

WOOLEN AND WORSTED PLY
WEAVES

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WOOLEN AND WORSTED PLY WEAVES

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INTRODUCTION

1. In the manufacture of woolen and worsted fabrics, and especially in the production of the former, it is often desired to make a heavier and warmer fabric than is possible when only two systems of yarns are employed, as in single cloths. Since it is desirable to produce a fabric with a fine face, the additional weight cannot be obtained by increasing the size of the yarns; nor is it feasible to increase the number of ends and picks in the fabric, because of the difficulty in weaving and the impossibility of making a level cloth. It therefore becomes necessary to add one or more systems of yarn, either of warp or filling or both, to the back of the cloth, thus producing what is known as a **ply fabric**. Ply fabrics are also often manufactured for the purpose of producing a cheap fabric that will have the weight of more costly cloths. This is readily accomplished by using cheaper yarns for that portion of the fabric that constitutes the back of the cloth; in this manner, the weight is gained, and a thicker and more substantial cloth produced at only a slightly increased cost, and without injuring the quality or appearance of the face of the goods.

2. Classification of Ply Fabrics.—There are two general classes of fabrics to which extra yarn is added for the purpose of giving thickness, weight, and warmth. The first class includes those fabrics to which only one system

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of yarn is added (that is, cloths with a *backing* warp or filling); these are known as **backed cloths**, and are divided into *warp-backed fabrics* and *filling-backed fabrics*. The second class includes fabrics constructed of two or more distinct cloths stitched, or bound, together at intervals and consisting of two or more distinct series of both warp and filling; this class of fabrics includes *double* and *triple cloths*, which are made not only for gaining weight and warmth, but also, in many cases, for producing a double face on the goods, or to obtain two distinct effects, one on each side of the cloth. In a fabric of the latter description, the face of the cloth may be of a solid color, say blue, while the back of the fabric, which will form the lining of the garment when the cloth is made up, may show a plaid pattern, or vice versa. Such goods as these are frequently used for golf capes and overcoats, the fabrics being often three-ply cloths. Double cloths are largely used for suitings, both worsted and woollen, while backed fabrics are also used for suitings, trouserings, etc. to a large extent.

All fabrics having two or more systems of both warp and filling do not, of necessity, have the same number of systems of each, some having three warps and two fillings or three fillings and two warps, etc. Yarn added in this way to pure double or triple cloths is usually for tying purposes if warp yarn, and for wadding if filling yarn, to make the cloth heavier. Such fabrics could truly be called two-and-a-half-ply fabrics, etc.

BACKED FABRICS

FILLING-BACKED FABRICS

3. *Filling-backed cloths* are the simplest in structure of all ply fabrics, being somewhat simpler than warp-backed fabrics, since the latter involve special methods of constructing drawing-in and chain drafts. A **filling-backed fabric** may be considered as a single cloth consisting of one warp and one filling, but having bound, or tied, to the back an extra system of filling threads that are interlaced with the face cloth just enough to keep them attached and prevent their forming long, loose floats on the back of the cloth. This effect is obtained by so raising the warp yarn that when the face filling is inserted it will interlace with the warp according to the weave desired on the face of the cloth. When the pick of backing filling, however, is placed in the cloth, the whole warp is raised, with the exception of those ends that are depressed, in order to bind, or tie, the backing filling to the face cloth. This has the effect of making the pick of backing filling float on the back of the cloth, except where it passes over the few ends that tie it to the cloth. The method of attaching the backing yarn to the cloth is known as *binding*, *tying*, or *stitching*, and the places where the backing yarns are interlaced with the face cloth are known as the binding points, stitching places, tying points, ties, etc. These tying places should be so arranged that the backing filling will float over the warp thread between two floats of the face filling over the same end. The object of this is to cover the tying places so that they cannot be seen on the face of the cloth, the two floats of the face filling, one on each side of the float of backing filling on the face, crowding over the backing pick and thus hiding it from view.

Not only should the tying places be so arranged as to be

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invisible on the face of the cloth, but they should also be distributed uniformly throughout the fabric so that the cloth will not cockle or finish unevenly. The best method of distributing the tying places is in satin order, as by this means not only are they evenly distributed, but all liability of the binding points forming twill lines on the face of the fabric is obviated. Many weaves, especially those constructed on a satin basis, can usually be tied in satin order when backed with warp or filling.

Although the method of distributing the tying places in satin order is the most satisfactory, because of the scattered, yet uniform, distribution of the interlacings of the backing filling with the warp, it often happens that the character of the face weave is such that the tying places cannot be distributed in this manner, and at the same time have each occur between two flushes of the face filling. When such is the case, it is always better to adopt some other system of binding rather than run the risk of having the backing yarn show on the face of the goods. The designer should always distribute the tying places as evenly and uniformly as possible; if not in satin order, then in some other regular order, so that each end will be depressed under the backing filling the same number of times. This is not so important when the backing filling is comparatively fine as when a coarse, heavy backing yarn is used. Sometimes a weave may be tied to advantage in broken crow order.

4. Filling-backed fabrics are made with 1 pick of face and 1 pick of back, with 2 picks of face and 1 pick of back, and also with 2 picks of face and 2 picks of back, etc. As filling-backed fabrics necessitate the use of two fillings, a box loom must be employed for their production, unless the same yarn is used for the backing filling as for the face filling. However, this is not usually the case, as the backing yarn is generally softer twisted, in order to give the fabric a soft, warm feeling, and in the majority of cases is also composed of cheaper material, and often of coarser yarn.

Weaves with 2 consecutive picks of face and 2 of back are necessary in case the cloth is woven in a loom with extra boxes on one side only, since with this type of loom it is not possible to put in a single pick of filling, as the shuttles always come to rest on the side of the loom that has the changeable boxes. Fabrics that have a single pick of backing filling require a pick-and-pick box loom, with changeable boxes on each side, unless, as previously stated, the backing filling is of the same yarn as the face filling. When, as is often the case, coarser yarn is used for the backing than is used for the face filling, the fabric should be made with 1 pick of backing and 2 picks of face, and sometimes in extreme cases 3 or even 4 face picks should alternate with 1 backing pick.

With filling-backed fabrics, it is impossible to form any fancy effects on the back of the fabric; and, in fact, this is not desired, the main object being to obtain a heavy- or medium-weight fabric, yet with a fine face produced with yarns of comparatively high numbers.

5. When making weaves for filling-backed fabrics, the first step is to indicate the face and backing picks on the design paper, in order that they may not be mistaken and the weaves placed on the wrong picks. If the design is to be composed of 1 pick of face alternating with 1 pick of backing, it is better to start at the bottom of the design and make the first pick a face pick. The second pick should be made a backing pick, and so on until sufficient picks on which to place the design have been marked. When a fabric is to be composed of 2 face picks alternating with 1 backing pick, it is customary to mark off the design paper 1 face, 1 back, 1 face. When the weave is made with 2 face and 2 back, it may be laid out 1 face, 2 back, 1 face. The above methods, of course, make no real difference in the weave and are not always used by any means. They are mentioned only in order that it may be understood that although the first pick of the weave may be a face pick and the next a backing pick, it may be laid out with 2 face picks alternating with

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1 backing pick, since the next 2 picks may be face picks. When making a filling-backed weave of any description, care must be taken to have both the face and backing weaves evenly repeated on the face and backing picks, respectively. The method of backing must also be carefully considered in this connection; that is, whether the weave is arranged 1 face and 1 back or 2 face and 1 back, etc.

6. To illustrate the method of constructing filling-backed weaves, suppose that it is desired to back the 8-harness twilled basket weave shown in Fig. 1 with filling, the cloth to be woven with 1 pick of face and 1 pick of backing filling. The complete weave will require 16 picks, 8 picks for the face weave and 8 picks for the backing weave. The first operation in constructing the weave is to indicate which are to be the face and which the backing picks. This may be done in any convenient manner, it being advisable for a beginner to shade the backing picks with a pencil; in Fig. 2, the backing picks are indicated by the pink-shaded squares. The next step is to place the face weave (in this case Fig. 1) on the picks that have been indicated (in Fig. 2) as face picks. The method of doing this is shown in Fig. 3, and it should be carefully noted that as yet the backing picks remain unmarked. The pink-shaded squares in Figs. 2 and 3 do not represent the warp as lifted, but simply indicate which picks are the backing picks. The next operation is to place risers on the backing picks, raising all the warp ends except such as are left down to bind the backing filling to the fabric, thus, in reality, forming a backing weave. The method of accomplishing this is shown in Fig. 4, in which the backing weave is shown by red squares and where it will be seen that the warp ends are depressed to form the tying, or binding, points at those places where the face filling will float over the same end before and after the backing pick. Thus, the filling floats of the first and third picks will cover the tying place on the second pick, and similarly, throughout the whole design, each tying place will be covered by the face filling. It should also be noted that the tying places are

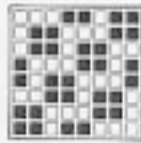


FIG. 1



FIG. 2



FIG. 3



FIG. 4



FIG. 5

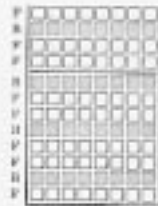


FIG. 6

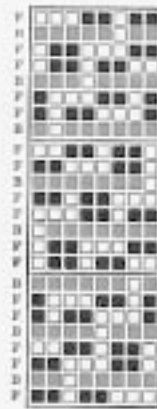


FIG. 7

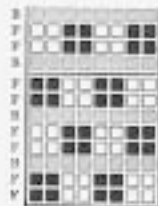


FIG. 8



FIG. 9



FIG. 10

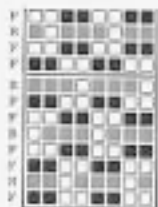


FIG. 11

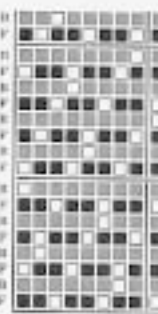


FIG. 12

distributed in 8-end satin order, thus forming a perfect filling-backed weave. Both black- and red-filled squares, in Fig. 4, represent the warp raised over the filling.

In Fig. 4, the backing filling is bound into the cloth only once in 8 ends, but it is possible in this design, if a firmer fabric is desired, to increase the number of tying places, thus making the floats of the backing filling shorter. This may be done, as shown in Fig. 5, by arranging two tying places on each pick. In this weave, it will be noticed that the same perfect structure is retained, and that each end of the warp is depressed under the backing filling the same number of times, thus insuring equality of take-up in weaving.

Suppose that it is desired to back the same weave, Fig. 1, with a coarser backing filling, the cloth to be arranged with 2 picks of face and 1 of back. The design paper may be shaded off as shown in Fig. 6 and the weave constructed on the principles previously explained. In this case, however, only 12 picks will be required for the complete weave, 8 face and 4 backing picks. In order that each end of the warp shall take up the same in weaving, two ties must be placed on each backing pick and so arranged that each end will be depressed under the backing pick once; this is accomplished in Fig. 7, which represents Fig. 1 backed as stated. If it were desired to back the 8-harness twilled basket with filling having the weave arranged 2 face and 1 back and having the backing filling tied only once in 8 ends, it would be advisable to repeat the weave, as shown in Fig. 8, since by no other means would it be possible to have a tying place on each end. If, as is often the case, a face weave complete on a few ends and picks is used and it is desired to tie the backing filling loosely, repetition of the weave is necessary; while in many other instances repeating the weave will enable a more perfect tying arrangement to be used.

7. In arranging the face weave, it is important in many cases to consider its best relation to the backing weave. For instance, suppose that it is desired to back the 4-harness basket weave with filling and that the weave is placed on

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design paper as shown in Fig. 9; in this case, there is no place where the backing can be raised for binding without having the warp up on one side, and, as previously explained, the stitching is liable to show on the face of the goods unless covered by face-filling floats. If, however, the face weave is placed on the design paper, as shown in Fig. 10, the backing can readily be stitched to the face, as shown, without any danger of its appearing on the surface. The back weave in this case is the broken crow weave.

Weaves that have a large percentage of warp on the face, especially warp-flush twills, are the hardest to back with filling, on account of there not being places in the weaves where perfect tying places can be arranged. When such weaves are backed with filling and it is impossible to have a face-filling flush on each side of the tying place, the design should be so arranged that the flush of face filling that is beside the tying place will follow rather than precede the tie. When the face-filling flush precedes the binding point, the tie will show up prominently on the face of the goods; but when the face flush follows the tie, the reed of the loom will push the face pick over the raised backing pick. This method is employed in Fig. 11, where the warp-flushed prunelle twill has been backed in the filling with the 9-harness satin. When filling-flush weaves are backed with filling, the tying places should be arranged as near the center of the face-filling floats as a regular system will allow, in order that the tie may be as well covered as possible.

Considerable ingenuity must occasionally be employed in tying the backing filling to the cloth, especially in cases where a coarse backing filling must be used and it is desirable to arrange the tying places so that each warp end will be depressed under the backing filling the same number of times. In fact, almost every weave requires some particular system of tying, and each should be carefully considered, in order to determine how it can be tied to the best advantage.

8. Fig. 12 shows the 10-end regular twill $\frac{5}{2}$ backed with filling, the weave being arranged 2 picks of face and 2 of

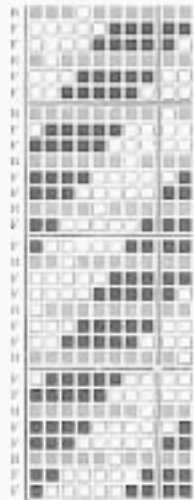


FIG. 12



FIG. 15

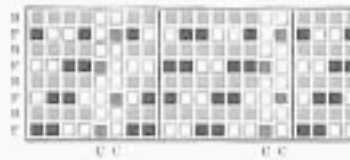


FIG. 14

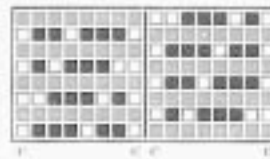


FIG. 16



FIG. 17



FIG. 18

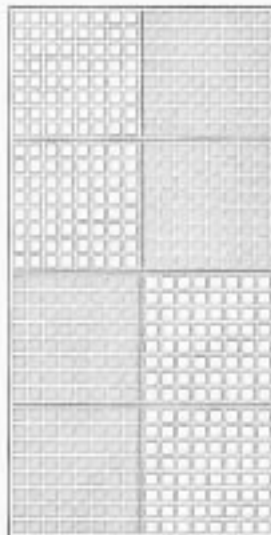


(a)

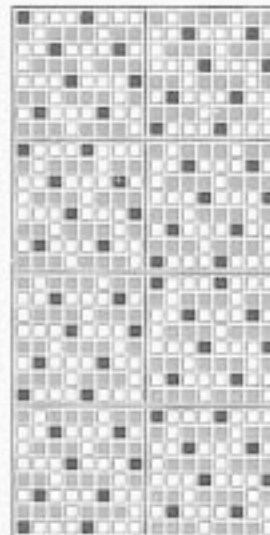


(b)

FIG. 19



(a)



(b)

FIG. 20

back. The method of tying the backing filling should be particularly noticed in this design, as well as the arrangement employed in Fig. 13, which represents 2 repeats of the same twill backed with filling and arranged 2 face and 1 back. The tying places are arranged in two twill lines, being alternated so that each backing pick is tied once in the repeat of the weave and each end contains one tying point.

CUT FILLING-BACKED FABRICS

9. Cut filling-backed fabrics are generally made for trousering or suiting patterns and show on the face of the goods a fine *cut mark*, or indentation, running usually in the direction of the length of the piece. This cut mark is commonly produced by allowing the backing filling to float over certain ends of the warp throughout the weave; this also binds the backing filling to the cloth. When the cut marks are to be near together, it is usually unnecessary to bind the backing filling to the cloth in any other manner; but if the stripe between the cut marks is to be wide, it is advisable to bind the backing filling in the ordinary manner, in addition to where the cut is to be formed. Generally two cutting ends are used, and although both are depressed on every backing pick, they are usually arranged to work in plain order with the face picks.

In Fig. 14, the cassimere twill is shown backed with filling and arranged to form a stripe of 8 ends and then a cut. The backing filling floats over both cutting ends, which, however, as shown by the blue risers, work in plain order with the face filling.

If desired, the cut may be made to run diagonally across the cloth instead of lengthwise. This is sometimes done when backing twill weaves, the backing filling being arranged to float over the warp in the same direction as the twill of the face weave, thus making the cut accentuate the boldness of the twill. Fig. 15 shows the 8-end twilled basket weave backed with filling in such a manner as to make a diagonal cut mark.

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10. When all the filling is of the same material, another method of producing cut marks may be employed. The filling yarn is brought to the face in one section, or stripe, and interweaves with the warp according to the face weave, while in the other section the same pick is allowed to float on the back of the cloth as a backing pick. Fig. 16 shows a design constructed on this principle, the face weave being the $\frac{3}{1}$ regular twill. The first pick is a face pick for the first section of 8 ends and then it passes to the back of the cloth and becomes a backing pick for 8 ends, when it comes to the face again. In the same manner, the second pick is a backing pick for 8 ends and then a face pick for 8 ends. In this way, a cut mark is made at the first and sixteenth and the eighth and ninth ends, where the filling is reversed. If a prominent cut mark is desired, the face weave should not be placed on the cutting ends, which should be left as shown in Fig. 16. Each pick is as much a backing pick as a face pick and vice versa, so that if a fabric of uniform appearance is to be made, the filling must all be of uniform size and quality.

FILLING REVERSIBLES

11. When filling-flush weaves are backed with filling interlacing with the warp after the same manner as the face filling, a reversible, or double-faced, fabric is formed having the same appearance on both sides; that is, if both fillings are of the same material and color. Satin weaves are generally used for these designs and the cloths are known as **satin reversibles**. Twill weaves are also used. In cloths of this description, the warp yarn is entirely concealed, being embedded between the two fillings, and consequently is usually of a cheaper material, cotton warps being largely employed.

Fig. 17 shows a 5-end satin reversible, which, if woven, would have a filling-flush satin face on each side of the cloth. If this weave is picked 1 black and 1 red, the face of the cloth will be black and the back red, since each color will show only on one side. Fig. 18 is a filling reversible weave with

the $\frac{1}{2}$ twill running to the right on each side of the cloth. When making weaves for this class of fabrics, the backing weave should be twilled in the opposite direction to the face weave, in order that it may run in the same direction when the cloth is turned over. In Fig. 18, it will be noticed that two of the tying places are not perfect; however, they have been arranged so that the face filling flush follows the tying point instead of preceding it. Then again as the backing and face filling in this class of fabrics are usually of the same material, there is not so much danger of the tying showing prominently on the face of the goods; that is, if the face filling and the backing filling are of the same color, as well as of the same material.

12. Figured Filling Reversibles.—Designs for figured filling reversibles are usually made, according to a given motive, with two filling reversible weaves, one arranged to throw the odd-numbered picks on the face and the even-numbered picks on the back, and the other arranged to produce the opposite effect. Thus, if the weave is picked, say, 1 white and 1 green, the motive will be reproduced in white on a green ground on the face of the goods, and in green on a white ground on the back of the cloth, or vice versa. Since the warp is entirely hidden in the fabric, cotton warps are commonly used and the fillings are of equally good quality. Any two filling reversible weaves may be used in constructing designs of this description, but those complete on a small number of ends and picks are to be preferred if the motive is comparatively small. Take, for instance, Fig. 19 (*a*) and (*b*). In both of these weaves, the filling-flush broken crow weave is backed with filling tied in broken crow order; in other words, both are filling reversibles. In (*a*), however, the odd-numbered picks are the face picks and the even-numbered picks the backing picks, while in (*b*) the reverse is the case; so that if these designs are woven, say, 1 white and 1 green, (*a*) will produce a cloth white on the face and green on the back, and (*b*) a cloth green on the face and white on the back. It will be seen, therefore, that

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these two weaves may be combined to produce figured effects.

The arrangement of the weaves, as already stated, is usually accomplished according to a given motive. Suppose, for instance, that a simple checker-board effect, with square figures arranged in plain order, is desired; then all that is necessary is to lay out the motive the required size, and place the weave shown in Fig. 19 (*a*) on it, and that shown in Fig. 19 (*b*) on the ground, or vice versa. When arranging the motive for the reception of the weaves, it should be enlarged twice as much filling-way as warp-way, since filling-backed weaves arranged 1 face and 1 back require twice as many picks as ends to give the same number of face or backing picks as ends, or, in other words, to give a squarely built texture to the face and back. If the motive were not laid out in this manner, the length of the check or other figure, as the case might be, would be reduced one-half, which would cause it to appear distorted. The assumption in this case is, of course, that it is desired to construct the cloth with as many face or backing picks as ends per inch; if, however, the proportion of face or backing picks to ends is different, the weave must be constructed accordingly, in order to retain the symmetry of the motive. Fig. 20 (*a*) shows a motive for a checker-board effect, the light-blue-shaded squares indicating the motive and the blank squares the ground. Fig. 20 (*b*) shows the check effect constructed with the weaves shown in Fig. 19 (*a*) and (*b*), Fig. 19 (*a*) being placed on the motive and Fig. 19 (*b*) on the ground. If this design were woven with 1 pick of white and 1 pick of green filling, a white-and-green check would be made on both sides of the cloth, which would be of the reversible type, the green portion on the face covering a white check on the back, and vice versa. Other weaves than Fig. 19 (*a*) and (*b*) may easily be made, and any suitable motive may be used as a basis for combining them to produce figured filling reversible cloths.

EXAMPLES FOR PRACTICE

1. Construct a filling-backed weave arranged 1 face, 1 back, using the $\frac{4}{4}$ regular twill as a face weave and tying the backing filling perfectly on each warp end.
2. Make an 8-end satin filling reversible weave arranged 1 face and 1 back.
3. Back the cassimere twill with filling, the weave to be arranged 1 face, 1 back, and to be capable of being woven on 4 harnesses.
4. If a 12-end regular twill is backed with filling, the weave being arranged 1 face, 1 back, 1 face, on how many ends and picks will the design be complete, supposing that only 1 repeat of the face weave is shown?
5. Back the $\frac{2}{2} \frac{2}{2} \frac{1}{1}$ regular twill with filling, arranging the weave 1 face, 1 back. Tie each backing pick once in 10 warp ends.
6. Back the $\frac{3}{1}$ twill twilled to the left with the 8-end satin, arranging the design 1 face, 1 back, and being careful to have the float of face filling follow, rather than precede, the tying point.

WARP-BACKED FABRICS

13. Warp-backed fabrics are cloths constructed with one system of filling yarn and two systems of warp yarn, in which one system of warp interlaces with the filling to form the face of the cloth, while the other floats on the back of the cloth for the purpose of adding weight and warmth to the fabric. Warp-backed fabrics are similar in construction to filling-backed fabrics, with the exception that the backing yarn is warp instead of filling. They require more harnesses than filling-backed fabrics, because of the extra, or backing, warp, but on the other hand may be woven on single-box looms; that is, if the filling is of the same color and material throughout. The same length of time is required to weave warp-backed cloths as single cloths, since the former require only as many picks as the latter; a longer time is necessary, however, for the weaving of filling-backed fabrics, owing to the extra picks of backing filling that must be put into the cloth.

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Color also can be applied to the back of warp-backed fabrics to advantage, since stripe effects can be easily made, while with filling-backed cloths only bars across the cloth can be produced, and this is rarely a satisfactory method of applying color. However, particular care should be taken, in all cases where a different color from that of the face yarn is applied to the reverse side of backed cloths, to have all binding points perfect, so that the color of the backing yarn will not show on the face of the goods.

In many warp-backed cloths, two beams are required, since the backing warp is often a coarser yarn and also interlaces differently with the filling than the face warp, except in the case of warp reversibles. It is necessary for the backing yarn in a warp-backed fabric to be harder twisted than the backing yarn in a filling-backed fabric, since there is always more strain on warp than on filling yarn. Thus, it will be seen that warp-backed fabrics are generally harsher and stiffer feeling goods than filling-backed fabrics, in which soft-twisted yarns are almost exclusively used for the backing filling. Warp-backed cloths are largely used for producing heavy fabrics with a cheaper back than face, as for instance, worsted suitings and trouserings with a fine worsted face and woolen back. However, if very cheap and tender yarn must be used for the back, a filling-backed weave is to be preferred.

14. In constructing weaves for this type of fabric, there are several important points that should be noted: (1) The backing warp must be raised over a pick in every instance where it is desired to bind the back to the face cloth. With filling-backed fabrics the reverse is the case; there a warp end is depressed in order to bind the extra system of yarn to the cloth. (2) In warp-backed fabrics, the tying places should always be placed between two warp flushes of the face cloth, if possible, in order that the tying may not show on the face of the goods; if in any case this is impossible, the backing warp should be raised either to the right or to the left of a face-warp flush, although the most perfect



FIG. 21

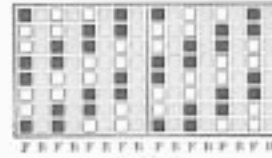


FIG. 22

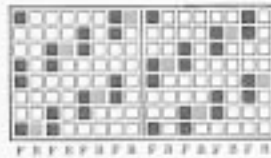


FIG. 23

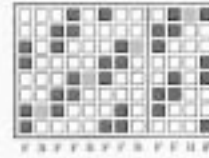


FIG. 24

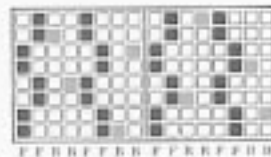


FIG. 25



FIG. 26

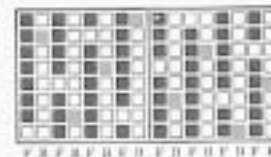


FIG. 27



(a)



(b)

FIG. 28

results cannot be obtained by this means. (3) If there are a great many more intersections of the face warp with the filling than of the backing warp with the filling in a given number of picks, or if one series of warp yarn is coarser, it will be necessary to place the two warps on separate beams, since the take-up of the warps in weaving will be different. (4) It is always best to select weaves of regular structure, such as satins, twills, broken crow, etc., for the backing weave, so that each backing end will have the same number of interlacings. (5) Care should be taken to have the face and backing weaves repeat evenly on the design, so that the number of ends in the complete design will be the least common multiple of the number of ends in the two weaves; that is, supposing the design to be arranged 1 face and 1 back. Warp-backed fabrics, however, are often arranged with 2 ends of face and 1 end of back, and sometimes with 2 ends of face and 2 of back. Care should be taken, though, in any case, to have the face and backing weaves evenly repeated.

In addition to the above, there are often many other things to be considered when constructing weaves for warp-backed cloths. For instance, if a design of this class is arranged 1 face and 1 back, the backing warp should never be of heavier yarn than the face, since, if this is the case, the back is liable to show through on the face of the cloth. If the design is arranged 2 face and 1 back a proportionately heavier yarn can be used for the backing warp. If cheaper material is used for the backing warp and the cloth is to be fullled, a backing yarn of as nearly as possible the same fulling properties as the face yarn should be used.

15. To illustrate the method of constructing a warp-backed weave, suppose that it is desired to back the cassimere twill with warp, using the 8-harness satin weave on the back of the goods, or in other words tying the backing warp in 8-end satin order, the design to be arranged 1 face warp and 1 backing warp. As the backing weave in this case will require 8 ends, it will be necessary to show two repeats of the face weave in the complete design; therefore, the

16 WOOLEN AND WORSTED PLY WEAVES

finished weave will require 16 ends and 8 picks. The first operation is to shade, or in some manner indicate, the backing ends, in order that they may be distinguished from the face ends. The method of doing this is shown by the pink-shaded squares in Fig. 21, where the design paper is prepared for the reception of the face weave. Fig. 22 shows the cassimere weave, which is used for the face weave in this design, placed on the face ends. The final step is to place the backing weave on the design. As the backing weave, which is to be the 8-harness satin, must flush on the back of the cloth, it should be raised only once in 8 picks on each backing end and in satin order, as shown by the red squares in Fig. 23. The method of raising the backing warp at the tying places between two face-warp flushes should be noted carefully, the object, of course, being to allow the flushes of face warp to cover and hide the tie.

Fig. 24 shows the cassimere twill backed with warp, arranged 2 ends of face and 1 end of back, the backing warp being tied in regular twill order. Fig. 25 is a warp-backed weave having a 4-harness basket face weave backed with the 8-end satin, the design being arranged 2 ends of face and 2 ends of backing warp.

WARP REVERSIBLES

16. Double warp-faced fabrics are made with the reverse face put on with warp in a somewhat similar manner to that employed in filling-reversible cloths, and like them are generally made with satin weaves, the face warp flushing on the face of the cloth and the backing warp on the back. Weaves for these cloths are constructed as for other warp-backed fabrics, but the backing warp is usually of as good quality as the face, while the filling, as it is entirely concealed in the fabric, may be of cotton or other cheap material. Since both the face and backing warps interlace with the filling in the same manner, cloths of this description require only one beam for weaving. Fig. 26 shows a 5-harness and Fig. 27 an 8-harness warp satin reversible, both being

arranged 1 face and 1 back and both having perfect tying places.

17. Figured warp reversibles may be constructed in a similar manner to that employed in producing figured filling-reversible effects, with the exception that the designs are constructed by amalgamating two warp-reversible weaves instead of two filling-reversible weaves.¹ The design is usually figured, according to a given motive, with these two warp reversibles, one of which is arranged to throw the odd-numbered ends on the face and the even-numbered ends on the back, and the other to produce the opposite effect; thus, if the cloth is warped 1 white and 1 black, the motive will be reproduced in white on a black ground on the face of the cloth and in black on a white ground on the back of the cloth, or vice versa. Since the filling is entirely hidden in the fabric, cotton filling is commonly used; but the warp yarns should be of equally good quality, since the warp alternately appears on the face and back of the cloth. Any two warp-reversible weaves may be used in constructing designs of this description, but those complete on a small number of ends and picks will be found most convenient. Fig. 28 (*a*) shows a warp-reversible weave constructed with the 5-harness satin on the face and back, while Fig. 28 (*b*) shows the same reversible weave with the exception that in (*a*) the odd-numbered ends are the face ends and the even-numbered ends the backing ends, while in (*b*) the reverse is true. If these designs are warped 1 white and 1 green, (*a*) will produce a cloth with a white face and a green back, while (*b*) will produce a cloth with a green face and a white back. Therefore, if these two weaves are combined according to a proper motive, a figured effect will be obtained.

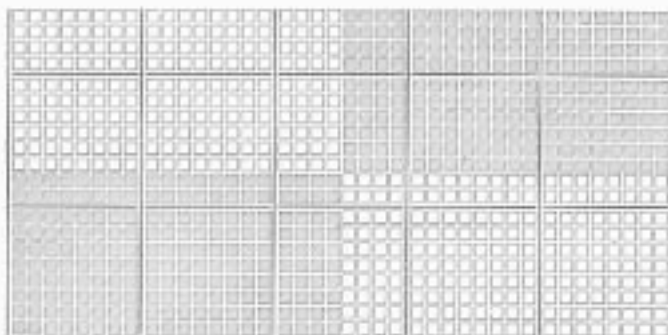
Suppose, for instance, that a simple checker-board effect consisting of square figures arranged in plain order is desired; then in order to form a figured warp reversible all that is necessary is to lay out the motive to the required size and place Fig. 28 (*a*) on the motive and Fig. 28 (*b*) on the ground, or vice versa. When arranging the motive for the reception of

the weaves, it should be enlarged twice as much warp-way as filling-way, since warp-backed weaves arranged 1 face and 1 back require twice as many ends as picks to give the same number of face or backing ends as picks per inch. If the motive is not laid out in this manner, the width of the check or other figure, as the case may be, will be reduced one-half, while the length will remain the same, that is, if there are the same number of picks as face ends, which will cause it to appear distorted. Fig. 29 (*a*) shows the motive for the desired check effect, the light-blue-shaded squares indicating the motive and the blank squares the ground. Fig. 29 (*b*) shows the weave for the check effect desired, constructed with the weaves shown in Fig. 28 (*a*) and (*b*), Fig. 28 (*a*) being placed on the motive and Fig. 28 (*b*) on the ground. If this design, therefore, is warped 1 white and 1 green, a white-and-green check will be made on both sides of the cloth, which will be of the reversible type, a green check on the face covering a white check on the back, and vice versa.

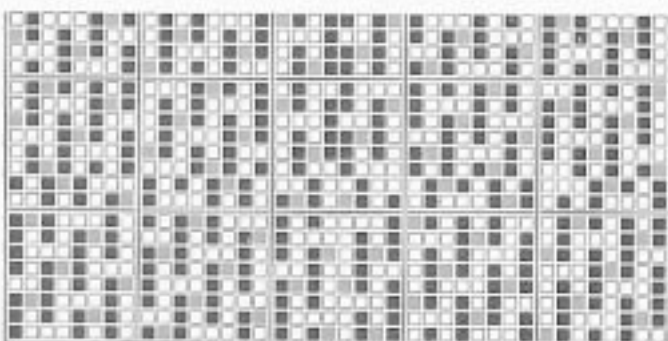
Other weaves than Fig. 28 (*a*) and (*b*) may easily be made, and any motive may be used as a basis for combining them to produce warp-reversible fabrics. For instance, if the first 5 picks of Fig. 29 are considered as the complete weave and the warp is arranged 1 white and 1 green, a white-and-green reversible stripe will be produced.

WARP-BACKED CLOTHS WITH A WADDING FILLING

18. In some cases, the required weight cannot be obtained by backing with warp alone and at the same time the appearance and texture of both the face and back of the fabric be retained. When this is the case, extra picks of filling, known as **wadding picks**, may be inserted in such a manner that they will not show either on the face or back of the cloth. In order to obtain this result, it is only necessary to raise all the face warp and depress all the backing warp when the wadding pick is inserted, thus laying the pick between the two warps, but not interlacing it with either.



(a)



(b)

FIG. 29

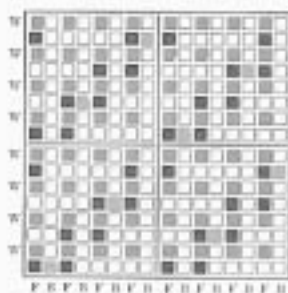


FIG. 30

The wadding filling may be of any cheap material, as it does not show at all, but should not be much larger in size than the face warp if a level cloth is desired. Fig. 30 shows the warp-backed weave shown in Fig. 23 arranged alternately with 1 pick of face filling and 1 wadding pick. The blue squares show the face warp raised over the wadding picks.

DRAFTING OF BACKED WEAVES

19. Filling-backed weaves, since they contain only one system of warp yarn, may be drawn through the harnesses, and the chain and drawing-in drafts constructed exactly the same as for a single cloth. In these weaves, only as many harnesses are required as are necessary for producing the face weave. In the case of warp-backed fabrics, however, since the backing warp interlaces with the filling differently from the face warp, it must be drawn in on separate harnesses; therefore, in these fabrics, one set of harnesses is required to produce the face weave and an additional set to govern the interlacings of the backing ends. A warp-backed weave may be drawn in exactly as a single cloth, if it is so desired. In this case, if the weave is arranged 1 face and 1 back, the first harness will be a face harness, the second harness will have the backing warp drawn through it, etc., each alternate harness being a backing harness; that is, with a straight draft. If the weave were arranged 2 face and 1 back, 1 backing warp harness would alternate with 2 face harnesses. This method of drafting is adopted in some instances in connection with warp-backed fabrics of simple design, but in the majority of cases it is desirable to separate the harnesses for the backing warp from those through which the face warp is drawn, since this method makes the harness draft much simpler for the weaver, thus rendering the liability of broken backing warp ends being tied in on face harnesses, or vice versa, less probable.

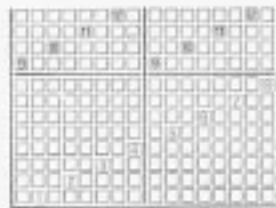
There are two systems of separating the harnesses through which the backing warp is drawn from those through which

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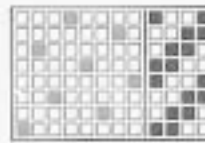
the face warp is drawn. The first method consists of drawing the backing warp on the back harnesses and the second of drawing the backing warp on the front harnesses. Both of these systems are largely in use, but the latter method is to be preferred, as by this means the backing warp is more readily accessible to the weaver, and since the backing ends are frequently of poorer material and break oftener, this is somewhat of an advantage. For the same reason, namely, that the backing ends are often weaker than the face ends, it is an advantage to place the backing warp on the front harnesses, since the harnesses in the rear are lifted higher than those in the front of the loom, thus bringing more strain on the yarn drawn in on those harnesses. If, however, the face warp has a fancy pattern, it is better to draw it on the front harnesses.

20. To illustrate the method of making the drafts for a warp-backed weave, suppose that it is desired to construct harness and chain drafts for Fig. 23. The first step is to make the harness draft, which is accomplished in identically the same manner as with single cloth, except that two processes are required in order to draft both the face and backing weaves. It will be supposed in this case that the backing warp is to be drawn on the front harnesses. The drawing-in draft for the backing weave will therefore be made first, and as in this case the backing weave is an 8-harness satin it will require 8 harnesses. Proceed exactly as in single cloth, taking care, however, as Fig. 23 is arranged 1 face and 1 back, to leave every other vertical row of squares of the harness draft for drawing in the face warp. Next, indicate the drawing-in draft for the face weave, placing it above the draft for the backing weave, but on the vertical rows of squares reserved for the face warp. As the face weave in Fig. 23 occupies but 4 harnesses, there will be two repeats of the face drawing-in draft to one repeat of the draft for the backing weave.

Fig. 31 (*a*) shows the drawing-in draft for Fig. 23 with the backing warp drawn through the first 8 harnesses and the

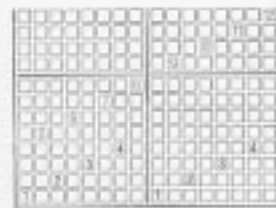


(a)

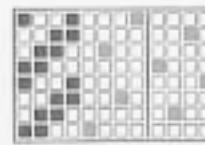


(b)

FIG. 31



(a)

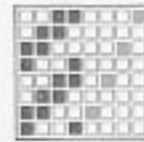


(b)

FIG. 32



(a)



(b)

FIG. 33

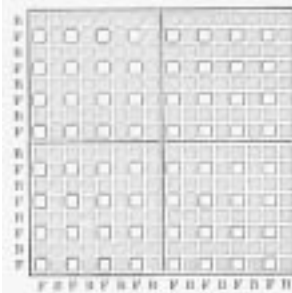


FIG. 34

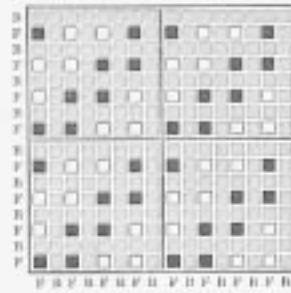


FIG. 35

face warp through the last 4 harnesses, as explained. Care should always be taken to arrange the alternation of the face and backing ends in the drawing-in draft exactly the same as they occur in the weave; that is, if the first end of the weave is a face end, the first end of the drawing-in draft must be drawn through a face harness, and if the second end of the weave is a backing end, it must be drawn through a backing harness. Thus, in Fig. 31 (*a*), the end drawn through the first harness is the first backing end, which is the second end of the weave; therefore, this end occupies the second vertical row of squares in the drawing-in draft. Having obtained the drawing-in draft as shown in Fig. 31 (*a*), it is a comparatively simple matter to construct the chain draft, the method being identical with that employed in a single fabric. Since the drawing-in draft is arranged to separate the face and backing warps, the face and backing weaves are separated in the chain draft, as shown in Fig. 31 (*b*), which shows the chain draft for Fig. 23 with the warp drawn in as shown in Fig. 31 (*a*).

21. If it is desired to draft Fig. 23 with the backing warp drawn in on the back harnesses and the face warp on the front harnesses, the drawing-in draft will be made as shown in Fig. 32 (*a*) and the chain draft as shown in Fig. 32 (*b*). The method of constructing the drafts in this case is exactly the same as for Fig. 31 (*a*) and (*b*) with the exception, of course, that in this case the face warp is drawn in on the harnesses at the front of the loom.

When drafting warp-backed weaves that are arranged 2 ends of face and 1 of back, the same methods are employed as previously explained, except that 2 face ends are drawn consecutively on the drawing-in draft in accordance with the arrangement of the face ends in the weave. The drawing-in draft for Fig. 24 is a draft of this description, as shown in Fig. 33 (*a*). Fig. 33 (*b*) shows the chain draft for Fig. 24 with the warp drawn through the harnesses according to Fig. 33 (*a*).

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EXAMPLES FOR PRACTICE

1. Back the $\frac{4}{2}$ regular twill with warp, arranging the design 1 face and 1 back and tying each backing end perfectly.
2. Back the $\frac{4}{2}\frac{3}{3}$ regular twill with warp, arranging the ends 1 face and 1 back. Tie the backing warp in 12-end satin order.
3. Make a design for a warp-backed fabric having the $\frac{3}{1}$ regular twill on the face and the 8-harness satin weave on the back, arranging the warp ends 1 face and 1 back. Show harness and chain drafts with the backing warp drawn in on the front harnesses.
4. Back the $\frac{4}{1}$ regular twill with warp arranging the design 1 face, 1 back, 1 face. Tie the backing warp in 5-end satin order. Show harness and chain drafts with the face warp drawn in on the front harnesses.
5. Make an 8-end warp satin reversible arranged 1 face and 1 back.
6. Back the $\frac{3}{1}\frac{2}{2}\frac{1}{3}$ regular twill with warp, arranging the design 1 face and 1 back. Tie the backing warp in regular order, each end to be tied once in 12 picks.

DOUBLE AND TRIPLE CLOTHS

DOUBLE CLOTHS

22. The term **double cloth** includes those fabrics that consist of two separate cloths, which may be woven in the loom independently, one above the other, or which may be bound together by allowing threads of one cloth to interlace at certain intervals with those of the other. Two systems of both warp and filling are required for the production of a double cloth, while for a backed cloth only one system of backing yarn is necessary. A double cloth may be considered as a combination of a warp- and a filling-backed fabric; that is, it may be considered as a fabric backed with both warp and filling, requiring not only extra harnesses in the loom but also extra filling and generally extra shuttles. In a double cloth, however, the backing warp and filling interlace with each other according to a definite weave, which may be the same as, or different from, the face weave. If a

double cloth, therefore, is woven without binding, or tying, the face and back fabrics together, two separate cloths will be formed in the loom, one on top of the other and only fastened together at the selvages. On the other hand, if a backed fabric were woven without tying the backing warp or filling, as the case might be, the face cloth would be formed perfectly, but the backing yarns would not interlace at all.

There are many objects that lead to the production of double cloths, among which may be mentioned: (1) To reduce the cost of heavy-weight fabrics by the addition of cheaper material to the back of the goods; (2) to produce heavy-weight fabrics, the face of which shall be composed of comparatively fine yarns; (3) to produce double-faced fabrics having the same appearance on each side; (4) to produce double-faced fabrics having a different appearance, or pattern, on each side.

23. In constructing double-cloth weaves, they may be arranged 1 face and 1 back in both warp and filling, or 2 face, 1 back, etc. Sometimes double-cloth weaves are arranged 1 face and 1 back in the warp and 2 face and 1 back in the filling, or vice versa. To illustrate the method of constructing a double-cloth weave, suppose that it is desired to back the cassimere twill with a 4-end basket weave, the design to be arranged 1 face and 1 back in both warp and filling, and tied in 8-end satin order. Since the weave is to be arranged 1 face and 1 back and the stitching weave alone requires 8 ends and 8 picks, 16 ends and 16 picks, or 8 backing and 8 face ends and picks, will be required to show one repeat of the completed weave. As both the face and backing weaves are complete on 4 ends and 4 picks, they will be repeated evenly on the 8 face and backing ends and picks, respectively.

The first step in the construction of the weave is to indicate, by some arbitrary method, which ends and picks are to be the face, and which the backing, ends and picks. This may be conveniently accomplished by shading each backing end and pick, as shown by the pink-shaded squares in Fig. 34. The next operation is to place the face weave on the design

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paper, as shown in Fig. 35, opening it out both warp- and filling-way, in order that it may be placed on those ends and picks that have been indicated as face threads. After placing the face weave on the face ends and picks, the next step is to place the backing weave on those ends and picks that have been indicated as the backing ends and picks, as shown by the red squares in Fig. 36. In order that the backing filling shall not interlace with the face warp and thus show on the face of the goods, it is next necessary to raise every face thread on each backing pick. This is accomplished by raising the face warp at each intersection with the backing filling, as shown by the blue squares in Fig. 37. The weave completed to this stage would, if woven, produce two perfect and entirely distinct pieces of cloth, one woven with the cassimere twill and the other with the 4-end basket weave. In order, therefore, to so amalgamate these two fabrics as to produce a double cloth, it is necessary to bind, or tie, them together.

24. There are two methods of tying ordinary double cloths. The first, and the one adopted in the majority of cases, is to raise each backing end in regular order over a face pick. Care should be taken in doing this to raise the backing end in the same manner as in the case of warp-backed fabrics; namely, between two face warp flushes on the same pick. If possible, it is also always best to have the tying places occur on each of the backing ends an equal number of times in a given number of picks, thus making each end of the backing warp take up the same in weaving. The second method of stitching a double cloth is to depress the face warp threads under the backing filling, making the system of tying as uniform as possible and binding each face-warp thread, in order that the face warp shall take up evenly in the weaving. When tying by this method, the face warp should be depressed, or in other words the backing filling should be raised, in such a manner that the tying places will occur between two flushes of the face filling, as when tying filling-backed fabrics. This method of tying

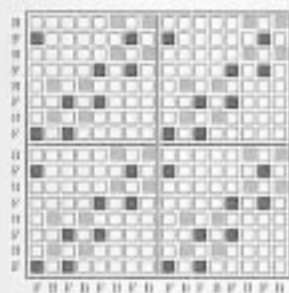


FIG. 36

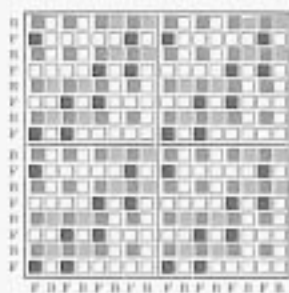


FIG. 37

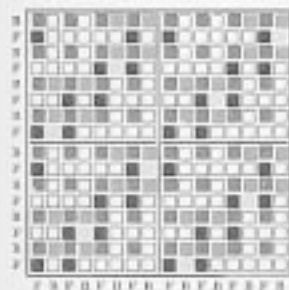


FIG. 38

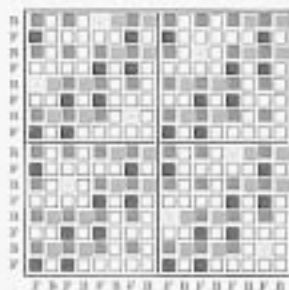


FIG. 39

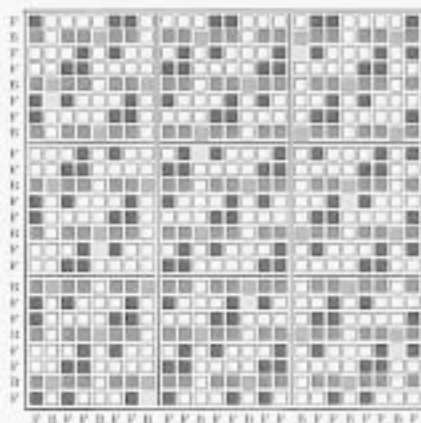


FIG. 40

double cloth is not used so much as the first method, but is useful in tying cloths that have a predominance of filling on the face; that is, in cases where the face weave is a filling-flush weave.

The completed design for the double-cloth weave under consideration, tied by raising the backing-warp ends over the face picks in 8-end satin order, as indicated by the green squares, is shown in Fig. 38. As each tie is formed by raising the backing end between two flushes of the face warp over the same picks, the ties will be concealed from the face of the goods. The distribution of the ties in this case is perfect, since each backing-warp end has the same number of ties. It is always better to use a satin order for the ties, if possible, since the regular, yet distributed, order of the binding points always makes a perfect cloth with no liability of its cockling. In Fig. 39, the same double-cloth weave is shown as in Fig. 38 with the exception that the stitching is accomplished by allowing the backing picks to float over the face ends. The binding is shown by the green dots, but it should be remembered that in this case it is done with sinkers and not with risers, since each tying place represents the backing filling floating over the face warp. The binding is shown by green dots simply to show the position of the tying points more clearly; the squares thus represented should actually be blank squares.

In tying double cloths, it should always be borne in mind that in all perfectly tied double cloths there are the same number of binding places on each backing or face end, according to whether the cloth is tied with the backing warp or filling, and that when the face weave is a warp-flush weave it is better to tie the cloth by raising the backing warp, as the tying will then be covered as well as possible, but when the face weave is a filling-flush weave, it is better to tie the cloths by raising the backing filling, as the flushes of face filling will then cover the tying places to the best advantage. The binding of double cloth also has an influence on the ultimate character of the fabric, since the oftener the cloth is bound, that is, the more tying places there are, the harder

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and firmer the fabric will feel, while if tied only at wide intervals the cloth will feel loose and spongy.

25. If, when designing a double-cloth weave with a twill on the back, it is desired to have this twill run to the right, it must be made to run to the left on the design paper, and vice versa. If it is desired to have a warp-flush weave on the back of the cloth, the reverse, or filling-flush, of the desired weave must be placed on the design paper. The reason for this is that the backing weave will always be seen from the under, or reverse, side after the cloth is woven. Care should always be taken, when arranging the weaves for a double cloth, to arrange them in such a manner as to make the best possible places for tying the cloths together.

26. Double-cloth weaves are often constructed so as to be woven with twice as many face as backing ends and picks. Fig. 40 shows a weave of this description arranged 1 face, 1 back, 1 face in both warp and filling; the face weave is the cassimere twill and the backing weave plain. The two cloths are bound together by raising the backing warp over the face filling in 8-end satin order. The double-cloth weave shown in Fig. 41 is arranged 3 face and 1 back. The face weave is the 6-end regular 45° twill $\frac{3}{3}$, while the backing weave is the cassimere twill. In this weave, the ties are evenly distributed on each twill line of face-warp floats, which is accomplished by twilling the binding points in the opposite direction to the twill of the face weave. This arrangement of the face and backing yarns is suitable for goods with a fine worsted face and a woolen back; the method of constructing the weave is the same in principle as one-and-one and two-and-one double-cloth weaves.

It often happens that the same proportion of face and back is not used in the warp as in the filling of a double cloth. The design shown in Fig. 42 is of this type, as it is arranged 1 face and 1 back in the warp and 1 face, 1 back, 1 face in the filling. The face weave is the cassimere twill, while the backing weave is the small rib weave shown in Fig. 43. The face and back cloths are bound together in 8-end satin order

in this weave. Another double-cloth weave of unevenly balanced construction is shown in Fig. 44, in which the warp is arranged 1 face, 1 back, 1 face, and the filling 1 face, 1 back. The face weave is the cassimere twill and the backing is the plain weave; the two cloths are tied on the warp-flush twill line of the cassimere.

When making double-cloth weaves where two backing ends are placed together, care should be taken to have the tying places on the two backing ends that are together on different picks, so as to allow the face ends to cover them perfectly. In the weave of this description, shown in Fig. 45, careful notice should be taken of the method of tying. In this design, the face weave is the regular 8-harness twill $\frac{4}{4}$, while the backing weave is the cassimere twill.

TYING WITH A STITCHING WARP

27. Double-cloth weaves are often arranged to be tied with an extra system of tying threads instead of with the yarns that compose the face and back cloths, as in the ordinary methods of binding. These threads, often cotton, are generally wound on a spool, which is placed at the back of the loom in such a manner as to let off the tying yarn as the cloth is woven. The tying threads are arranged in the weave so as to float over every backing pick and under every face pick, except at certain points where they are raised over a face pick between two floats of the face warp over the same pick and certain other points where they are allowed to be depressed under a backing pick between two backing ends that are also depressed, that is, that float on the back of the fabric. The alternate interlacing of this system of tying threads first with the face and then with the back fabric serves to bind the two cloths securely together, although a fabric tied in this manner is never so firmly bound as one tied by raising the backing warp or filling into the face cloth. Fig. 46 shows a double-cloth weave having the cassimere twill on the face and back and tied with a tying warp. The weave is arranged 1 face, 1 back, 1 tying in the warp and

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1 face, 1 back in the filling. It will be noted that each tying end passes over 1 face pick, as shown by the filled green square, and under 1 backing pick, as shown by the shaded green square which indicates the warp depressed, but at all other points lies between the face and backing picks, being raised over the backing picks, as shown by the blue dots, but floating under the face picks.

DOUBLE-CLOTH WEAVES WITH WADDING YARNS

28. Double-cloth weaves are sometimes arranged with a wadding warp or filling, generally the latter, for the purpose of adding weight and bulk to the goods by inserting cheaper material between the face and back cloths in such a manner that it will not show on either the face or back of the fabric. A double-cloth weave arranged with a wadding filling is shown in Fig. 47. Both the face and the backing weaves in this case are the cassimere twill, and the cloth is tied perfectly in 8-end satin order. The weave is arranged 1 face, 1 back in the warp and 1 face, 1 back, 1 wadding in the filling. When a pick of the wadding yarn, which is usually a bulky slack-twisted thread of cheap construction, is inserted, all the face-warp ends are raised, as shown by the blue dots, and the backing warp depressed, so that the picks will lie in the center of the fabric without interlacing with either the face or backing warps and without showing on either side of the cloth. By this means the weight and bulk of the goods may be increased very cheaply, and at the same time the appearance of the fabric suffers no deterioration.

A double-cloth weave having the same construction as Fig. 47, except that a wadding warp instead of wadding filling is used, is shown in Fig. 48. This weave is arranged 1 face, 1 back, 1 wadding in the warp and 1 face, 1 back in the filling. The wadding ends are raised over every backing pick, as shown by the blue dots, and depressed under every face pick, so that they lie in the center of the cloth without interlacing, in exactly the same manner that the wadding filling is inserted in Fig. 47. However, it is not possible to use as

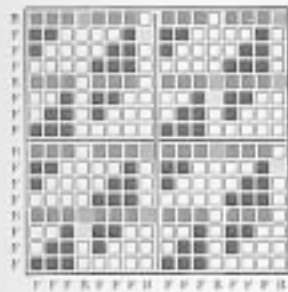


FIG. 41

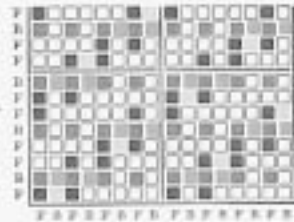


FIG. 42



FIG. 43

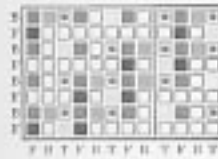


FIG. 46



FIG. 44

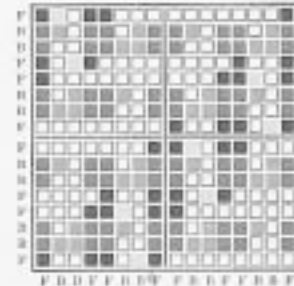


FIG. 45

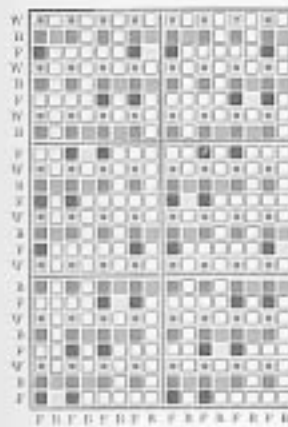


FIG. 47

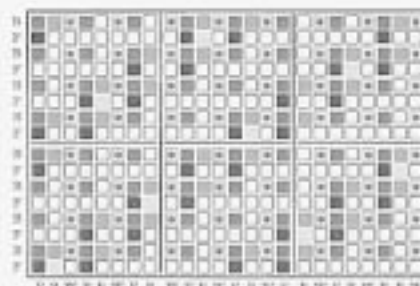


FIG. 48

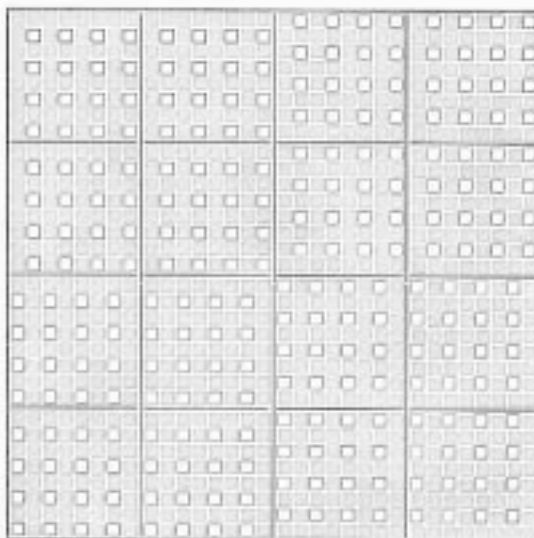


FIG. 49

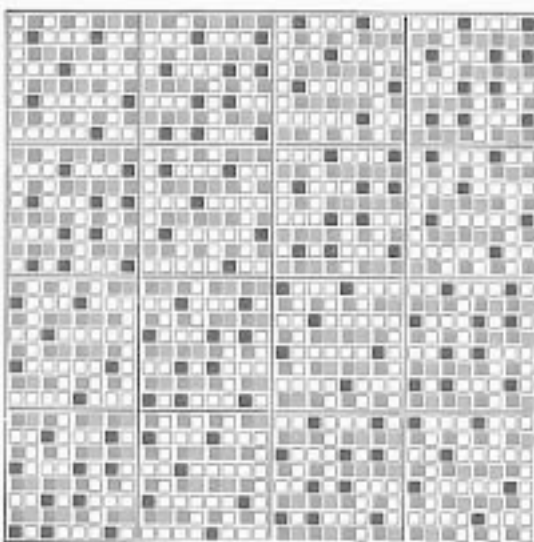


FIG. 50

cheap a grade of yarn for a wadding warp as for a wadding filling since a warp yarn must always possess a certain amount of strength in order to withstand the chafing of the harnesses and reed during the weaving process.

CUT DOUBLE CLOTHS

29. Double-cloth weaves that produce fine indented lines, or *cut marks*, on the surface of the fabric are known as **cut double cloths**. These cut marks may be produced in double-cloth weaves arranged 1 face and 1 back by reversing the weave in either the warp or filling or both, the principle being similar to that employed for producing a cut mark in the filling-backed weave shown in Fig. 16. The cut marks are generally arranged so as to run lengthwise of the fabric or else so as to run both lengthwise and crosswise and produce checks in the fabric. Suppose, for example, that it is desired to produce a cut double-cloth weave in which the cut marks shall run in the direction of both the warp and the filling.

The first step in the production of such a weave is to shade the design paper so as to indicate which are the backing and which are the face ends and picks, at the same time arranging for reversing the weaves to produce the cut marks. Fig. 49 shows the design paper shaded in this manner, the pink-shaded squares indicating the backing ends and picks; it will be noticed that in the first section of 16 ends the odd-numbered picks are the face picks and the even-numbered picks the backing picks, while in the second section of 16 ends the reverse is true. Thus, the first pick of the weave is a face pick for 16 ends and between the sixteenth and seventeenth ends passes to the back of the cloth and becomes a backing pick, while the second pick is a backing pick for the first 16 ends and then passes to the face of the cloth and becomes a face pick. The filling passing to the back and to the face between the sixteenth and seventeenth ends throughout the cloth will produce a fine cut mark the whole length of the piece. In a similar manner, the first end of the weave is a face end for 16 picks and then passes to the back of the cloth and becomes a

30 WOOLEN AND WORSTED PLY WEAVES

backing end for 16 picks, while the second end is a backing end for the first 16 picks and a face end for the next 16 picks, and so on throughout the weave. Thus, it will be seen that the ends, in passing from face to back and back to face between the sixteenth and seventeenth picks, will produce a cut mark running across the fabric.

After the design paper is shaded in this manner, it is simply necessary to place a face weave on the face ends and picks and a backing weave on the backing ends and picks and to raise all the face warp on the backing picks. In Fig. 50 the completed design is shown, the $\frac{2}{1} \frac{1}{2} \frac{1}{1}$ regular twill being used for a face weave and the 8-end twill basket for a backing weave. Generally, it is unnecessary to introduce the ordinary double-cloth binding between the face and the back cloths, as the transposing of the face ends and picks and backing ends and picks serves to bind the cloth securely on each cut mark both warp-way and filling-way; but in case the cut marks are arranged so as to form checks of any considerable area, it is advisable to tie the face and backing weaves in each section exactly the same as in an ordinary double cloth, since the pockets formed between the cut marks will otherwise be too large and thus render the fabric somewhat loose in structure.

The cut marks can be made much more prominent by using a cut check weave for the face weave or for both the face and backing weaves and reversing the warps and fillings at the points where the cut of the face or face and backing weaves occurs. By this means, the cut marks that would naturally occur by using a cut check weave in the cloth are greatly accentuated and serve to divide the sections of the check very prominently. Cloths woven with weaves like Fig. 50 are generally woven white and then piece-dyed one solid color, and as both series of yarns appear on the face, both should be of the same quality.

30. When it is desired to produce cut marks in double-cloth weaves arranged with two face threads alternating with one back thread, a somewhat different method is

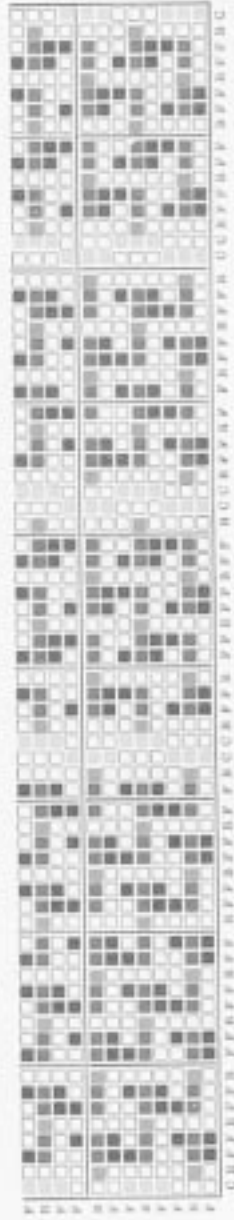


FIG. 4

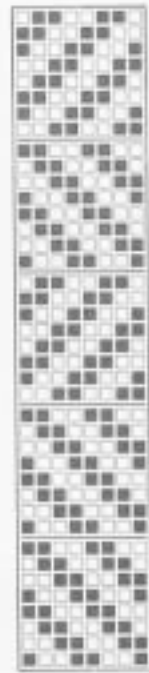


FIG. 5

employed. In this case, if a cut mark running lengthwise of the goods is desired, 2 ends are inserted in the weave that interlace with both the face and backing filling exactly as in a single-cloth weave; or if a cut mark across the cloth is called for, 2 picks similarly interlaced with both warps are inserted. Fig. 51 is a double-cloth weave with cut marks made by this method, arranged to run lengthwise of the fabric. The face weave in this case is an angled stripe weave made with the cassimere twill as shown in Fig. 52, while the backing is the plain weave. Wherever it is desired to make a cut mark, 2 cutting ends are substituted for 2 face ends, these ends being arranged to interlace alternately $\frac{2}{3}$ with the fillings, as shown by the green squares. Thus, cut marks will be produced between the second and seventy-first, twenty-sixth and twenty-ninth, forty-first and forty-fourth, fifty-sixth and fifty-ninth ends. It will be noticed that the cut marks are so arranged as to coincide with and accentuate the cuts that would naturally occur in the face weave. By arranging a weave with cutting picks, the cut marks may be made to run across the fabric; and by combining both methods, the cut marks may be made to form checks in the fabric. A cut double-cloth weave arranged in this manner is shown in Fig. 53, the face weave being a cut check made with the Mayo weave, as shown in Fig. 54, and the backing weave plain.

DOUBLE PLAIN WEAVES

31. Double plain weaves, although constructed similar to ordinary double-cloth weaves, are never tied by raising the ends or picks of the backing fabric into the face fabric, but always by reversing the positions of the two cloths; that is, by bringing the backing ends and picks to the face and passing the face ends and picks to the back. A double plain fabric consists of two plain cloths, that is, cloths woven with the $\frac{1}{1}$, or plain, weave, arranged so that one cloth is above the other in the loom exactly like an ordinary double cloth.

A weave that will produce this effect is shown in Fig. 55, which is an ordinary double-cloth weave with the plain

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weave on the face ends and picks and also with the plain weave placed on the backing ends and picks. The face and back cloths in this weave are not tied together, and so two plain woven cloths will be formed in the loom, one above the other, as shown in Fig. 56. If Fig. 55 were warped and woven 1 black, 1 red, that is, if all the face ends and picks were black and the backing ends and picks red, the face fabric would be black and the back fabric red, as indicated in Fig. 56. By comparing Figs. 55 and 56, it will be seen that this is true, since the first pick (black) floats under the first end, over the second, third and fourth, under the fifth, and over the sixth, seventh and eighth, while on the second pick (red), the filling floats over the fourth and eighth ends and under the first, second, third, fifth, sixth and seventh, etc., the filling alternately interlacing first with one cloth and then the other, each color being always interlaced with its own color of warp.

A section of the weave shown in Fig. 55 is shown in Fig. 57, and indicates the interlacing of the filling with the warp. The ends are numbered from 1 to 8, the odd numbers being on the face of the cloth and the even numbers on the back. In this case, however, the cloth is not warped and picked 1 black and 1 red, as in Fig. 56, but is all of one color, being woven from one shuttle, so that the two cloths will be tied at each edge, thus producing a tube, or bag, in the loom. In Fig. 57 only 8 ends are shown, but it will be understood that actually there are a large number of ends working like ends 3, 4, 5, and 6, and that the cloth is bound only on each edge.

If it is desired to produce a cloth that is interwoven at one edge only, and will thus open out to twice its width when taken from the loom, 2 picks should be placed in the face, then 2 picks in the back, instead of 1 face and 1 back. The weave for accomplishing this is shown in Fig. 58, while a section of the fabric is shown in Fig. 59.

32. In order to bind double plain cloths so as to produce a firm double fabric, it would be impractical to raise a

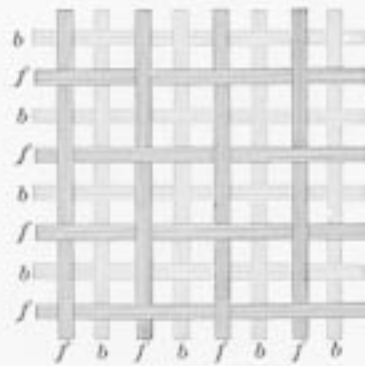


FIG. 36

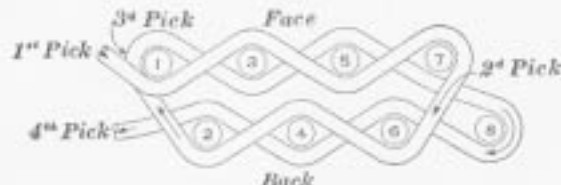


FIG. 37



FIG. 38



FIG. 39



FIG. 40



FIG. 41



FIG. 42

backing warp thread to the face on account of the impossibility of finding a place in the face weave that would cover the tying place perfectly. The system adopted, therefore, for amalgamating the face and back fabrics and at the same time for producing patterns with double plain weaves is to reverse the fabric; that is, to pass the face cloth, warp and filling, through the fabric to the back and the backing yarns to the face.

Double plains are largely used in producing stripe patterns, it being possible by their employment to produce a heavy fabric of fine texture with stripes of solid color on both sides of the cloth. As a rule, the filling yarn should be finer than the warp yarn in this class of fabrics, and there should be more picks than ends per inch. If there are more ends than picks, the lines or stripes of color will not be so perfect or compact. In designing a double plain stripe, the simplest method is to shade the ends 1 face and 1 back, as in the case of double cloth, reversing the weave by bringing 2 back or 2 face ends together. By this means, since the warp is dressed with a thread of one color alternating with a thread of another color, one color of the warp is brought to the face in one portion of the stripe and the other color is brought to the face for the other stripe. The filling interlaces first on the face and then on the back of the cloth, according to which color of warp is on the face or back, each pick of filling always interlacing with its own color.

Fig. 60 shows the design paper shaded for a double plain stripe arranged in the warp 1 face and 1 back for 8 ends and then 1 back and 1 face for 8 ends, in order to reverse the weave as previously explained. The first pick is a face pick for the first section of 8 ends and a backing pick for the next 8 ends, while the second pick is the reverse of the first, so that the filling being picked alternately with different colors will interlace with its own color of warp both on the face and back of the cloth. After the design paper is shaded, it is simply necessary to place the plain weave on both the face and the backing ends and picks and to raise the face warp on the backing picks, as shown by the blue squares,

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in order to complete the weave as shown in Fig. 61. If this weave is warped and woven 1 black and 1 red, black and red stripes will be formed on both sides of the cloth, the black stripe on the face covering the red stripe on the back, and vice versa. That this is true may be seen by examining the section of this design given in Fig. 62, which shows the method in which each pick interlaces with the warp. From this section, it will be seen that the black picks, which are put in the cloth alternately, interlace only with the black, or odd-numbered, ends, and the red picks interlace only with the red, or even-numbered, ends. Where the odd- and even-numbered, or the black and red, ends change places at 7, 8, 9, and 10, the two cloths are tied together. The cloths are also tied together, of course, at the fifteenth, sixteenth, first, and second ends.

33. Double plain fabrics are useful in producing many other varieties of patterns besides stripes. Fig. 63 shows the design paper shaded for a double plain checker-board effect, while Fig. 64 shows the complete weave, the face and back plain weaves being placed on the face and backing ends and picks, respectively, and the face warp raised on the backing picks. If this weave is warped and picked 1 black and 1 red, a reversible checker-board effect consisting of black and red checks on the face and back of the goods will be formed, the black checks on the face covering the red checks on the back of the goods, and vice versa. The weave is bound at the first and thirty-second and the sixteenth and seventeenth ends and picks by reversing the cloths. This will have the effect of forming pockets in the cloth, each check being the extent of the pocket. Double plains are not confined to the simple effects that have been described here, as solid twill lines of color, fancy, or figured effects may be readily obtained, the method being to mark out the desired motive and place the double plain weave on it, then reverse the weave around the outline of the figure, and place the reverse double plain weave on the ground. By this means, a weave may be warped and woven 1 black and 1 red and a red spot

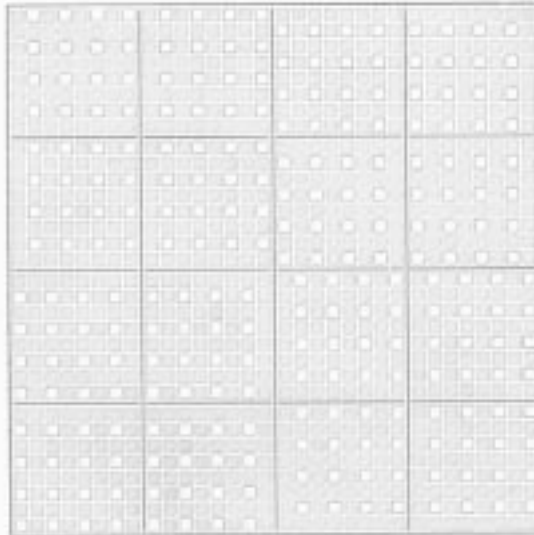


FIG. 63

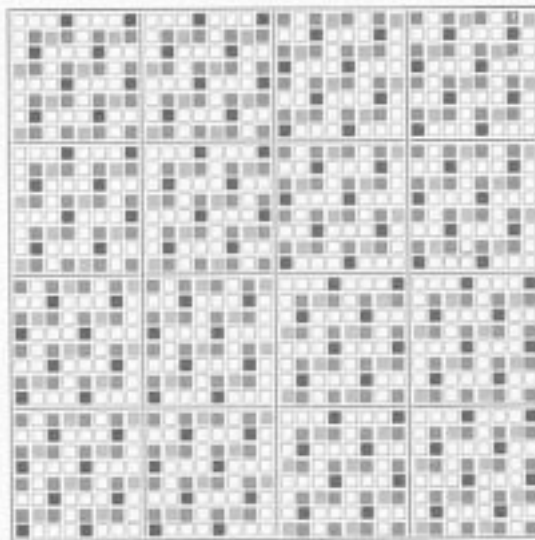
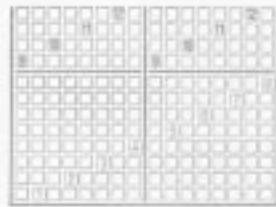
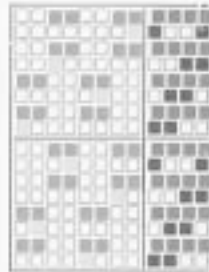


FIG. 64



(a)

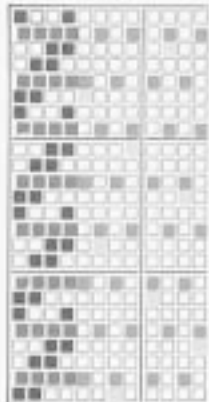


(b)

FIG. 65

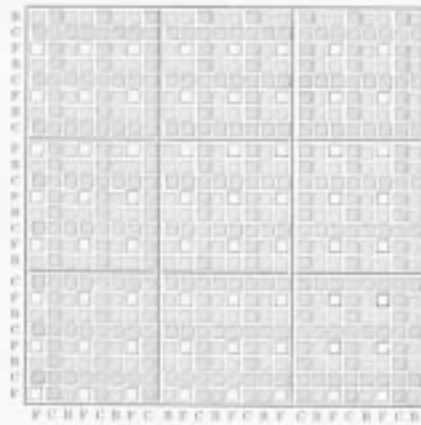


(a)



(b)

FIG. 66



or figure on a black ground made on the face of the cloth, while the back of the cloth will show a black figure on a red ground.

DRAFTING OF DOUBLE-CLOTH WEAVES

34. In constructing the harness and chain drafts for double-cloth weaves, the same methods are employed as for warp-backed weaves. Double-cloth weaves may, of course, be drafted exactly the same as single-cloth weaves, but for the reasons given, when dealing with warp-backed weaves, it is better to separate the harnesses through which the face and backing warps are drawn, constructing the chain draft in each instance to correspond with the method adopted for drawing in the warps. The following drafts for double-cloth weaves indicate the method employed: Fig. 65 (*a*) is the drawing-in draft and Fig. 65 (*b*) the chain draft for the double-cloth weave shown in Fig. 38, the backing warp being drawn on the front and the face warp on the back harnesses. Fig. 66 (*a*) is the drawing-in draft and Fig. 66 (*b*) the corresponding chain draft for Fig. 40, the face warp in this case being drawn on the front harnesses and the backing warp on the back harnesses.

Reversible weaves in which the warp alternately interlaces on the face and on the back of the fabric are best drafted exactly like single cloths, although double plain weaves are occasionally drafted so that one color will be drawn on the front harnesses and the other on the back harnesses.

EXAMPLES FOR PRACTICE

1. Construct a double-cloth weave arranged 1 face and 1 back in both warp and filling, placing the 8-harness twilled basket on the face and the plain weave on the back and tying the backing weave perfectly to the face in 8-harness satin order. Make harness and chain drafts with the face warp drawn on the front harnesses.

2. Make a double-cloth weave arranged 1 face, 1 back, 1 face in both warp and filling, placing the cassimere weave on the face and the 4-end basket on the back and tying the backing weave perfectly to the face in 8-end satin order. Make harness and chain drafts with the backing weave drawn on the front harnesses.

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3. Make a double-cloth weave arranged 1 face and 1 back in the warp and 1 face, 1 back, 1 face in the filling, the face weave to be the $\frac{3}{2} \frac{2}{1}$ regular twill and the backing weave plain. Make two repeats of the face weave in the filling and alternately tie the backing ends to the face weave on the warp-flush twill line. Make harness and chain drafts, the backing weave to be drawn in on the back harnesses.

4. Make a double-cloth weave arranged 1 face and 1 back in both warp and filling, the face weave to be the $\frac{4}{1}$ regular twill and the backing weave to be a 5-harness satin showing a filling flush on the back of the cloth. Stitch in regular order and show harness and chain drafts with the face warp drawn in on the front harnesses.

5. Make a double plain weave on 16 ends that if warped and picked 1 black, 1 red will show a black stripe on the face of the cloth three times the width of the red stripe, and vice versa on the back—a red stripe three times the width of the black stripe.

TRIPLE CLOTHS

35. Triple-cloth weaves are used for heavy-weight woolen goods, such as golf capes, cloakings, etc. As the name indicates, a triple cloth is composed of three cloths woven one on top of the other in the loom. These three cloths are known as the *face*, *center*, and *back cloths*. The center cloth is tied to the face cloth and the back cloth to the center cloth, thus uniting all three cloths into a strong heavy-weight fabric. The same laws regarding tying that were laid down when dealing with double cloths are applicable to triple cloths. When binding the back to the center, however, more care should be taken to bind every end regularly than to lay any stress on raising the backing end between two warp floats of the center cloth, since imperfect stitching of this description cannot show on the face of the goods. Wherever possible the back cloth should also be tied to the center cloth so that the tying points will be covered on the back of the cloth.

When laying out triple-cloth weaves, it is always better to use some loose weave for the center cloth, since this cloth does not affect the appearance of the goods, but simply adds weight. Satin weaves are especially appropriate to use in this connection. The first step when making a triple-cloth

weave is to shade the design paper, and for this purpose two differently colored pencils may be used, one to shade the center ends and picks and the other to shade the backing ends and picks. As more familiarity with the construction of both double and triple cloths is obtained, it will be possible to construct the simpler weaves without shading the ends and picks, but for the beginner, or with complicated and large designs, shading is to be preferred, as it eliminates the possibility of error.

To illustrate the construction of a triple-cloth weave, suppose that it is desired to make a weave having the cassimere twill on the face, the center cloth to be an 8-end satin, and the back of the fabric to show the 4-harness basket weave. The center cloth is to be bound to the face cloth and the back to the center in 8-end satin order, the weave to be arranged 1 face, 1 center, 1 back, in both warp and filling.

The first step is to shade the center and backing ends and picks with differently colored pencils after the manner shown in Fig. 67, in which the light-blue-shaded squares represent the center ends and picks, and the pink-shaded squares the backing ends and picks. The next process is to place the face, center, and backing weaves on their respective ends and picks, as shown in Fig. 68, where the face weave is shown in black, the center weave by the blue marks, and the backing weave by the red-filled squares. After placing the weaves on the design paper, the cloths are tied by raising the center ends over the face picks, arranging the binding points in 8-end satin order and so that the center end will be raised between two face warp floats. This binds the center to the face, but does not bind the back cloth, this latter being accomplished by raising the backing warp ends over the center picks in a similar manner. After the separate cloths are tied together, the next step is to raise each face end over the center and backing picks and each center end over the backing picks, in order that each filling may interlace with its own warp. The completed triple-cloth weave with each of the above points worked out is shown in Fig. 69, where it will be noticed that the binding of both the center to the

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face and the back to the center cloth is accomplished in satin order. In this design, the black squares represent the face weave; the blue squares, the center weave; and the red squares, the backing weave. The green squares show the method of stitching the center to the face, and the green dots indicate the tying of the back to the center cloth. The black-shaded squares indicate the face warp raised over the backing and center picks, while the light-blue-shaded squares indicate the center warp raised over the backing picks.

DRAFTING

36. When making the drafts for triple-cloth weaves, it is always better to separate the face, center, and backing ends, as by this means the harness draft is simplified for the weaver. The method of procedure in drafting is the same as that employed for double cloths, except that three separations are made instead of two. Fig. 70 (*a*) shows the harness draft for Fig. 69 with the face ends drawn in on the first 4 harnesses, the center on the next 8, and the back on the last 8 harnesses. The chain draft for Fig. 69, according to the drawing-in draft in Fig. 70 (*a*), is shown in Fig. 70 (*b*).

EXAMPLES FOR PRACTICE

1. Make a double plain stripe weave complete on 8 ends and 4 picks, which, if dressed and woven 1 red and 1 black, will produce red and black stripes on each side of the cloth.
2. Make a triple-cloth weave, the face to be the $\frac{3}{1}$ regular twill, the center weave the 8-harness satin, and the backing weave the cassimere twill. Tie the center to the face and the back to the center in 8-harness satin order. The design is to be arranged 1 face, 1 center, and 1 back. Give harness and chain drafts.
3. Make a double plain weave for a stripe, the face of the cloth to show 8 red ends, 4 black, 8 red, and 2 black.
4. Make an original triple-cloth design.
5. Make a double plain checker-board weave on 24 ends and picks, that if dressed and woven 1 black and 1 white, will show solid checks of black and white on each side of the cloth.

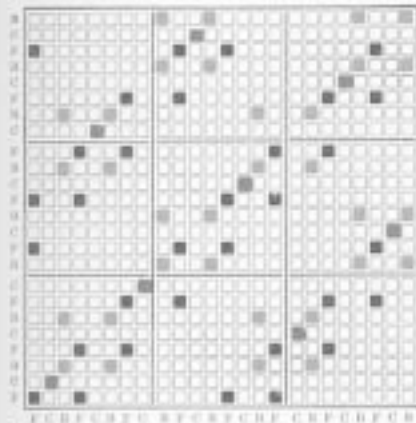


FIG. 68

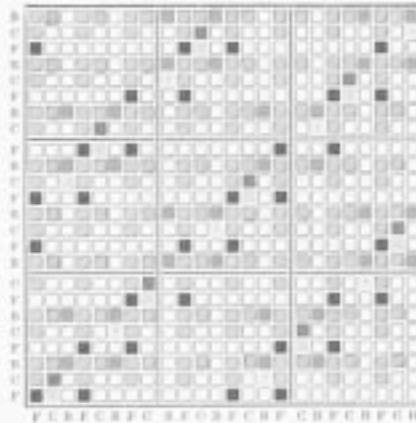
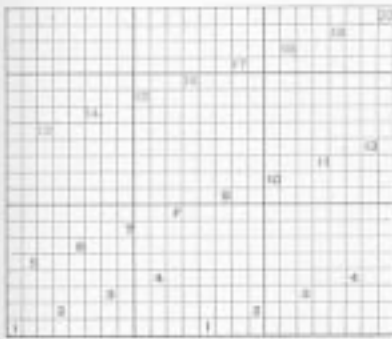


FIG. 69



(a)



(b)

FIG. 70