties is of particular importance in the construction of reversible double weaves, such as are used for fine woollen and worsted overcoatings, in which the same effect is produced on both sides. Plans A to E in *Figure 7.10* illustrate the construction of a reversible 7-shaft whipcord, in which the threads are arranged in the order of 1 face, 1 back, in warp and weft. As the back of the cloth is warp surface, the same as the face, the back weave is exactly the opposite of the face weave. So far as regards the face of the cloth, the position of the back warp stitching lifts may be varied, as there are a large number of face floats to cover them. The positions of the back warp lifts must be selected carefully, and are indicated by the marks

between the picks of the plans B, C, and D respectively, in which it will be noted that the position of the back weave is changed to accord with the position of the ties. Section F in *Figure 7.10* shows the interweaving of the first face and the first backing end with the weave and ties placed as at A and B;

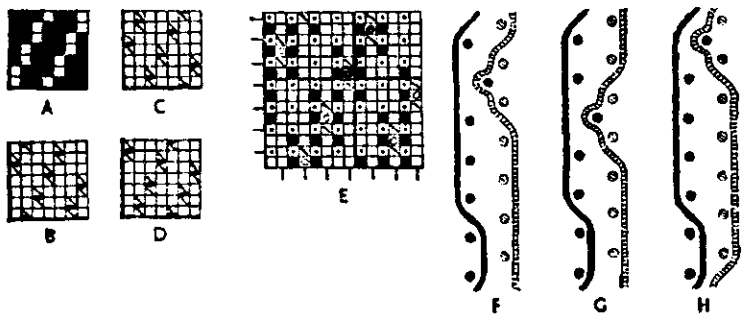

Figure 7.10

section G, as at A and C; and section H as at A and D. In each case the back of the cloth is as perfect as the face, the weaves being the same except that the twill runs in the reverse direction. E in *Figure 7.10* shows the complete double cloth design with A as the face weave and B the back weave.

Beaming and drafting of self-stitched double cloths

In double cloths the stitches put tension on the warp threads hence, other things being equal, the series used for tying requires to be longer than the unstitched series, and two warp beams are therefore necessary. By employing double-stitching, however, and using similar yarns and weaves of equal firmness for the two fabrics, a perfect double cloth can be woven with only one warp beam. Such a double weave is illustrated in *Figure 7.11,* in which the same weave—shown at A and B—is used for face and back, while both series of threads are used for tying, as indicated at C, in which the circles and crosses, respectively denote back warp up and face warp down, the cloth being double-stitched. The complete design is given at D, and the corresponding interlacing diagram at E, while F represents the interlacing of the first face and the first back end. It will be seen that the relative number of intersections is the same for each thread; hence, if the yarns in each fabric are similar, the contraction of the warp threads in weaving will be uniform, and the equal tension required for each series will be better obtained by using only one beam. If, however, the face yarns in a cloth are different from the back yarns, or, on the other hand, if the weaves are different as regards the relative number of intersections, it is better for two warp beams to be used, in order that the two series of threads may be separately tensioned. As a general rule, two beams are employed, and the proper tensioning of the two warps is then of great importance, because if the back warp is held tighter than the face warp the back warp stitches are liable to impair the softness of handle of the cloth, while if it is slacker the cloth is constructionally deficient. Normally, the two warps should be held at about the same tension.

With the exception that a set of healds is required for each fabric, the ordinary method of constructing a draft may be employed—i.e., the threads in each fabric which work alike may be drawn on the same heald. Therefore the

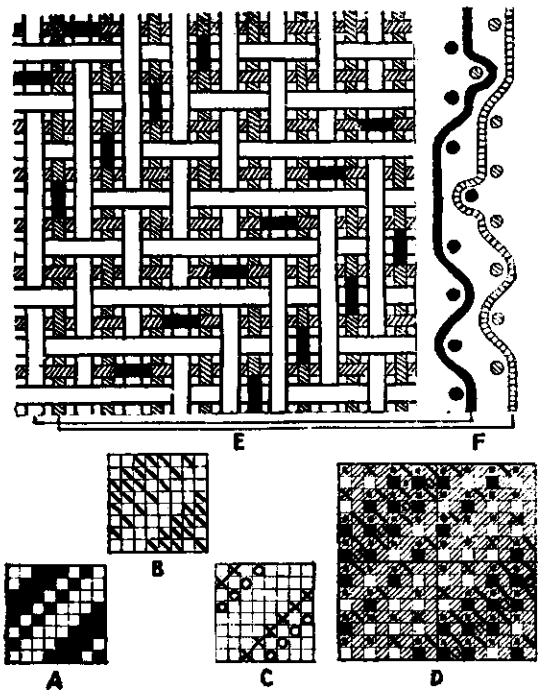

Figure 7.11

minimum number of healds in each set is decided by the number of threads in each fabric, which work different from each other. Thus, the design F in *Figure 7.12* requires eight back healds, although the back weave is on four threads because the back ends must be raised for tying independently of each other in the 8-thread sateen order given at C. Only four face healds are required, because the working of every fourth face end is the same. This will be understood from an examination of the interlacing diagram F and the section shown at G, which represents the interlacing of the first face and the first back end. The face ends work regularly in 2-and-2 order with the face picks, whereas the back ends, in addition to working in 2-and-2 order with the back picks, are raised for tying in 1-and-7 order with the face picks.

H, I, and J in *Figure 7.12,* in which different marks are used to distinguish the face ends from the back ends, show three different methods of drafting each suitable for the construction given at F. When the face and back healds are intermingled, as at H, it is convenient to employ as many healds as there are ends in the repeat of the design. Also, when a special draft such as I or J is used, the draft may be made upon the same number of face as back healds in order to give more scope in varying the weaves, and so that the healds will all carry an equal number of mails.

Sometimes it is convenient for the healds which have been used for the back fabric in a design to be subsequently employed as the face healds, and *vice versa,* in order that a change in the weave, or in the method of tying may be made without redrawing the warp. For example, if a face end be twisted to a back end, the drafts given at I and J in *Figure 7.12* may be employed for a double

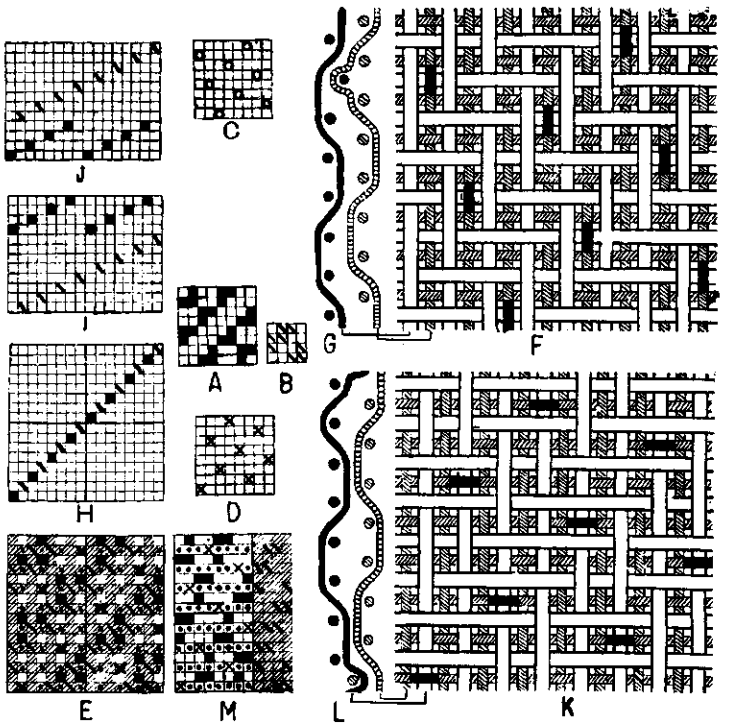

Figure 7.12

cloth in which the 8-shaft face weave shown at A is combined with the 4-shaft back weave given at B. As, however, there will then be only four back healds, it is impossible to effect the tying in 8-end order by means of the back warp lifts, but as there are eight face healds, the face ends may be depressed for tying independently of each other in the 8-end sateen order given at D in *Figure 7.12.* The complete double weave is shown at E, and M is the lifting plan for producing E on the draft given at I, the front eight healds of which are now used for the face ends, and the four rear healds for the back ends. The marks in M (with the exception of the crosses) represent healds raised. The interlacing diagram and a section showing the working of the first backing and the first face end are given at K and L in *Figure 7.12.* A comparison of F and G with K and L will show that when the first method of tying is employed, the back ends are affected, so that the number of back healds must be at least equal to the number of different tying positions in one repeat of the tying plan; while in the case of the second system of tying, the face ends are affected, hence the minimum number of face healds is determined in the same way.

From the above considerations it will be clear that the number of healds require in a self-stitched double cloth depends not only on the respective sizes of repeats in the face and the back cloths but also on the order of stitching. Thus, the construction given at F in *Figure 7.12* consisting of a double 2-and-2 twill would normally require only eight healds if it were stitched together by either method of tying in a 4-thread order. However, as the order of stitching consists of lifting the back ends on face picks in an 8-shaft sateen order, eight healds are needed for the back fabric alone and four more healds must be provided for the face fabric, thus increasing the total requirement to 12.

Considering the construction given at E and K in *Figure 7.12*, the face weave required eight healds by virtue of its repeat size and the back weave four. It will be clear that, if it is desired to stitch this cloth in an 8-sateen order, dropping the face ends on back picks will not increase the heald complement but the same order of tying by lifting the back ends on face picks will increase the total number of healds to 16. Thus, if it is necessary to economise on the number of healds employed, the method of stitching and the order of stitching must be considered in conjunction with the repeat size of each of the two weaves involved.

Selection of suitable stitching positions

General rules regarding the correct placing of the stitches or ties in a self-stitched double cloth were given in the opening sections of this chapter. To avoid confusion it was assumed that no difficulty would be experienced in placing a tie in such a manner that it would be adequately concealed by the structure in both the visible surfaces of a double cloth. It was also assumed that the order of the distribution of ties could always be arranged to the best advantage with the same number of ties placed on each end and each pick of the series which was employed for tying. Using the system of tying in which the back ends are raised for stitching over the face picks it may not be possible to realise the above assumption with some weave combinations and some face to back thread ratios because for perfect placement of the tie the following four conditions must coincide:

(1) The back end must be at that point away from the underside of the back cloth.
(2) It must 'surface' between two long warp floats of the face weave.
(3) The face pick over which the back end is raised must be absent from the surface of the face cloth.
(4) It must be only pulled down at a point at which its penetration into the back cloth level is covered by two adjacent weft floats on the underside of the back fabric.

Clearly, in some circumstances it will not be possible to achieve the simultaneous coincidence of all the four conditions.

Similarly, when the face ends are lowered for stitching under the back picks:

(1) The face end at that point must be absent from the surface of the face cloth.
(2) It must be lowered at a point at which two long back warp floats cover it on the underside of the back cloth.

(3) The back pick at the tie point must be away from the underside of the back cloth.

(4) It must penetrate towards the surface at a point at which it will be covered by two adjacent face weft floats on the surface of the face cloth.

Again, the simultaneous coincidence of the conditions may not, in some cases, be possible.

If it is conceded that the conditions (1) and (3) in each system of tying are absolutely compulsory then a certain degree of freedom must be accepted with regard to the conditions (2) and (4).

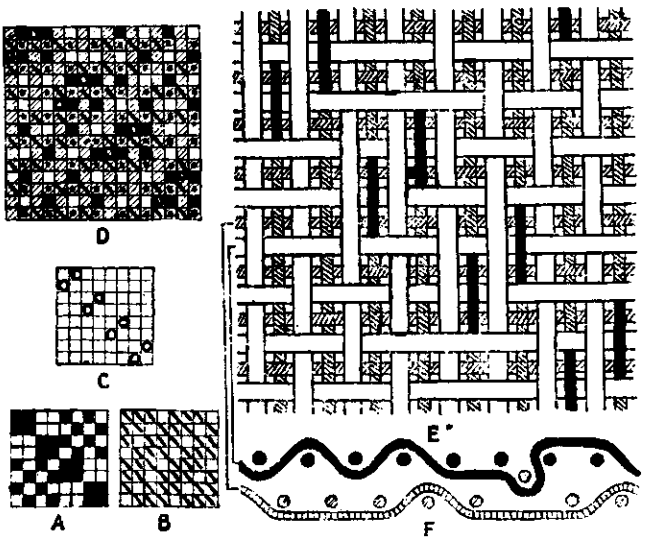

Figure 7.13

In the 1-face 1-back arrangement of the threads the ideal placement of stitches can usually be accomplished without much difficulty, except that all ties cannot be perfectly concealed in the case of such face weaves as the one shown at A in *Figure 7.13*. The complete cut which occurs in the weave between the second and third and the sixth and seventh ends and picks makes it impossible for the second and sixth back ends or picks to be concealed by the face picks or ends with a corresponding face float on both sides. In an example such as this, however, unless there is a considerable degree of contrast between the face and back yarns, it is better for a tie to fall on each thread of the series which is employed for tying rather than to select only those positions where the ties will be covered on both sides. C in *Figure 7.13* shows how the ties may be arranged for the back warp tying lifts, while at D the complete double weave is shown, the 4-thread twill given at B being used for the back fabric. The interlacing diagram of the structure is represented at E, and the interlacing of the fourth face and the fourth back pick at F. It will be seen that the ties on the fourth and eighth face picks are only covered on one side by the face warp. However, as there is the same number of ties on each back end and each face pick, the take up in weaving will be the same for each end, and the contraction in width the same for each pick. A more regular cloth will therefore be produced

than would be the case if no ties were placed on the second and sixth backing ends.

When the threads are arranged in unequal proportions it is frequently impossible for the same number of ties to be placed on each face thread, although it is usually an easy matter to place the same number on each back thread. Thus, in the standard method of tying the 2-face to 1-back arrangement, usually only half the face picks are passed over when the back warp is used for stitching, and only half the face ends are lowered in the alternative system of tying. For instance, the warp ties for the Mayo weave, given at G in *Figure 7.14* are usually distributed as shown at I, the alternate face picks only being passed over by the backing ends. J shows the complete design with the 2-and-2 twill, given at H, as the back weave. The corresponding interlacing diagram of the structure is represented at K. However, by changing the position of the face weave to that shown at L, so that it is situated in relation to the back threads, as indicated at O

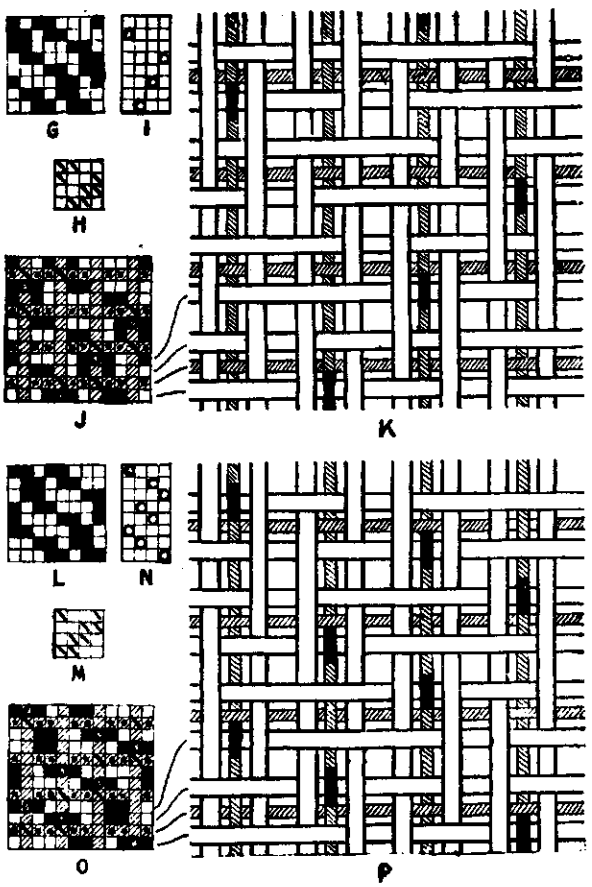

Figure 7.14

in *Figure 7.14*, it is possible for the ties to be distributed as represented at N. In this case, as shown in the design O (for which M is the back weave) and the corresponding interlacing diagram given at P, a tie is placed upon each face

pick. In the repeat of the double weave, however, each back end is stitched twice to the face texture.

The interlacing diagram given at V in *Figure 7.15* shows the standard method of distributing the ties in the 2 face, 1 back arrangement when the face warp is dropped for tying. The corresponding face weave is given at Q, the backing weave at R, and the order of tying at S. When the even face ends only are depressed on the backing picks, they will, in ordinary weaves, be liable to take up in weaving more rapidly than the odd ends. This weave, however, is exceptional in the fact that the odd face ends interweave more frequently with the face picks than the even face ends, there being four intersections in eight picks in the former, compared with two intersections in the latter. This is shown in the section given at W in *Figure 7.15*, in which the dotted line shows the interweaving of the first face end, the solid black line of the second face end, and the

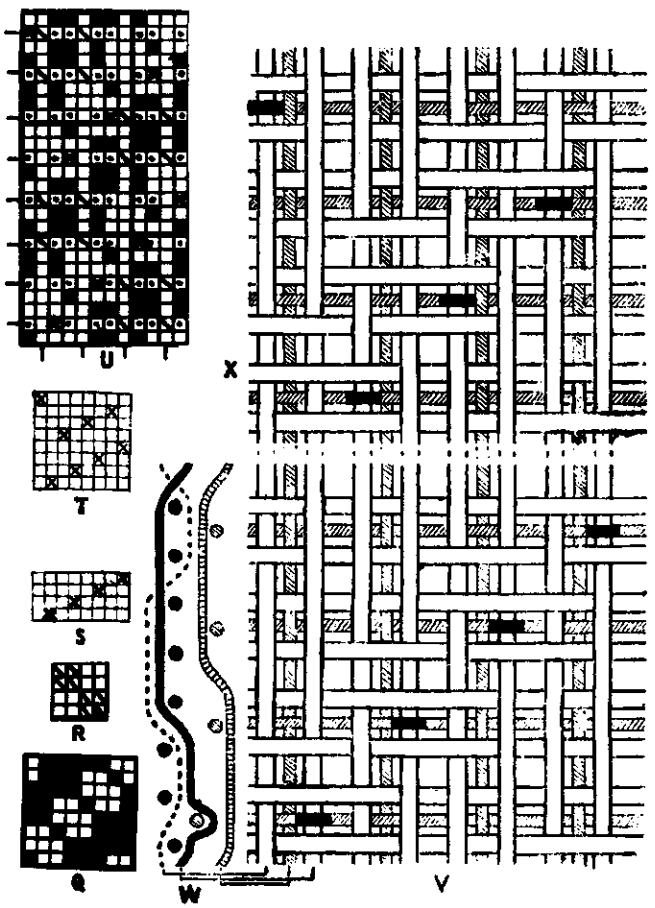

Figure 7.15

shaded line of the first back end. The placing of the ties on the looser woven ends will tend to neutralise the variation in the take-up caused by the difference in the number of intersections between the odd and even face ends. The

distribution given at V in *Figure 7.15* will therefore yield the best results in weaves of this character. However, in order to illustrate a method of stitching on every face end, the interlacing diagram is extended to another repeat of the weave, as shown at X, the ties being placed on the odd face ends in the second repeat in order to balance those which are placed on the even ends in the first repeat. The plan of the ties for the two portions lettered V and X is given at T in *Figure 7.15,* while the complete double weave is shown at U. When the floats of the face weave permit it, this method of distributing the ties may be adopted with advantage for ordinary weaves. The difficulty which is frequently found in the 2 face, 1 back arrangement, of placing a tie on each face end, is one reason why tying by dropping the face ends is usually not so suitable as tying by lifting the back warp. It is better to have the ties unevenly distributed on the face picks than on the face ends, so far as the weaving of the cloth is concerned.

In order that a regular cloth may be obtained, the back weave should be suitable for the back fabric, and similar to the face weave. Thus, the loose face weave given at Q in *Figure 7.15* is backed with the 2-and-2 hopsack weave shown at R. This combination will permit the use of thick backing yarns and yield a soft under texture.

When a twill weave is employed for the face fabric and the ties are distributed in twill order, they should coincide equally with each face warp twill lines in the case of the back warp tying lifts or each face weft twill line in the case of tying by lowering the face ends. If they fall on alternate twills only, as shown in the double-cloth design given at A in *Figure 7.16* adjacent twill lines are liable to appear different from each other. The example is a double 2 up,

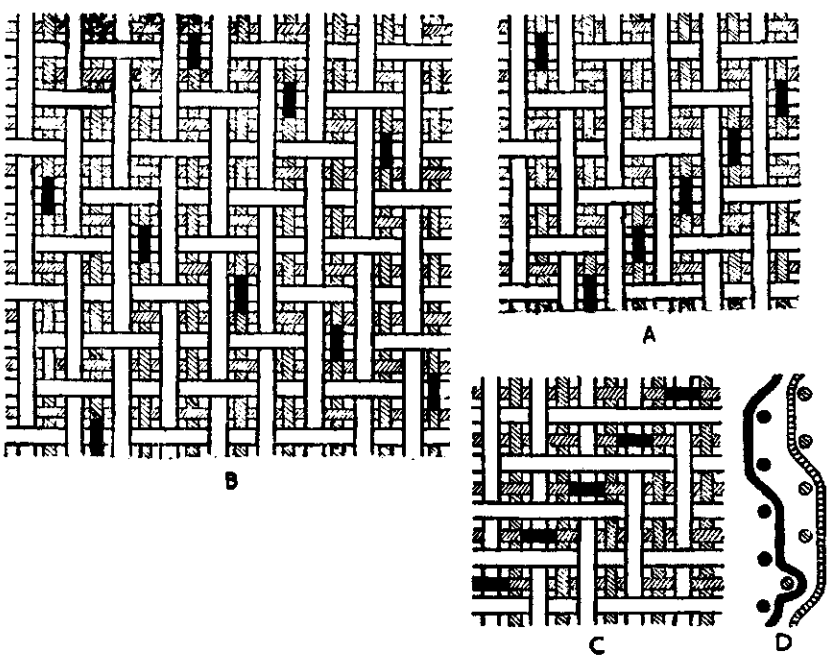

Figure 7.16

1 down twill structure, in which the threads are arranged in the order of 1 face, 1 back in warp and weft, the tying being effected by means of lifting of the back warp. By distributing the ties in 9-sateen order, as shown in the interlacing diagram given at B in *Figure 7.16* the ties will fall equally on each face warp twill line. In the construction B, however, the ties run somewhat distinctly in the opposite direction to the twill of the face fabric, and there is, therefore, a liability of a cross-twill showing in the cloth.

The interlacing diagram C in *Figure 7.16* illustrates that in face warp tying if there is a choice of two consecutive positions for a tie in the face weave, it is, as a rule, better to select that which will be covered by the greater number of following face picks. The section D, representing the interweaving of the first face and the first back end, shows this clearly. The example is a double 2 up, 3 down twill, and the threads are arranged 1 face, 1 back. It will be seen that the first face end may be lowered for stitching either between the first and second face picks, or the second and third. The former position is shown in the illustrations, and is preferable to the latter, because the beating up of two succeeding face covering picks gives a better opportunity of the tie being concealed.

The ties form the connection between the two fabrics in a double cloth, and are thus common to both weaves. Therefore, since it is first necessary for the ties to be placed according to the positions of suitable binding places in the face weave, the back weave should afterwards be suitably placed in accordance with the position of the ties.

There are three positions which a face warp or weft tie may occupy in relation to the floats on the underside of the cloth—viz., between two corresponding floats; with a corresponding float on one side, and an opposite float on the other; and between two opposite floats. Each position is illustrated in *Figures 7.17* and *7.18* which correspond with each other in every respect except that the back warp is raised for tying in *Figure 7.17*, while the face warp is employed for tying in *Figure 7.18*. The threads are arranged 1 face, 1 back in warp and weft, and the 2-and-2 twill weave is employed for both the face and the back of the cloth. In the face fabric the 2-and-2 twill is placed throughout as shown at A in *Figure 7.17*, while the ties are placed to suit the face weave as at B for *Figure 7.17* and as at C for *Figure 7.18*. The back weave, however, is placed in the three different positions given at D, E, and F in *Figure 7.17*. Thus N in *Figures 7.17* and *7.18* shows the flat view of the structure from the face side of the cloth, with the back weave placed as at D; R with the back weave placed as at E; and V, with the back weave placed as at F. Sections O, S, and W respectively show the interlacings of the first face and the first back pick of N, R, and V. The interlacing diagrams P, T, and X in each figure correspond with N, R, and V, and show the appearance of the underside when the cloth is turned over horizontally, as indicated by the numbers above the warp threads. Sections Q, U, and Y respectively show the interlacing with their respective picks of the first face, and the first back end (numbered 1 and 2) of P, T, and X.

It will be noted that in each arrangement the ties will be correctly covered on the face of the cloth by the corresponding face floats between which they are placed. By comparing the diagram N and the section I in each figure with the diagram P and the section Q, it will be seen that with the back weave placed as at D in *Figure 7.17*, the back of the cloth will be as perfect as the face,

because all the four conditions of perfect placement of the ties mentioned earlier are satisfied simultaneously. A comparison of R and S with T and U, however, shows that with the back weave placed as at E, the back fabric will not be so

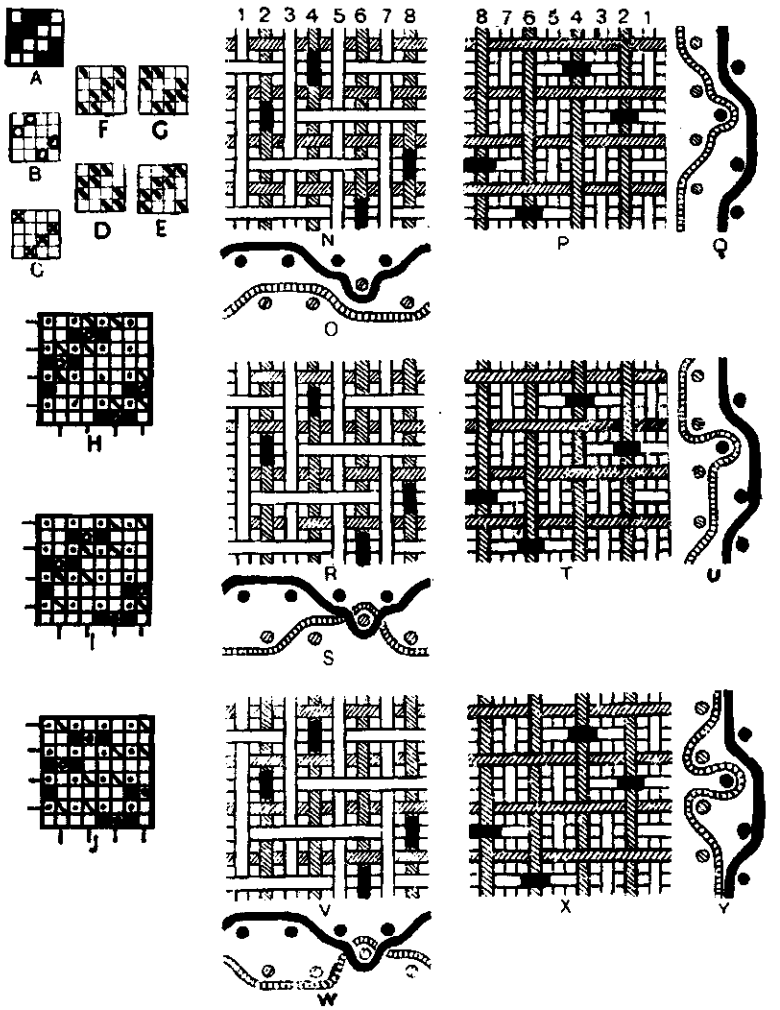

Figure 7.17

perfect as in the former case, because the position occupied by each tie on the underside is between a corresponding and an opposite back float. This kind of defect frequently cannot be avoided, as, for example, when a plain back weave is employed. Although in well set cloths the defect is practically invisible, it should only be allowed to occur when absolutely necessary. A comparison of V and W with X and Y in which the backing weave is placed as at F, shows the most serious defect which can occur in the back fabric. In this case the position occupied by each tie on the underside is between two opposite back floats. When the back warp is employed for tying, this causes the warp floats in the

underside to be broken by the face weft, as shown at Y in *Figure 7.17*, while when the face warp is employed for tying the back weft floats on the underside are broken by the face warp as shown at W in *Figure 7.18*. This not only results in the ties showing prominently on the underside, but as the intersections of the back threads are correspondingly increased, the back fabric is made firmer and harder than it should be.

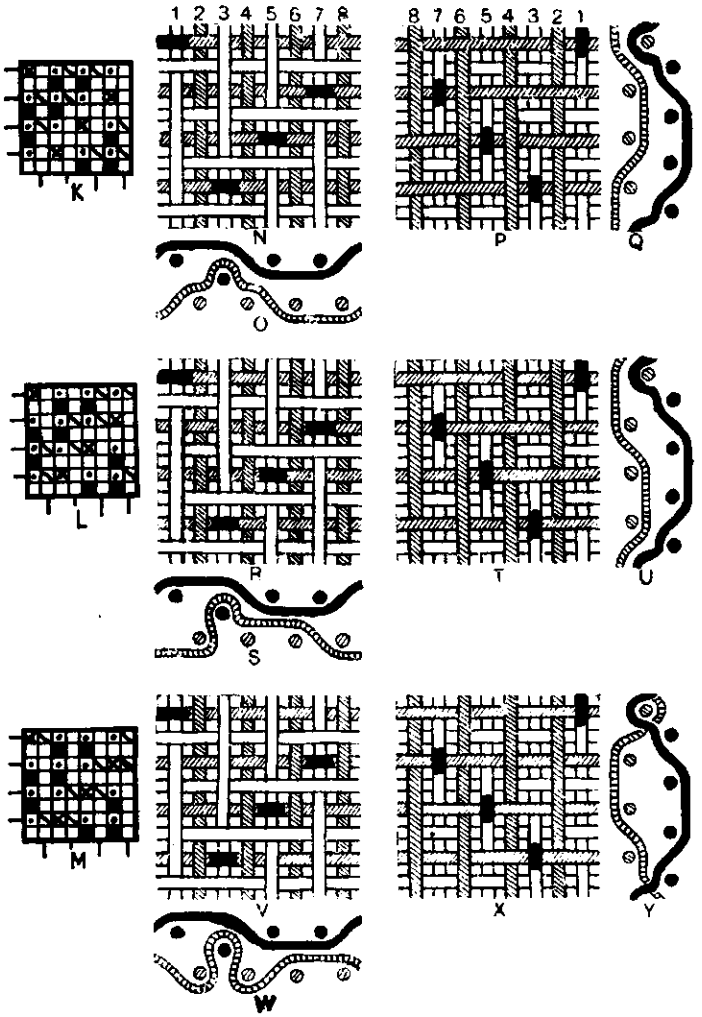

Figure 7.18

The complete plans for the interlacing diagrams given in *Figure 7.17* are shown respectively at H, I, and J. A comparative examination shows that in tying by lifting the back warp the most perfect back fabric is obtained when each back end is raised on the back picks which precede and succeed the face pick on which the tie is placed. In the same way a comparison of the plans given at K, L, and M with the corresponding diagrams in *Figure 7.18* shows

that in tying by lowering the face ends the most regular back fabric results when back ends float under the back picks, one on each side of the face end which makes the stitch (crosses in K, L, and M indicate warp down). The back weave may also be placed in respect of the face weave as shown at G in *Figure 7.17*, but this will produce a similar defect to that produced by placing it as at E.

For some of the simpler standard double cloths in which the ties are distributed in regular order, the position of the back weave in relation to the ties can be reasoned out without difficulty. Thus, in the foregoing example the best result is obtained with the face and back weaves occupying corresponding positions, as shown at A and D in *Figure 7.17*. A weft or warp float on the surface of the upper fabric should be above a similar float on the top side of the under fabric, so that where the two fabrics are in contact, a warp float of one is against a weft float of the other. The best conditions are thereby obtained for the interweaving of the warp threads of one cloth with the weft threads of the other cloth. For example, in a 1 face, 1 back arrangement of the threads, the 4-and-4 twill, shown at A in *Figure 7.19*, may be backed with the same weave in a similar position, as shown at B; while in a 2 face, 1 back arrangement it may be backed with the 2-and-2 twill in the position shown at C. If the threads are arranged in the proportion of 7 face to 5 back, the 3 up, 4 down twill in the position shown at D may be backed with the 2 up, 3 down twill in the position shown at E.

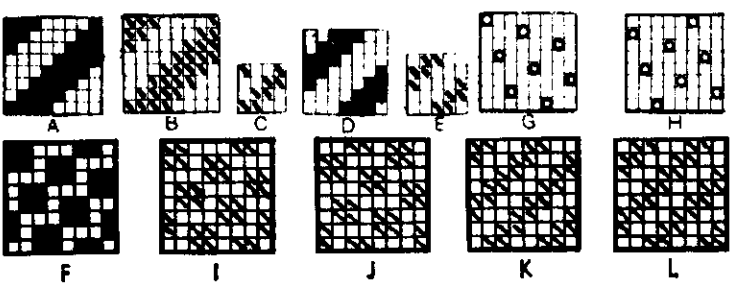

Figure 7.19

In only the simplest cases, however, it may be safely assumed, without experiment, that the best relative position of the back weave has been obtained. Thus, taking F in *Figure 7.19* as the weave for both the face and the back of a 1 face, 1 back double cloth the back warp stitching lifts may be either placed as shown in the plan G, or with the same result, so far as the face of the cloth is concerned, they may be placed one pick lower, as shown at H, the marks indicating back ends raised over face picks. With the ties placed as at G, the most perfect under-fabric will be obtained by commencing the back weave exactly like the face weave, as shown at I, but with the ties placed as at H, it will be necessary for the back weave to be changed to the position shown at J in order to secure the best results. In the same way assuming that the weave F is required to be backed with a 2-and-2 twill, K shows the best position of the weave for tying as at G, while L is the best for tying as at H. It is evident, therefore, that the positions of the face weave, the ties, and the back weave, cannot be decided upon haphazardly, but that they should bear a definite relationship to each other.

WADDED DOUBLE CLOTHS

A wadded double cloth consists of a face and a back fabric, tied together by floating back ends on face picks, or face ends under back picks as in ordinary self-stitched double cloths, with the addition of a special series of weft or warp threads introduced independently of the face and back yarns. The weft-wadded cloths thus consist of three series of weft and two series of warp threads, while in the warp-wadded cloths there are three series of warp and two series of weft threads. The wadding threads lie between the two fabrics, and are visible neither on the face nor back; hence a thicker and cheaper yarn than that used for the face and back may be employed for wadding without the appearance of the cloth being affected. The type of construction is therefore useful in cases where increased weight and substance are required to be economically obtained in conjunction with a fine face texture. The wadding threads may be introduced into any arrangement of the face and back threads, but the common proportions are 1 wadding to 1 face and 1 back, 2 face and 2 back, or 2 face and 1 back. The first arrangement is suitable when the wadding yarn is not so much thicker than the face yarn, and the second and third when very thick wadding is used.

Weft-wadded double cloths

The construction of designs for these cloths is illustrated by the examples given in *Figure 7.20* in which A is the plan of the face weave, and B of the back weave. Since the wadding yarn simply lies between the two fabrics without interweaving with either, the same conditions are necessary, so far as regards the face weave, the ties and the back weave, as in the construction of ordinary double cloths.

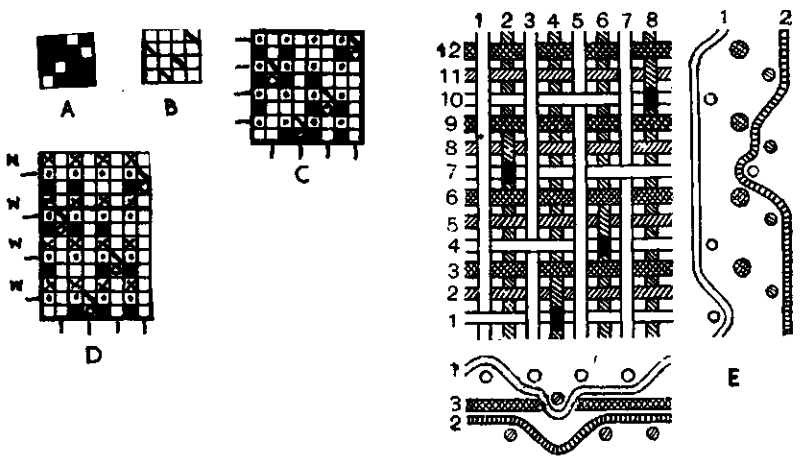

Figure 7.20

The wadded design is therefore exactly the same as the ordinary double design except for the inclusion of the wadding threads; and in order that comparisons may be made, the double weave without the wadding is given at C. In the complete design, given at D the solid squares indicate the face weave, the circles

the ties (back warp up on face picks), the diagonal marks the back weave, the dots the face ends up on the back picks, while crosses are inserted to show the lifts of the wadding threads. It will be noted that in weft-wadded structures all face ends are up, and all back ends are down, on wadding picks.

In the interlacing diagram given at E in *Figure 7.20*, which corresponds with the complete design shown at D, the back and the wadding threads are shaded in different ways in order that they may be readily distinguished. The wadding threads are also represented as being of a larger diameter than the face and back threads. In the interlacing diagrams the threads, for convenience, are

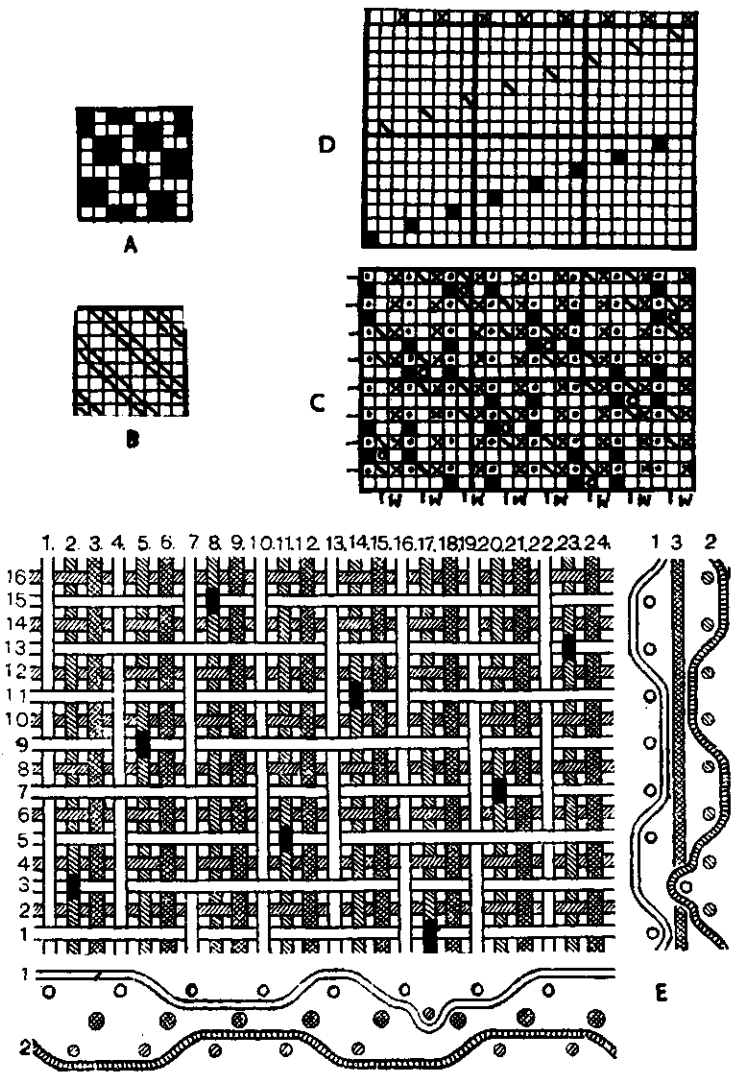

Figure 7.21

placed alongside each other at approximately uniform distances apart in the same order as in the designs. The positions of the ties are indicated by the solid marks.

In the example given in *Figure 7.20* the picks are arranged in the order of 1 face, 1 back, 1 wadding; and the ends 1 face, 1 back. The 4-thread satinette weave, warp surface on both sides of the cloth, is employed, the tying being effected by raising the backing ends in a similar order over the face picks. In the corresponding sectional views, the section on the right of the interlacing diagram shows the interweaving of the ends 1 and 2, and that below of the picks 1, 2, and 3.

Warp-wadded double cloths

The wadding yarn is more economically and conveniently introduced in the warp than in the weft but the greater strain put on the warp threads in weaving necessitates the use of a better quality of wadding material. The construction of the designs is illustrated in *Figure 7.21* in which the face and back weaves are given at A and B respectively, while the complete design is given at C and the draft at D.

In the corresponding interlacing diagrams at E the ends are arranged in the order of 1 face, 1 back, 1 wadding, and the picks 1 face, 1 back. The face weave is the 8-thread twilled hopsack, the back weave is 2-and-2 twill, and a sateen order for back warp tying lifts is used. In the warp-wadded structures the wadding ends must be raised on all back picks and left down on all face picks.

The draft for the design C in *Figure 7.21* is given at D. The wadding ends require only one heald, but in fine setts, to avoid crowding, they may be drawn on two or more healds which are then operated as one.

The introduction of wadding threads increases the strength of a double cloth in the direction of the wadding yarn; and sometimes, for the purpose of obtaining increased firmness the wadding threads are stitched to the double cloth, these stitches being placed next to the ordinary stitches in order to minimise their effect. Thus, in stitching the wadding weft in *Figure 7.20*, each back end would pass over the wadding pick which precedes the normal stitch. In *Figure 7.21* wadding ends would also lift over the face picks on the right of each backing warp stitch.

CENTRE-STITCHED DOUBLE CLOTHS

In wadding a double cloth the chief object is to get a heavy structure by introducing a yarn which is usually thicker and cheaper than the face and back yarns. In centre stitching, however, although the threads may be introduced in the same order as in wadding, and additional weight thereby be obtained, the specific purpose is to bind the two fabrics together with the centre threads, which as a rule are finer than either the face or backing threads. In this system the threads of one fabric do not interweave with those of the other fabric; the centre threads oscillate between one and the other, and lie between them when not employed for tying. The two fabrics are less firmly united than with the

self-stitching, and the cloth has a softer and fuller handle. It is a useful method for cloths in which there is a great difference either in the thickness or the colours of the face and back yarns, such as overcoatings in which a check lining is woven with the face fabric, and heavy cloaking and mantle cloths which are made with coloured checks on one side and solid shades on the other. In such cloths the ordinary method of tying is not suitable, as the contrast in colour and the difference in thickness between the face and back yarns make the ties liable to show.

In the accompanying interlacing diagrams the back and centre threads are shaded in different ways, and the latter are also represented as being of smaller diameter than the face and back threads. The face and back weaves are given separately for each example. In the complete designs the solid squares indicate the face weave, the diagonal marks inclined to the left the back weave and the dots the face ends up on the back picks. The lines at the side and below the designs indicate the positions of the back threads and the centre-stitching threads are denoted by an 'S'.

Centre-warp stitching

In centre-warp stitching the following procedure needs to be observed: (a) Where no ties occur the centre warp lies between the face and the back fabric and, therefore, must be lowered on the face picks and raised on the back picks. These separating lifts are indicated in the designs by the dots. (b) In tying to the face cloth the centre ends are raised over the face picks where these are absent from the face, i.e., where they are covered by two adjacent floats of the face warp. These tying lifts are indicated by the circles in the designs. (c) In tying to the back cloths the centre ends are lowered on the back picks where these are absent from the underside, i.e., where they are covered on the underside of the back cloth by two adjacent floats of the back warp. These tying positions are represented by the crosses in the designs and indicate centre warp down.

Thus, the instructions in respect of all the designs are: Peg or cut all marks except the crosses.

The plans in *Figure 7.22* are illustrative of the construction of double cloths arranged 1 face, 1 back, in which the two fabrics are stitched together by means of centre warp. The design D is a double 2-and-2 twill, the face weave being as at A, and the back weave as at B, while the ends are arranged in the proportion of 4 face and 4 back to 1 stitching, as indicated at D. The interlacing diagram C corresponds with the design D, the section on the right of the flat view showing the interweaving of the ends 7, 8, and 9, and that below of the picks 2 and 3.

As each repeat of the double weave given at D contains only one stitching end, the ties always occur in the same line, both on the face and back of the cloth. A better arrangement is given in the design E, in *Figure 7.22*, in which the ends are in the proportion of 2 face and 2 back to 1 stitching. The face weave and the back weave are the same as in the design D. In this case there are two stitching ends in one repeat of the double weave, which not only causes the fabrics to be more firmly united, but enables an alternate distribution of the ties to be made. This is clearly shown in the corresponding interlacing diagram

given at F. The section on the right of the flat view shows the interweaving of the ends 3, 4 and 5, and that below of the picks 2 and 3. The draft is given at G, and the lifting plan at H.

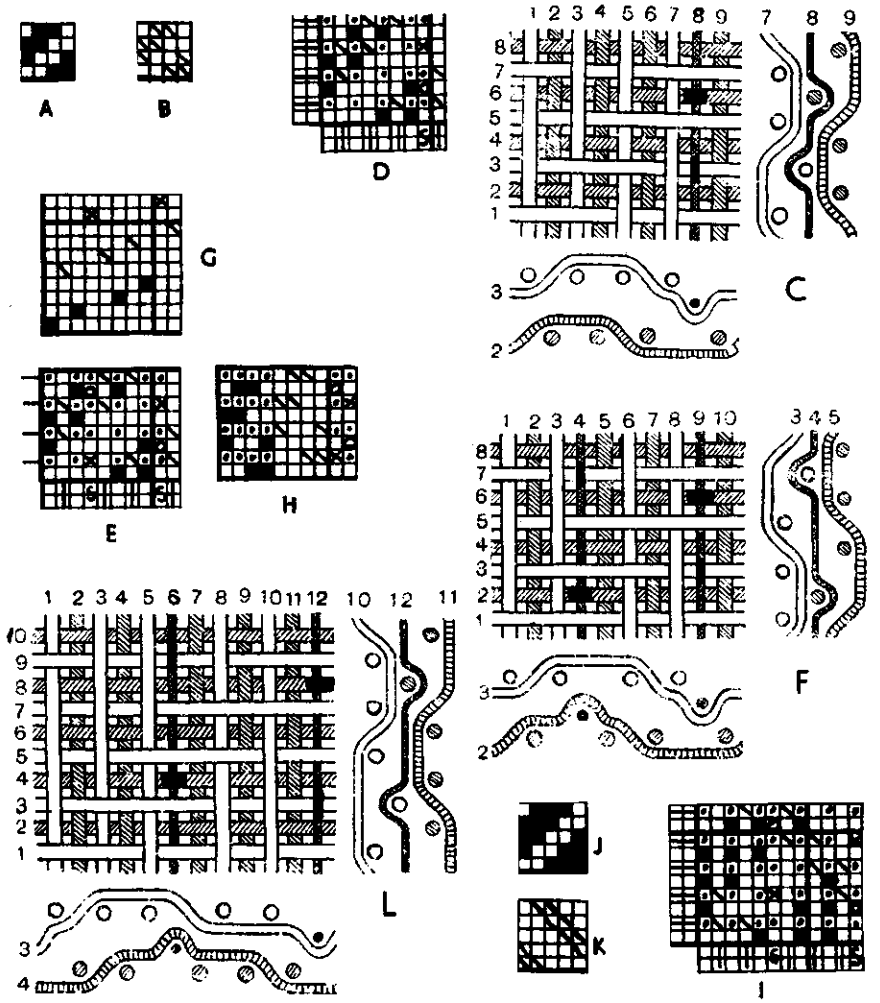

Figure 7.22

The design I in *Figure 7.22* is a 3 up, 2 down twill weave backed by a 2 up, 3 down twill with two stitching ends in each repeat. In this example the face and back weaves (given at J and K respectively) are so arranged that the direction of the twill line when the piece is turned over is the same as on the face side, the cloth being thus perfectly reversible. The corresponding interlacing diagrams are given at L, the section on the right of the flat view showing the interweaving of the ends 10, 11, and 12, and that below of the picks 3 and 4. As shown here, in centre-stitched cloths the back weave requires to be placed in such a position in relation to the face weave that the ties on each stitching thread will be about

half the repeat distant from each other. Thus the second stitching end (end number 12) at L is raised for tying on the third pick, and depressed half the repeat distant on the eighth pick.

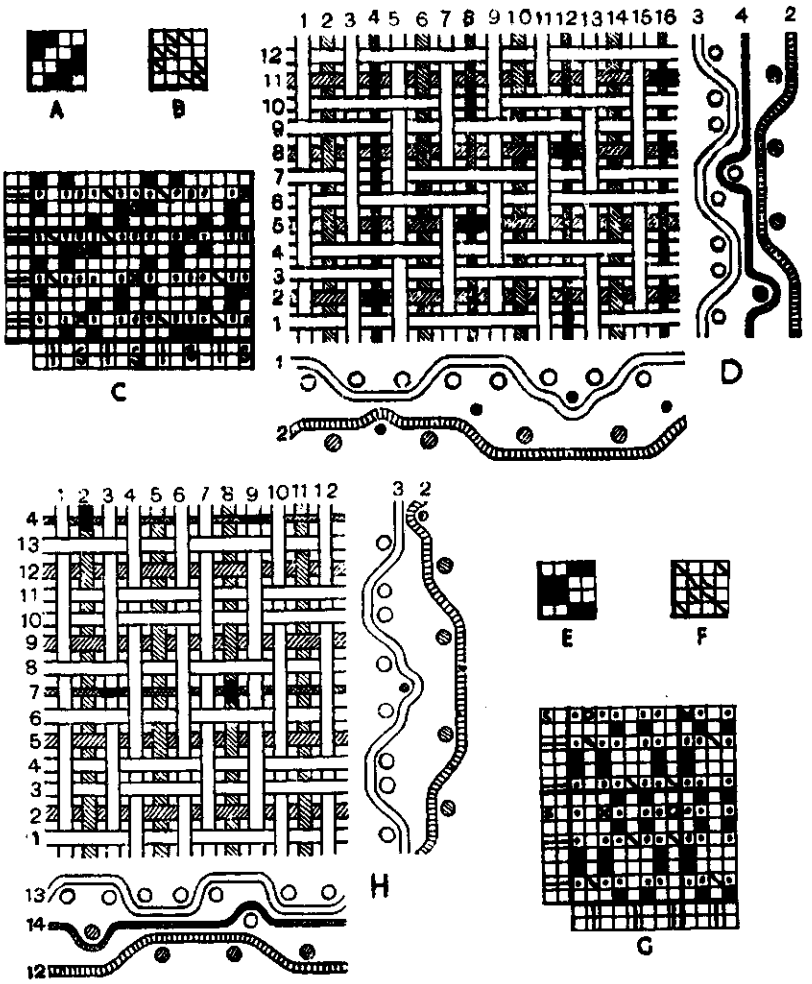

Figure 7.23

An example is illustrated at A to C in *Figure 7.23,* in which the proportion of face threads to back threads is 2 to 1, an arrangement which permits the use of very thick yarns in the under-fabric. C is a double 2-and-2 twill, with the face weave as at A, and the back weave as at B. The tying is effected by means of four centre ends in the repeat, the complete order of warping being 1 face, 1 back, 1 face, 1 centre, as shown at C. The corresponding interlacing diagrams are given at D in *Figure 7.23,* the interweaving of the ends 2, 3, and 4 being shown on the right, and of the picks 1 and 2 below the flat view. The example shows how a tartan-lined overcoating cloth is constructed. The tartan-check side is composed of the finer yarns, and is taken as the face in weaving, although in

the made-up garment it forms the back; while the solid side consists of the coarser fabric which forms the back in weaving and the face when made up.

Centre-weft stitching

This form of stitching is not very often used as it reduces the rate of cloth production. This is due to the fact that when the centre weft picks are introduced the take-up must be rendered inoperative and thus the picks do not contribute to the length of cloth being produced. In constructions in which the use of centre stitching threads is essential it is, therefore, preferable to use the centre warp stitchers. However, there are some situations which make it necessary to use the centre weft and one reason for the use of this method occurs when all the existing jacks in a dobby are required to operate the face and the back healds and none are left to control the centre warp ends. Occasionally the centre weft is also used if the mounting of an extra beam required by the centre warp threads presents a particular difficulty in respect of the control or access to the warp yarns.

In using centre-weft stitching the following procedure needs to be observed: (a) Where no ties occur the centre weft lies between the face and the back cloth. To achieve this on centre weft picks the face ends are raised (as indicated by the dots in design G, *Figure 7.23*) and the back ends are lowered. (b) To achieve a face fabric stitch a face end must be dropped on a centre pick at a point at which it is absent from the surface, i.e. when it is covered by two adjacent floats of the face weft. This is indicated in the design G by the crosses. (c) To achieve a back fabric stitch a back end is raised on a centre pick at a point at which it is absent from the underside of the cloth, being covered by two adjacent floats of the back weft. This is indicated by the circles in the design G. Thus, the lifting instructions for the design G are: Peg or cut all marks with the exception of the crosses.

The plans E to G in *Figure 7.23* illustrate the principle of stitching by means of centre weft. The double 2-and-2 hopsack weave is employed, the face weave being given at E, and the back weave at F. The picks are in the proportion of 4 face and 2 back to 1 stitching as indicated at G, one repeat of the double weave thus containing two centre picks. The complete design is given at G, and in the corresponding diagrams represented at H, the interweaving of the ends 2 and 3 is shown alongside, and of the picks 12, 13, and 14 below the flat view.