

**TEXTILE DESIGN AND COLOUR**

**WORKS BY WILLIAM WATSON**

**SUPERINTENDENT AND LECTURER IN TEXTILE MANUFACTURE  
THE ROYAL TECHNICAL COLLEGE, GLASGOW**

**TEXTILE DESIGN AND COLOUR**

**ELEMENTARY WEAVES AND FIGURED FABRICS**

**WITH DIAGRAMS. 8vo.**

**ADVANCED TEXTILE DESIGN**

**WITH DIAGRAMS. 8vo**

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*ELEMENTARY WEAVES AND  
FIGURED FABRICS*

BY

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SALFORD, AND THE TECHNICAL SCHOOL, SHIPLEY

*WITH DIAGRAMS*

SECOND EDITION

With an Appendix on Standard Yarns, Weaves, and Fabrics

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## PREFACE TO SECOND EDITION.

IN the present edition corrections have been made in the original text, and new matter has been added in the form of an Appendix on "Standard Yarns, Weaves, and Fabrics." Much has been published recently on this branch of the subject, notably in the *Textile Mercury Annuals*, and the *Textile Manufacturer Year Book*, while as long ago as June, 1905, a commencement was made in the Museum Report of the Textile Department of the Bradford Technical College with a section on the "Standardising of Trade Terms." In this issue, particularly in the section on Standard Fabrics, the idea has been to deal chiefly with examples which possess some special feature as regards either structure or method of manufacture. The writer has spared no effort in securing authentic and full information, and he has received valuable assistance from many individuals and sources, for which he wishes to place on record his appreciation and thanks.

WILLIAM WATSON.

GLASGOW, *March, 1921.*

## P R E F A C E

AN exhaustive treatise on the designing and colouring of textile fabrics has been found by the writer to be much beyond the scope of a single volume, and this book deals chiefly with cloths that are composed of one series of warp and one series of weft threads. The subject is continued in a second volume—entitled *Advanced Textile Design*—which treats on compound and special classes of cloths.

In the following pages the construction and combination of simple and special weaves, the structure of standard classes of cloths, the theories of colour, and the application of colours to textile fabrics are described and illustrated; while the designing of ordinary figured fabrics, to which eight chapters are devoted, forms a very important section of the work. Textile calculations, and the principles and limitations of weaving machinery, so far as they concern woven design, are fully dealt with. The illustrations form a distinct feature in both number and quality, and there are 413 figures which include over 1800 different diagrams, designs, and representations of woven fabrics.

The chapters on the designing of figured fabrics have previously appeared in the form of serial articles in the *Textile Recorder*, while the section on colour and weave effects has similarly been published in the *Textile Manufacturer*. The writer is indebted to the editors and proprietors of these journals for encouragement in the preparation of the articles. In re-issuing this matter in book form many of the original illustrations have been used, but opportunity has been taken carefully to revise the text, and to introduce new examples. And to the matter which has been previously published eleven chapters have been added, in order to make the book a complete work on the designing and colouring of the simpler classes of cloths.

To the publishers and printers the writer wishes to express his indebtedness for the regard they have had to his wishes in the preparation of the book.

W. W.

GLASGOW, October, 1912.

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# TEXTILE DESIGN AND COLOUR

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### CLASSIFICATION OF WOVEN FABRICS

Woven fabrics are composed of longitudinal or warp threads and transverse or weft threads, which are interlaced with one another according to the class of structure and form of design that are desired. The terms "chain" and "twist" are applied to the warp, and the warp threads are known individually as "ends," while the terms "picks" and "filling" are applied to the weft threads. In the following the term threads is used in referring to warp and weft collectively, but in order to clearly distinguish one series from the other the warp threads are mostly described as "ends," and the weft threads as "picks."

Woven textures may be conveniently divided into three principal classes, as follows:—

(1) Fabrics in which the ends and picks intersect one another at right angles, and in the cloth are respectively parallel with each other. In addition to "single or simple" cloths which are composed of one series of ends and one series of picks, this class includes compound textures that contain two or more series of ends, or picks, or both ends and picks, as in extra warp and extra weft-figured styles and backed, double, treble, etc., cloths.

(2) Cloths in which certain of the ends interweave alternately to right and to left of adjacent ends. Gauze and leno fabrics of all kinds are included in this class, and also lappet structures.

(3) Pile or plush fabrics in which a portion of the threads (either warp or weft) projects from a foundation cloth and forms a nap or pile on the surface.

### DESIGN PAPER

The order in which the warp and weft threads interweave in a fabric, or are required to interweave, can be conveniently indicated upon design or point-paper. The paper is ruled in vertical parallel lines, as shown at A in Fig. 1, the spaces between which represent warp threads; and in horizontal parallel lines, as shown at B, the spaces between the lines in the latter representing weft threads. The crossing of the lines divides the paper into small rectangular spaces, as shown at

C; and in indicating a design it is necessary to consider the paper, not as small rectangular spaces, but as vertical spaces or warp threads, which are crossed by horizontal spaces or weft threads. That is, each small rectangular space represents a position where a warp and a weft thread cross one another; hence, the insertion of a mark on a space may be taken to indicate that one thread passes over the other. According to the idea of the designer the marks may indicate ends passing over picks (warp up), or picks passing over ends (weft up); the blanks, in either case, representing the opposite of what the marks indicate. Thus, the cross shown in C (Fig. 1) may indicate either that the second end passes over the second pick, or that the second pick passes over the second end, according to whether the marks indicate warp up or weft up. In the same manner the dot indicated in C may show that the sixth end passes over the fifth pick, or the fifth pick over the sixth end. As a further illustration, D in Fig. 1 is a flat view diagram showing the interlacing of the threads in plain cloth; if warp on the surface is indicated (that is, if the marks indicate how the ends are raised during weaving) the structure will be represented as shown at E. On the other hand, if the marks

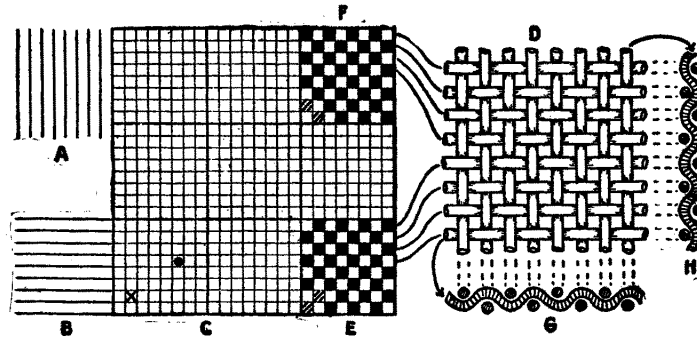


Fig. 1.

are taken to represent weft on the surface, the structure will be indicated as shown at F. Conversely, the blank spaces in E correspond with the positions where the weft is on the surface, and in F, where the warp is on the surface. Marking either for "weft up" or "warp up" may be practised; the designer should be accustomed to both methods, as frequently the type of design or class of structure renders one method more convenient than the other.

An arrangement of marks, to correspond with a given or required order of interlacing, is termed a plan, weave, or design; and it may extend over two, or any greater number of vertical and horizontal spaces of the point-paper. In each vertical and each horizontal space of a design, there must be at least one mark and at least one blank.

Design paper is divided by thick lines into a series of squares, as shown at C in Fig. 1, in which every eighth line, both vertically and horizontally, shows more prominently than the others. In the construction of small weaves the presence of the thick lines is chiefly of use in facilitating the counting of the spaces or threads, the number of spaces between the thick lines being immaterial except in special cases; paper which is divided in eighths ( $8 \times 8$ ) is extensively used. In the construction of large designs, however, it is necessary to use design paper which is

PLAIN WEAVE

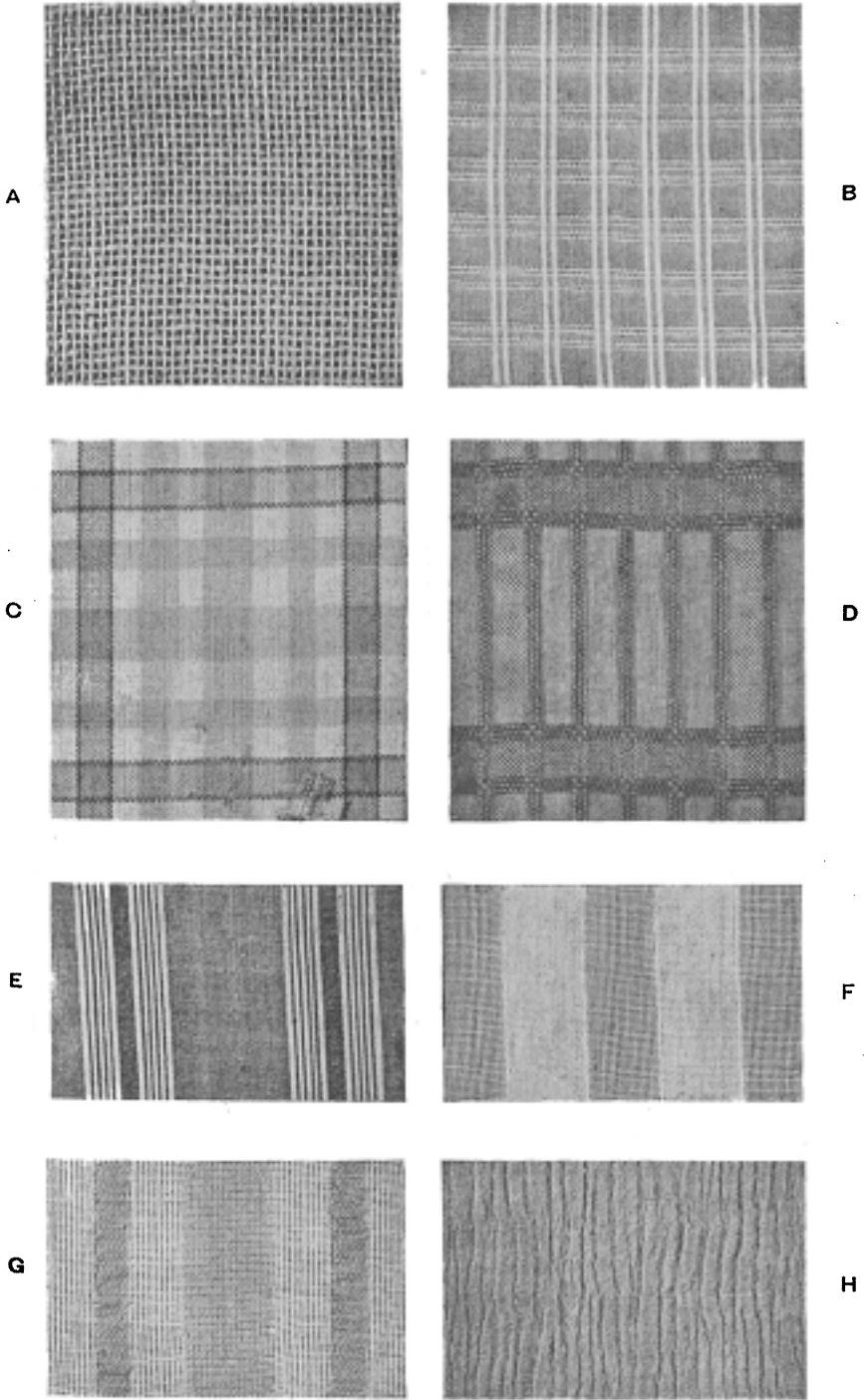


Fig. 2.

ruled to suit the ratio of warp threads to weft threads, while the arrangement of the hooks and needles in a jacquard is a determining factor. Examples of differently ruled paper are given in Fig. 258.

### PLAIN WEAVE

In plain weave the threads interlace in alternate order, and if the warp and weft threads are balanced—that is, are similar in thickness and number per unit space, the two series of threads bend about equally. This is illustrated at G in Fig. 1, which shows how the first pick of E interlaces, and at H, which represents the interlacing of the last end of E. In this class of plain cloth each thread gives the maximum amount of support to the adjacent threads, and in proportion to the quantity of material employed, the texture is stronger and firmer than any other ordinary cloth. The weave is used for structures which range from very heavy and coarse canvas and blankets made of thick yarns that are numbered by the yards per ounce, to the lightest and finest cambrics and muslins, which are made in cotton yarns of 150's count and upwards. In the trade such terms as tabby, calico, alpaca, and taffeta are applied to plain cloth.

Plain weave produces the simplest form of interlacing, but it is used to a greater extent than any other weave, and diverse methods of ornamenting and of varying the structure are employed, as for example: Threads which are different in colour, material, thickness, or twist are combined; the number of threads per split of the reed, or of picks in a given space, is varied in succeeding portions of a cloth; the ends are brought from two or more warp beams which are differently tensioned, or are passed in sections over bars by which they are alternately slackened and tightened; while by means of a specially shaped reed which rises and falls the threads are caused to form zig-zag lines in the cloth. Two or more of the foregoing methods may be employed in the same cloth, and after weaving further variety may be produced by the processes of dyeing, printing, mercerising, and finishing. A number of different kinds of plain cloth are illustrated in Fig. 2. A represents a plain white canvas cloth; B shows the combination of threads which vary in thickness in both warp and weft; in C the threads are all of the same thickness, but different colours are combined in check form; in D the threads are the same in colour, but in both warp and weft they vary in material (silk and cotton) and in thickness; E illustrates the combination of threads which are different in colour and in thickness; in F the pattern is formed by combining different orders of denting; G shows a crinkled or "crepon" stripe produced by using two warp beams which are differently tensioned; while H represents an all-over crepon effect that is due to the use of hard-twisted (crepon) weft which, when the cloth is scoured, shrinks irregularly.

### WEAVES DERIVED FROM PLAIN WEAVE

The next simplest form of interlacing to plain weave consists of extending the latter either vertically, or horizontally, or both vertically and horizontally, by which warp rib, weft rib, and hopsack or mat weaves are respectively produced.

**Warp Rib Weaves.**—These result from extending the plain weave vertically, as shown in the examples given at A to F in Fig. 3. A, B, and C produce regular warp ribs in which each end passes alternately over and under 2, 3, and 4 picks

respectively, and is brought prominently to the surface on both sides of the cloth. This is shown at G in Fig. 3, which indicates how the ends interlace with the picks in the plan A. Lines or ribs, that are equal in size, are formed running the width of the cloth, as shown in Fig. 4, which represents a fabric produced in the weave given at A in Fig. 3.

D, E, and F in Fig. 3 are irregular warp ribs, which produce horizontal lines that are unequal in size. In D and E the odd ends are chiefly on the surface (taking the marks to indicate warp up), while the even ends are mostly on the back, as shown at H, which represents how the threads interlace to correspond with the

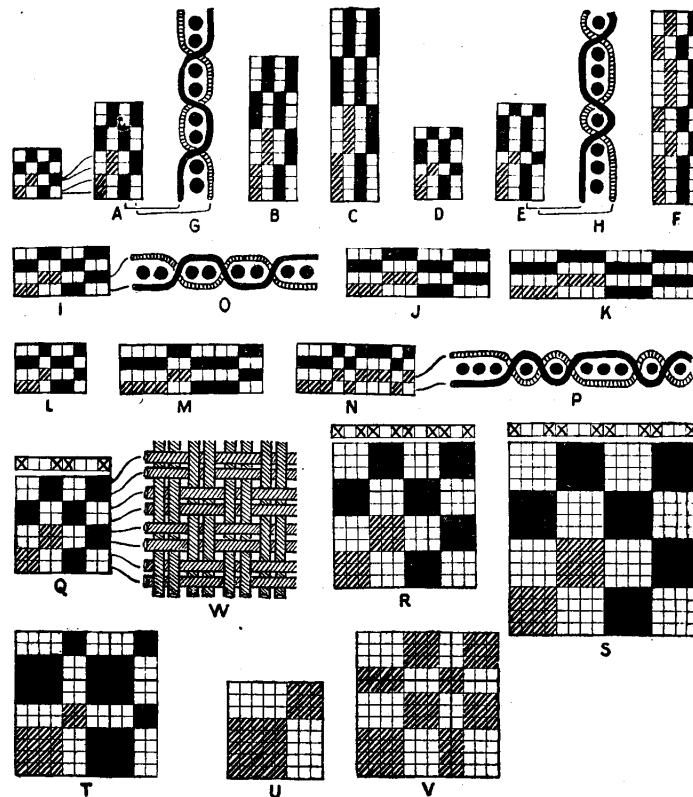


Fig. 3.

weave E. By using a good class of material, such as silk, for the odd ends, and a cheaper material—say, cotton—for the even ends, a cloth with a good appearance may be economically produced in designs such as D and E. In the design F in Fig. 3 a wide rib alternates with two finer ribs, but in this case all the ends are equally on the surface.

**Weft Rib Weaves.**—These are opposite to warp rib weaves, and result from extending the plain weave horizontally, as shown in the examples I to N in Fig. 3. In I, J, and K, which are regular weft ribs, each pick of weft passes alternately under and over 2, 3, and 4 ends respectively; the weft is brought prominently

to the surface and forms lines running the length of the cloth on both sides. L, M, and N are irregular weft ribs, which produce longitudinal lines that are unequal in size; and L and M, in which the even picks are mostly on the surface (taking the marks to indicate warp up), may be economically woven with better material for the even than for the odd picks. The diagrams O and P respectively correspond with the plans I and N, and show how the picks interlace with the ends. The fabric represented in Fig. 4, if turned one-quarter round, will illustrate the appearance of a weft rib weave. (Special classes of rib weaves are described and illustrated in Chapter VII.)

**Hopsack, Mat, or Basket Weaves.**—These are constructed by extending the plain weave both vertically and horizontally, so that in both directions there are two or more threads working together in the same order. Q, R, and S in Fig. 3 are regular hopsacks arranged respectively 2-and-2, 3-and-3, and 4-and-4; the warp and weft show equally on the surface of both sides of the cloth in the form of small equal-sized squares or rectangles. The flat-view given at W represents

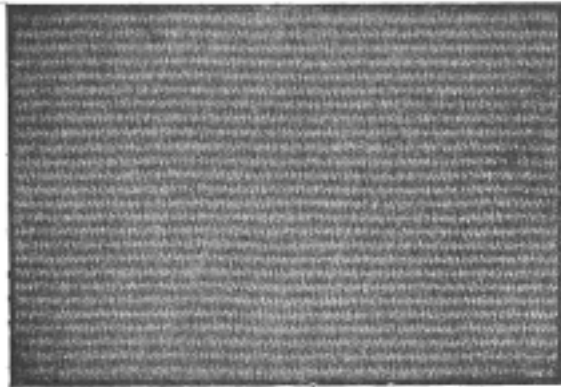


Fig. 4.

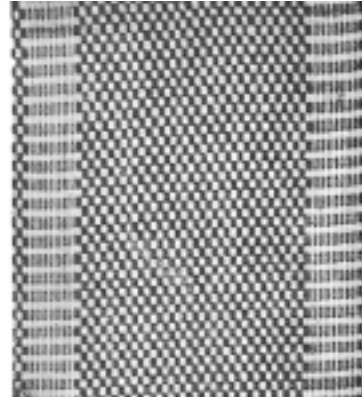


Fig. 5.

how the threads interlace in the weave Q, while a fabric to correspond is illustrated in Fig. 5. T, U, and V in Fig. 3 are irregular hopsack weaves, which form unequal spaces in the cloth. On account of the loose method in which the threads interlace in ordinary hopsack weaves, large designs are only employed in fine fabrics. Special methods of obtaining greater firmness and variety in the weaves are illustrated in Fig. 75.

**Denting of Weft Rib and Hopsack Weaves.**—The ends which work together tend to twist or roll round each other as the cloth is woven, and if this takes place the cloth suffers in appearance, while the weaving process is made more difficult. The twisting of the ends can be prevented by denting them in such a manner that those which work alike are separated by the wires of the reed. Above each plan Q, R, and S in Fig. 3 a system of denting is given in which the marks and blanks indicate the order in which the ends are passed together through the reed, the threads of a group being passed through different splits. The same orders of denting are applicable to the weft rib weaves I, J, and K.

Cloths are produced in plain weave which resemble the plan given at A in Fig. 3



by inserting the weft in double picks, and a special effect is sometimes obtained by having differently coloured threads wound alongside each other on the cops or pirns. The withdrawal of the weft in the direction of the length of the pirn or cop causes the threads to make one twist round each other for every revolution made by them on the pirn or cop. The slight amount of twist thus inserted causes the colours to show intermittently in the cloth, an irregular or streaky colour effect being formed, as shown in the fabric represented in Fig. 6. A similar effect to the

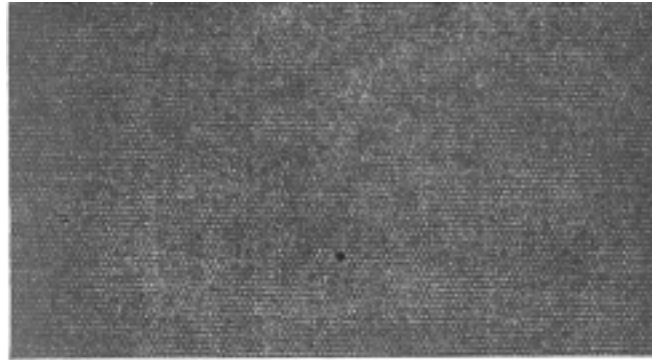


Fig. 6.

plan given at I in Fig. 3 is obtained in plain weave by placing two ends in each mail, in which case, if they are differently coloured, the rolling of the threads round each other causes the colours to show intermittently in the cloth.

### REPETITION OF WEAVES

Any weave repeats on a certain number of ends and picks (or of vertical and horizontal spaces); generally only one repeat need be indicated on design paper. In most of the examples given in Fig. 3 four repeats are shown, but one exact repeat is indicated by shaded marks. The number of ends and picks in a repeat may be equal, or unequal, but in every case the complete repeat must be in rectangular form on account of the threads interlacing at right angles. For instance, a weave cannot take the form shown at A in Fig. 7; if, as shown in the example, any part of the complete repeat extends over 10 ends and 10 picks, every other portion must extend over 10 ends and 10 picks.

It is necessary for the marks and blanks to join correctly at the sides, and at the top and bottom of a design, in order that when the pattern is repeated in the loom from side to side and from end to end of the cloth an unbroken weave will result. The joining of the repeats of a weave is illustrated at B and C in Fig. 7, in which B shows four complete repeats of a weave on 6 ends and 6 picks detached from each other. In each repeat the last end and pick respectively join correctly with the first end and pick, so that when the repeats are put together, as shown at C, a continuous and unbroken weave is formed. A warp, 30 inches wide, with 80 ends per inch, will contain  $30 \times 80 = 2,400$  ends, which will give  $2,400 \div 6 = 400$  repeats of the weave B across the width of the cloth.

D and E in Fig. 7 show that a weave may appear different on account of being

commenced in a different position, if only one repeat is shown, but such an alteration does not cause any change in the woven cloth, as either D or E will produce exactly the same effect as C.

### DRAWING OF FLAT-VIEWS AND SECTIONS OF CLOTHS

The representation of simple cloths by means of drawings, used in conjunction with the design paper method, is of great assistance in enabling systems of interlacing to be understood; while in many complex structures it is almost impossible to reason out how the threads interlace without the aid of drawings. A simple, but convenient, method of constructing flat-views and sections is illustrated at F to K in Fig. 7. First, vertical and horizontal lines, to represent the positions

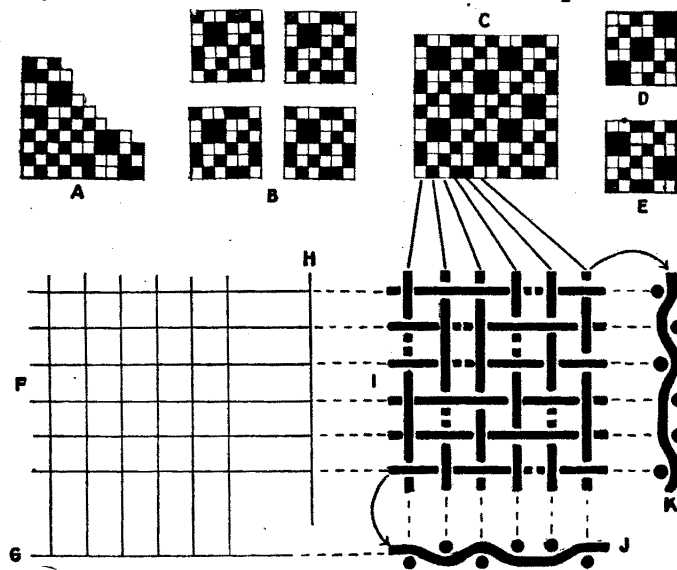


Fig. 7.

of the warp and weft threads, are ruled faintly in pencil about three-sixteenths of an inch apart, as shown at F, and lines are drawn below and alongside, as indicated at G and H. The vertical lines are then thickened to correspond with the surface warp floats, and the horizontal lines to correspond with the surface weft floats, as shown at I in Fig. 7, which is a representation of one repeat of the design given at C, the marks in the latter being taken to indicate warp up. Also, where there is a float on the underside the lines are dotted between the threads. D in Fig. 1. and W in Fig. 3 illustrate more elaborate methods of constructing flat-views, in both of which each thread is first represented by a double base line.

In constructing the warp section given at J in Fig. 7, which shows how the first pick of I interlaces, the ends that are raised are indicated above, and those that are depressed, below the construction line G, the interlacing of the pick being then readily shown. A similar method is employed in drawing the section through the weft given at K, which shows how the last end of I interlaces with the picks. (The foregoing method of constructing sections is sufficiently accurate when they

are drawn in conjunction with a flat-view, but a more correct method is illustrated in Fig. 11, in which the threads that are floated over in succession are placed close together.)

### SIMPLE OR ORDINARY TWILL WEAVES

The twill order of interlacing causes diagonal lines to be formed in the cloth, as shown in the fabric represented in Fig. 8. The weaves are employed for the purpose of ornamentation, and to enable a cloth of greater weight, substance, and firmness to be formed than can be produced in similar yarns in plain weave. Twilled effects are made in various ways, but in simple or ordinary twills (which are now under consideration) the points of intersection move one outward and one upward on succeeding picks. A twill cannot be made upon two threads, but upon any number that exceeds two; a simple twill is complete upon the same number of picks as ends (or of horizontal spaces as vertical spaces). Twill lines are formed on both sides of the cloth, and the direction of the lines may be either to the right or to the left, but the direction on one side is opposite to that on the other side when the cloth is turned over. Warp and weft floats on one side of the cloth respectively coincide with weft and warp floats on the other side; thus, if warp float predominates on one side weft float will predominate in the same proportion on the other side.

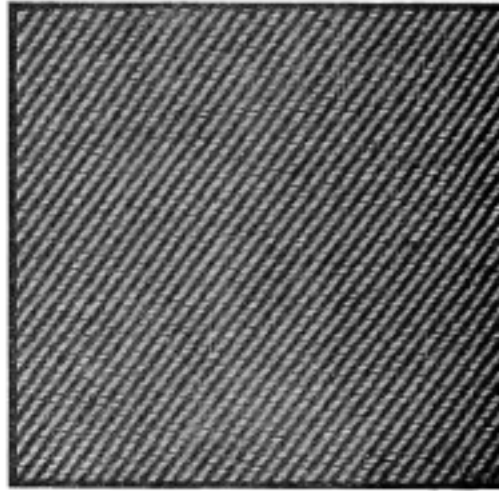


Fig. 8.

A, B, C, and D in Fig. 9 illustrate all the possible ways in which twills on three threads may be woven. If A forms the face C will form the reverse side when the cloth is turned over, and *vice versa*; and in the same manner B and D are the reverse of each other. Actually only one twill order of interlacing—viz., 1-and-2—is possible on three threads, but, as shown at A, B, C, and D, the twill may run either to right or left, and there may be either one-third or two-thirds of either yarn on the surface. The terms “Cashmere,” “Jean,” “Jeannette,” and “Genoa” are applied to the 1-and-2 twill.

On four threads two twill orders of interlacing can be made—viz., 1-and-3 and 2-and-2—but as the 1 and-3 order may be arranged with either weft or warp predominating, three different twills can be formed, each of which may be inclined in either direction. Hence twills on four threads may be formed in six ways, as shown at E, F, G, H, I, and J in Fig. 9. The weaves E, F, and G on one side will have H, I, and J respectively on the other side when the cloth is turned over. Next to plain weave the 2-and-2 twill, which is similar in appearance to Fig. 8, is probably used more than any other weave, and it is known by special terms;

as, for instance, "serge," "blanket," "sheeting," "shalloon," and "cassimere." The term swansdown is applied to the 1-and-3 twill weave.

On five threads six twill weaves, running to the right, may be woven, as shown at K to P in Fig. 9, while similar effects may be made twilling to the left. K and N are opposite to each other, and also L and M, and O and P; therefore, if one weave of a pair is formed on the face, the other weave will be formed on the reverse side, but twilling in the opposite direction, when the cloth is turned over. Actually, there are only three different orders of interlacing, and the six weaves can be

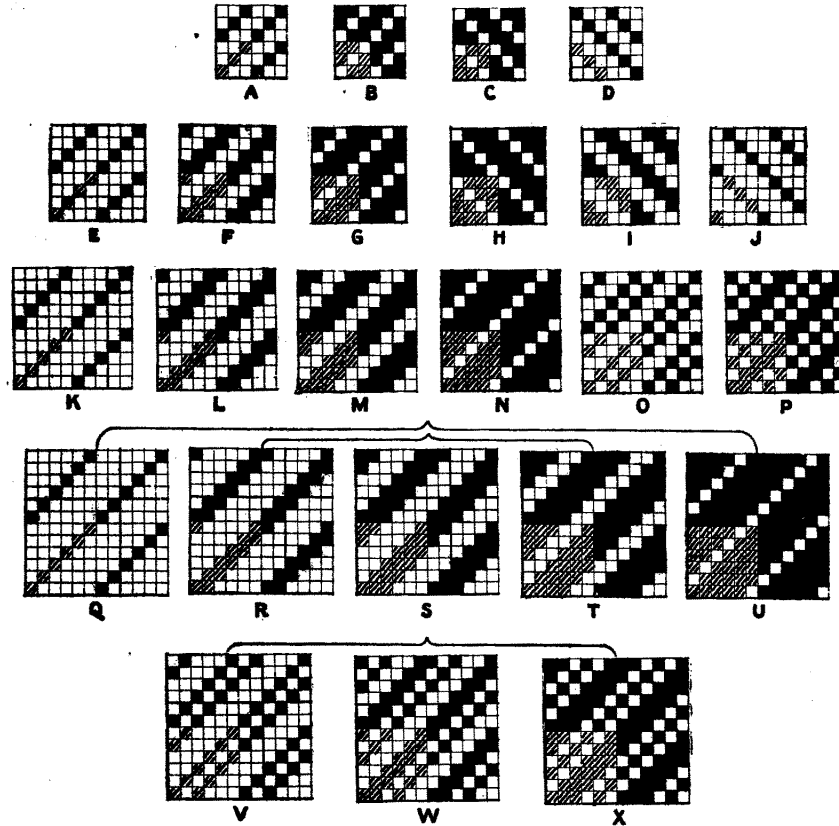


Fig. 9.

obtained from the plans K, L, and O by taking the marks to indicate first warp up, and then weft up.

The complete series of 6-thread twills, running to the right, is given at Q to X in Fig. 9, and, as before, each twill may be inclined in the opposite direction. There are really only five different orders of interlacing, as the weaves that are bracketed together are alike except that in one the marks predominate, and in the other the blanks. In S and W the warp and weft floats are equal, and each produces the same effect on both sides of the cloth, but the twill lines run in opposite directions. Fig. 8 illustrates the appearance of the Design S.

A systematic method of constructing simple twills is illustrated in Fig. 10,

which shows all the possible effects on seven threads. A single row of marks is inserted in the first weave A, then in each weave B to F a line of marks is successively added alongside. Commencing again with A, a single line of marks, separated by one space from the marks previously inserted, is added to A, B, C, and D, as shown at G, H, I, and J; then the single line is placed two spaces distant, as shown at K, L, and M; and afterwards three spaces apart, as indicated at N and O. A double line of marks is then added to A, B, and C with one space between, as shown respectively at P, Q, and R; then to A and B with two spaces between, as indicated at S and T; and afterwards to A with three spaces between, as shown at U. A commencement is again made with A, and two separate lines of marks are added, as shown at V and W.

The process may be carried still further in constructing twills on a larger number of threads, and by working systematically, as shown in the foregoing, it is possible to ensure that all the possible twills are obtained. It is necessary, however, to examine the weaves carefully, and weed out those that are duplicates of others. In Fig. 10, for the purpose of illustration, duplicate weaves (which are indicated in dots) are included, and it will be found that H, O, P, and U are alike, also I and M, K and N, L and S, and Q and T. A close

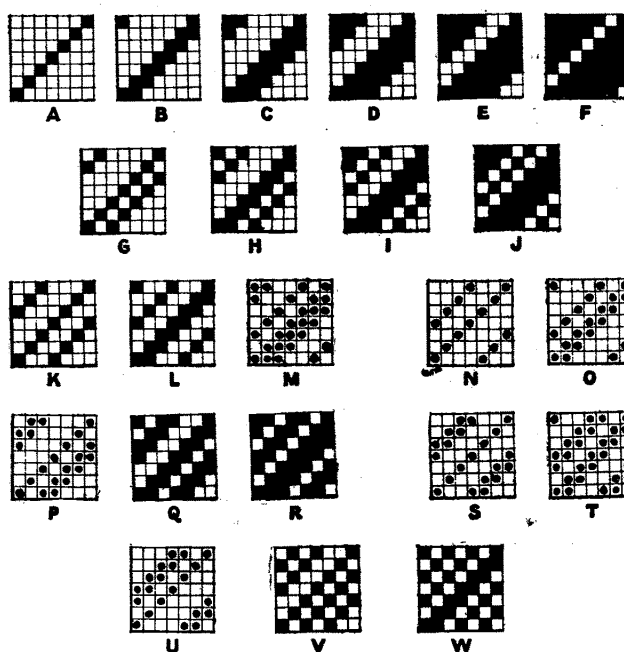


Fig. 10.

examination will also show that seven threads only give eight different twill orders of interlacing, since in the following pairs the weaves are opposite to each other:—A and F, B and E, C and D, G and J, H and I, K and R, L and Q, and V and W. Further, it will be seen that each plan A to F contains one warp and one weft float in the repeat, or is in two parts; each plan G to U contains two warp and two weft floats in the repeat, or is in four parts; while in V and W a repeat contains three warp and three weft floats, or is in six parts.

**Relative Firmness of Twill Weaves.**—Where a weave changes from marks to blanks, and *vice versa*, the warp and weft threads correspondingly change from one side of the cloth to the other, or “intersect” each other. Each thread must make at least two intersections in a complete repeat of a weave, one in passing from the face to the back, and another in passing from the back to the face; otherwise

the thread will float continuously on one side of the cloth. The intersecting of the threads gives the cloth firmness, and (with certain exceptions) the more frequent the intersections are the firmer the cloth is. If a twill fabric is correctly built "on the square"—that is, with the warp and weft threads equal in thickness and in number per inch—each intersection causes the threads to be separated by about the thickness of a thread. Therefore, other things being equal, the more frequently the intersections occur the further apart should the threads be placed. This is illustrated in Fig. 11, in which three 8-thread twill weaves are given at A, B, and C, while the interlacings of the first pick of the designs are represented at D, E, and F respectively, the marks being taken to indicate warp float. The dotted vertical lines are placed apart a distance equal to the diameter of a thread, and each intersection is taken to occupy a space equal to a diameter. (This is not strictly accurate, but is near enough for practical purposes.) Weave A repeats on eight threads,

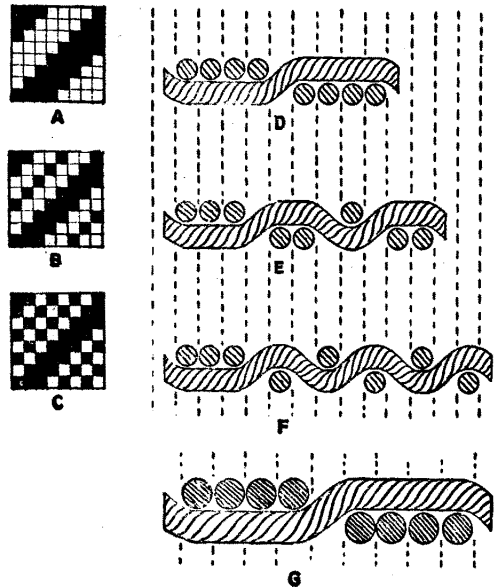


Fig. 11.

and each thread has two intersections, and thus occupies the space of ten diameters, as shown at D; the repeat of B contains eight threads and four intersections, and thus occupies the space of twelve diameters, as represented at E; while in the repeat of C there are eight threads and six intersections, which occupy the space of fourteen diameters, as indicated at F.

It will be readily understood that a cloth, which is of suitable firmness when woven in the weave C, will be looser if woven in the weave B, and will be still more lacking in firmness if woven in the weave A. That is, assuming that the warp and weft threads are the same thickness in each case, B will require more threads per unit space than C, and A than B; the relative proportions being (approximately) A 12 threads to B 10 threads; A 14 threads to C 10 threads; and B 14 threads to C 12 threads. On the other hand, assuming that the threads per unit space are the same in each case, thicker threads can be employed for A than for B, and for B than for C. This is illustrated at G, which represents the thickness of the yarn (approximately) that can be employed for the weave A if the threads per unit space are the same as for the weave C. It will be seen that 10 diameters in G occupy the space of 14 diameters in F. A loose weave (such as A), therefore, allows more yarn to be put into a cloth than a firmer weave (such as B), and permits a heavier cloth to be formed.

**Large Twills or "Diagonals."**—The term "diagonal" is applied to large twills, particularly those which show a prominent line, as in the example repre-

sented in Fig. 12. In Fig. 13 a method of designing diagonals is illustrated, which can be employed in constructing twills upon any number of threads. It is first necessary to decide upon the number of threads in the repeat, and then to consider the general prominence of the main line or lines of the twill, and whether warp or weft shall be brought chiefly to the surface; the latter point being mainly decided

by which is the better material. If the weft is superior to the warp, the weft float should predominate over the warp float, and *vice versa*, but if the warp and weft are similar in quality both may be floated equally. Frequently, however, a predominance of weft float is preferred, because as a rule, the weft is rather more lustrous than the warp on account of containing less twist. The next point to consider is the number of intersections in the repeat, which should be sufficient to give the cloth the proper firmness. The

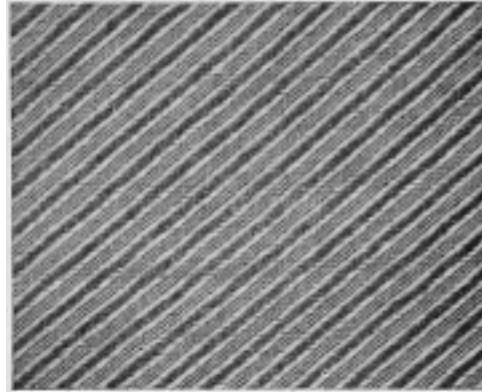


Fig. 12.

twill may then be arranged according to the pattern and structure required; and experiments can conveniently be made by indicating the marks in various ways on the first horizontal space of a number of plans, as shown by the crosses in the examples A, B, and C in Fig. 13. Such arrangements as are considered

satisfactory may then be carried out in full by copying the marks one square to the right on succeeding horizontal spaces, as shown at A and C, or one square to the left, as shown at B, according to the direction in which the twill is required to run. The marks are continued from one side to the other, and from the top to the bottom of the plan in such a

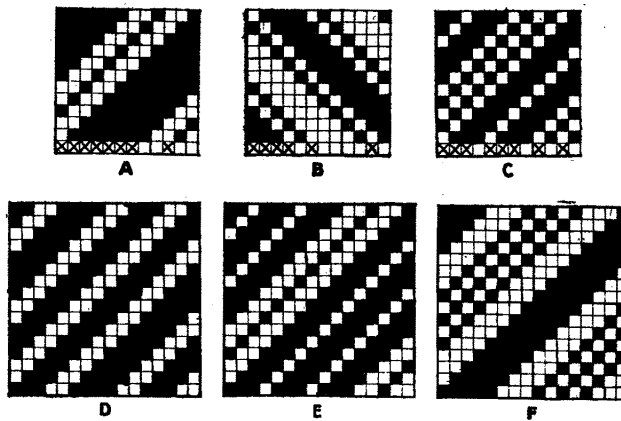


Fig. 13.

manner that the twill lines will be unbroken in succeeding repeats; and when the design is completed the same number of marks will have been inserted upon each horizontal and each vertical space.

In A and C (Fig. 13) the marks predominate over the blanks, and will, therefore, indicate warp or weft float according to whether the warp or weft is the better yarn, whereas in B it is immaterial what the marks indicate. As regards the number

of intersections it may be considered advisable, in constructing a large twill, to obtain about the same degree of firmness as is produced by a smaller twill in the same cloth. Thus, A in Fig. 13 contains four intersections in twelve threads, and is, therefore, equal in firmness to 3-and-3 twill, which contains two intersections in six threads. B contains six intersections in twelve threads, and is, therefore, equal in firmness to 2-and-2 twill, which contains two intersections in four threads, while C, in which there are eight intersections in twelve threads, corresponds in firmness to 1-and-2 twill, which has two intersections in three threads.

In constructing a large twill that contains a number of small lines in the repeat, it is necessary to avoid making the lines too much alike. The 16-thread twill, given at D in Fig. 13, is defective in this respect, as it is very little different from a 5-thread twill which can be more economically woven. With a slight alteration, as shown at E, the weave appears distinctly as a 16-thread twill. F in Fig. 13, which corresponds with the fabric represented in Fig. 12, shows distinctly as a large twill, yet it is equal in firmness to 2-and-2 twill.

The interlacing of the threads in twill weaves may be indicated graphically in the following manner:—2-and-2 twill,  $\frac{2}{2}$ ; 3-and-3 twill,  $\frac{3}{3}$ ; and the twills in Fig. 13, A,  $\frac{7\ 1}{2\ 2}$ ; B,  $\frac{4\ 1\ 1}{1\ 4\ 1}$ ; C,  $\frac{3\ 3\ 1\ 1}{1\ 1\ 1\ 1}$ ; D,  $\frac{3\ 4\ 3}{2\ 2\ 2}$ ; E,  $\frac{3\ 3\ 3\ 1}{1\ 1\ 2\ 2}$ ; and F,  $\frac{5\ 1\ 1\ 1}{3\ 1\ 1\ 3}$ . The numbers above the line may be taken to represent the marks, and those below the blanks, on either the first horizontal or the first vertical space.

**Influence of the Twist of the Yarns.**—The twist, which is put into yarns in order to bind the fibres together, affects the handle, strength, and wearing property of a cloth, and also has a considerable influence upon the appearance of a fabric in which any form of twill line is developed. Generally, just sufficient twist is inserted to enable the threads to withstand the strain of weaving. More turns per inch are required in fine than in thick threads, and for short than for long-fibred materials, while warp yarns are mostly harder twisted than weft yarns. The twist, while strengthening the yarn, makes it harder, and reduces its lustre, and to many fabrics the necessary firmness of structure is imparted by the warp, and softness and brightness by the weft. For special purposes yarns are twisted more or less than the normal according to the effect required in the cloth; thus “voile” and “crepon” yarns are very hard twisted, whereas yarns for raised fabrics are twisted soft.

If the direction of the twist is to the right, as shown at A in Fig. 14, it is termed “open-band,” and if to the left, as represented at B, “cross-band.” In cotton yarns A represents warp twist (twist way), and B weft twist (weft way), whereas in worsted yarns warp twist is as shown at B, and weft twist as shown at A. Single woollen yarn is almost invariably twisted, as indicated at B. In folded yarns the twist is mostly inserted in the opposite direction to that of the single threads, because this causes some of the twist to be taken out of the singles, and a softer folded yarn results than if the direction of the twist is the same in both twisting operations; the latter method increases the twist in the singles, and tends to make the folded yarn hard.

C, D, E, and F in Fig. 14 illustrate the different ways in which the warp and



weft threads may be placed in relation to each other as regards the direction of the twist. In C the warp twist is as shown at A, and the weft twist as at B, the surface direction of the twist being to the right in both threads when the weft is laid at right angles to the warp. D is the exact opposite of C, the surface direction of the twist being to the left. In E both series of threads are twisted as shown at A, and in F as at B. In C and D the direction of the twist, on the under side of the top thread, is opposite to that on the upper side of the lower thread, hence the threads do not readily bed into, but tend to stand off from each other, which assists in

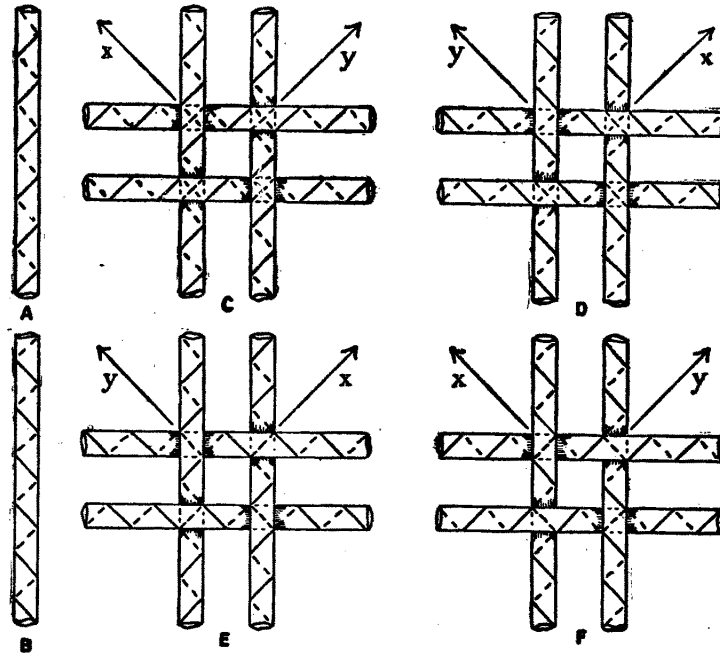


Fig. 14.

showing up the weave and structure of the cloth distinctly. In E and F, on the other hand, the twist on the underside of the top thread is in the same direction as that on the upper side of the lower thread, hence in this case the conditions are favourable for the threads to bed into each other and form a compact cloth in which the weave and thread structure are not distinct.

In twill fabrics the clearness and prominence of the twill lines are accentuated if their direction is opposite to the surface direction of the twist of the yarn. If, however, the lines of a twill are required to show indistinctly, the twill should run the same as the surface direction of the twist of the yarn. If one yarn predominates on the surface the twill should oppose, or run with, the twist of the surface threads according to whether the effect is required to show prominently or otherwise. Thus, in C and D in Fig. 14 the arrows X indicate the direction in which the twill should run if the lines are required to show boldly and clearly, and the arrows Y if an indistinct twill effect is desired. In E and F the arrows X show the proper direction for producing a bold twill, and the arrows Y for producing an indistinct

twill if the weft yarn predominates on the surface. If, however, the warp forms the face of the cloth in E and F, the arrows Y indicate the proper direction for a bold twill effect, and the arrows X for an indistinct twill.

If a twill runs both to right and left in a cloth (a herring-bone twill), it shows more clearly in one direction than the other. Also, the difference in the appearance of right and left twist is sufficient to show clearly in a twill fabric in which the weave is continuous, and "shadow" effects are produced in warp-face weaves by employing both kinds of twist in the warp threads.

### SATEEN WEAVES

In pure sateen weaves the surface of the cloth consists almost entirely either of weft or warp float, as in the repeat of a weave each thread of one series passes

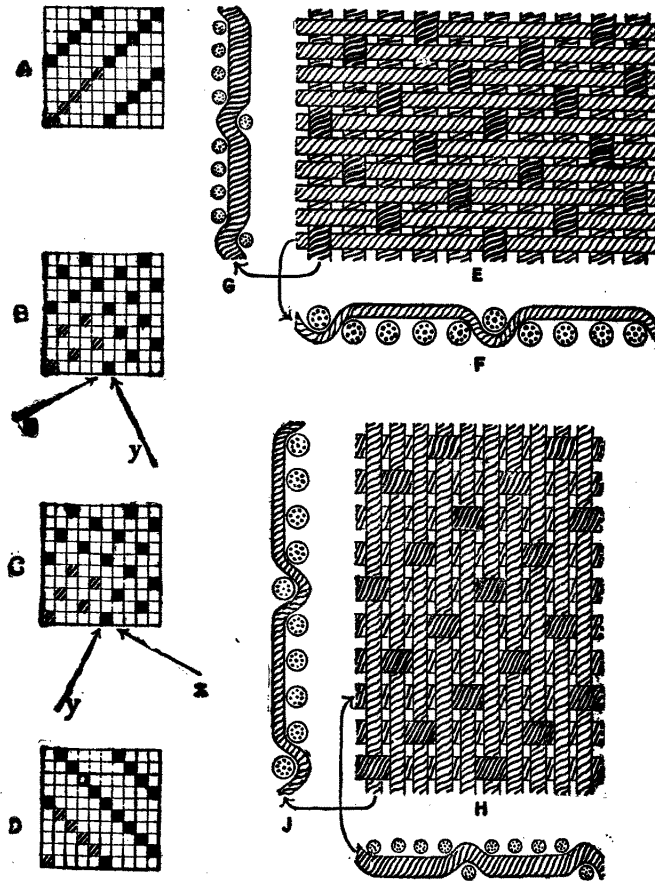


Fig. 15

over all but one thread of the other series. The production of what is practically a solid weft or a solid warp surface is a valuable feature in certain fabrics, but this is by no means the limit of the usefulness of sateens, as they are extensively

employed as bases of textile designs. The weaves are of two kinds—viz., regular sateens and irregular sateens.

**Regular Sateen Weaves.**—The examples given in Fig. 15 will enable the construction of twills and regular sateens to be compared. In twill weaves the distance from a mark on one thread to the corresponding mark on the next thread—termed a step, move, or count—is one, hence in the cloth the intersections support each other, and distinct twill lines are formed. In regular sateen weaves the step, move, or count is more than one, so that the intersections do not support each other, but as the distance moved each time is equal and regular a certain degree of twilliness is formed in the cloth. In the same yarn the prominence of the twill line varies according to (a) the order in which the threads interlace; and (b) the direction of the twill line in relation to the direction of the twist of the yarn. In the best regular sateens the points of intersection are equally distributed over the repeat area, and if the twill lines and the twist run in the same direction, a smooth, lustrous, and almost untwilled surface is formed.

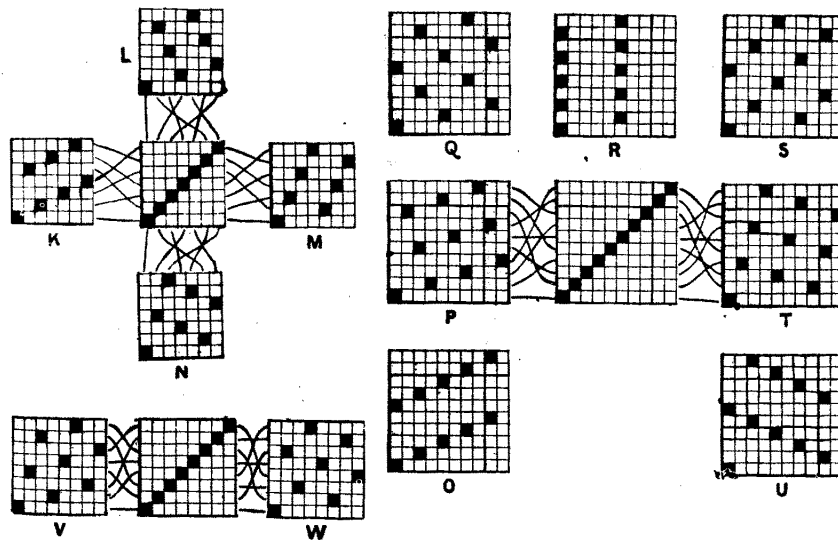


Fig. 16.

In Fig. 15, A shows a 5-thread twill in which the marks are arranged in the order of 1, 2, 3, 4, and 5; in B the move or count is two to the right, hence the marks are indicated on the spaces in the order of 1, 3, 5, 2, and 4; while in C the count is three to the right, the order of arrangement being 1, 4, 2, 5, and 3. By counting one less than the number of threads in the repeat a reversed twill is produced, as shown at D in Fig. 15. If a weft sateen surface is required the marks will represent warp up, and the angle of the twill line will be that indicated by the arrows X. If, however, the surface is warp sateen the marks will represent weft up, and the arrows Y will indicate the angle of the twill line. The designs B and C are alike, except that the twill lines run in opposite directions.

E in Fig. 15 shows a flat view of the plan B, assuming that a weft surface is formed, while F represents the interlacing of the first pick, and G of the first end. If the twist in the yarn is in the direction indicated on the threads in E the twill

lines will show indistinctly. (The term "broken twill" is applied to 5-thread weft sateen cotton fabrics in which the twill line is scarcely discernible.) The flat view, given at H in Fig. 15, corresponds with the design B, assuming that a warp surface is formed, the interlacing of the third pick being represented at I, and of the first end at J. In this case if the threads are twisted in the direction indicated, a rather distinct twill, running to the left, will be formed. (In cotton cloths the term "drill" is frequently applied to this structure.)

All the possible sateens on seven threads are given in Fig. 16 at K, L, M, and N, the threads of which are shown connected by lines with the 1-and-6 twill. K is constructed by counting two, L by counting three, M by counting four, and N by counting five, in each case to the right on succeeding picks. It will be seen, from an examination of the foregoing weaves, that the move may be either upward or outward; thus, in K the count upwards is four; in L, five; in M, two; and in N three on succeeding ends. N is similar to K, and M to L, but twilling in the opposite direction, and it will be noted that in each design the count is two either outward or upward, and to right or left. A typical sateen structure is not produced

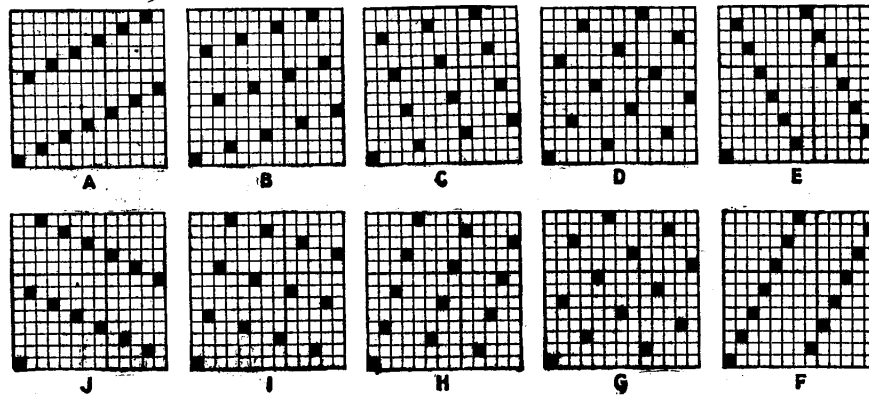


Fig. 17.

on seven threads, because the points of intersection fall into distinct lines in one or other direction.

O, P, Q, R, S, T, and U in Fig. 16 are constructed on ten threads by counting 2, 3, 4, 5, 6, 7, and 8 respectively, but only P (counting 3) and T (counting 7), which are similar but twilling in opposite directions, are proper weaves. In each of the others no marks are placed on some of the threads, hence 2, 4, 5, 6, and 8 cannot be counted in designing sateens on ten threads. From the example the following rule for the construction of regular sateens may be drawn:—Any number (with the exception of one, and a number that is one less than the number of threads in the repeat) may be counted which has no measure in common with the number of threads in the repeat of the weave. Similar effects, but twilling in opposite directions, are produced by counting in numbers that are respectively higher and lower than half the number of threads in the repeat. Thus, on eight threads, only 3 and 5 can be counted, which produce similar but opposite twilling effects, as shown at V and W in Fig. 16.

In Fig. 17 all the possible sateens on thirteen threads are given at A, B, C

D, E, F, G, H, I, and J, which are produced by counting 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 respectively. Similar sateens result from counting 2 and 11, 3 and 10, 4 and 9, 5 and 8, and 6 and 7, and in Fig. 17 the weaves are arranged in pairs one above the other to correspond. A, E, F, and J give poor sateen effects, because of the distinct twill lines that are formed; B, C, H, and I are better, but in each of these the marks form a more prominent line in one direction than in the other; in D and G, however, the distribution of the marks is perfect.

**Irregular Sateen Weaves.**—Regular sateens cannot be constructed on four and six threads, because no number can be counted which has not a measure in common with four and six.

A in Fig. 18 shows the 4-thread sateen in which the marks are arranged in the order of 1, 2, 4, and 3; the terms broken twill and broken swansdown are applied to the weave. In

the 6-thread sateen, given at B in Fig. 18, the marks are arranged in the order of 1, 3, 5, 2, 6, and 4. Irregular sateens are entirely free from twill lines, a feature that frequently gives them an advantage over regular sateens, and for this reason sateens are arranged irregularly on eight, ten, twelve, etc., threads. C

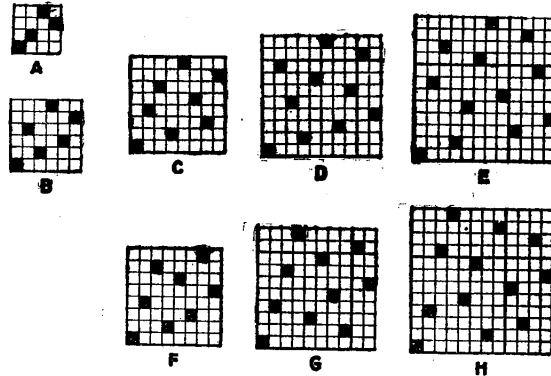


Fig. 18.

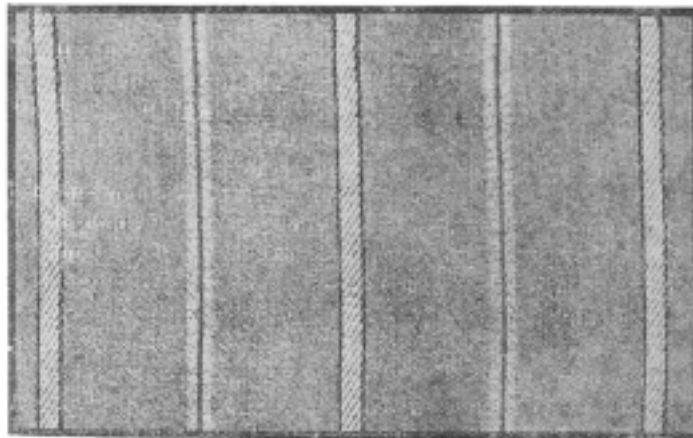


Fig. 19.

in Fig. 18 shows an irregular sateen on eight threads, in which 3 is counted to the right for four picks; on the fifth pick the count is equal to half the number of threads in the repeat—viz., 4—then on the succeeding picks 3 is counted to the left. A 10-thread irregular sateen is given at D, in which the count is 3

for half the number of picks, then 5 is counted, and afterwards the move is in 3's to the left. In the 12-thread irregular sateen given at E the count is 3 and 5 alternately for six picks, then 6, and afterwards 3 and 5 alternately to the left. The weaves F, G, and H respectively correspond with C, D, and E, and are constructed in the same manner except that the count is upward instead of outward.

In pure sateen weaves it is only possible to introduce different colours effectively in the threads which form the surface. In weft sateens, however, the colours run transversely, which is seldom desired, so that the introduction of coloured threads is practically limited to warp sateens. The latter weaves, however, so long as the warp threads are of good quality and free from lumps and thick places, are particularly suitable for displaying colours in stripe form, because the smooth, lustrous, and almost unbroken surface of the cloth enhances the brightness of the colours. Different materials may also be effectively combined in the warp, and in Fig. 19 a five-thread warp sateen cloth is represented, in which differently coloured silk and cotton ends are employed, while the weave is varied by the introduction of narrow stripes of 4-and-1 warp twill.

## CHAPTER II

### CONSTRUCTION OF DRAFTS AND WEAVING OR PEGGING PLANS

Limitations in Tappet and Dobby Shedding. Methods of Indicating Drafts. *Systems of Drafting*—Straight-over Drafts—Sateen Drafts. *Conditions in Designing, Drafting, and Pegging*—Construction of Designs from Given Drafts and Pegging Plans—Construction of Drafts from Given Designs and Pegging Plans—Construction of Drafts and Pegging Plans from Given Designs. Reduction in Fineness of Healds. *Heald Calculations*—Casting-out in Healds.

A DRAFT indicates the order in which the warp threads are drawn through the eyes or mails of the healds (the terms shafts, leaves, staves, cambs, and heddles are synonymous with the term healds). A weaving or pegging plan indicates the order in which the healds rise and fall. The weave or design results from the combination of the draft and the weaving or pegging plan.

**Limitations in Tappet and Dobby Shedding.**—The weaves now under consideration are such as can be woven in tappet or doobby looms, in both of which types there are certain limitations with which the designer should be familiar. Tappet looms, which are required to produce only one kind of weave, are, for economical reasons, made as simple in construction as possible, provision only being made for operating the required number of healds in the precise order desired. Thus, looms that are built to weave plain cloth only will accommodate not more than two healds (or four healds coupled together in pairs), which are operated in alternate order. In other cases tappet looms are built to accommodate any number of healds from two to five, and to weave designs repeating on from two to five picks. Again, some tappet looms will accommodate any number of healds up to eight, and can be arranged to weave any design repeating on eight or a less number of picks, and it may be taken that eight healds, and eight picks to the repeat is the general limit in ordinary tappet shedding. Further, a set of ordinary tappets will only produce one, or at most a small group of interlacings (with the same

tappets the 2-and-2, 3-and-3, and 4-and-4 orders of interlacing can be obtained). Woodcroft tappet looms, however, are built to accommodate eight healds, and to weave designs repeating on as many as twenty-four picks, while looms furnished with oscillating tappets will take twelve healds and weave designs repeating on from fifty to one hundred picks. The special forms of tappets, moreover, can be readily changed so as to produce a variety of interlacings, but they are chiefly used in weaving heavy fabrics for which a positive shedding motion is necessary. Therefore, as a general rule, in constructing weaves for tappet looms, the designer is limited to what can be woven in an ordinary loom in which, for each different system of interlacing, a different form of tappet is required.

Dobby shedding motions are constructed in different sizes, and will operate from eight to twenty-four healds (sometimes more), according to the build; from sixteen to twenty healds being most common. As many healds as the doobby is built for, or any smaller number, can be employed, while the number of picks to the repeat is only limited by the amount of space and the method of support that are available for the lags which form the pattern chain. In experimental work, and when only a small length of cloth is required in a new weave, it is frequently found convenient and economical to use a doobby shedding motion for designs that are within the range of tappets.

Each heald represents one order of interlacing in a design; therefore, in ordinary tappet looms from two to eight different orders of interlacing, repeating on from two to eight picks, can be obtained, whereas in doobby shedding from two to twenty-four different orders, repeating on an almost unlimited number of picks, can be woven. In each type of loom diversity of design is produced by varying the draft and the weaving or pegging plan, both of which form important elements in the origination of designs.

#### METHODS OF INDICATING DRAFTS

Various methods of indicating drafts may be employed, as for instance—(a) By ruling lines, as shown in Fig. 20 at A, B, and C, in which the horizontal lines represent the healds, and the vertical lines the warp threads, while the marks placed where the lines intersect indicate the healds upon which the respective threads are drawn. (b) By the use of design paper, as shown at D, E, and F in Fig. 20, in which the horizontal spaces are taken to represent the healds, and the vertical spaces the warp threads. Marks are inserted upon the small squares to indicate the healds upon which the respective threads are drawn. This method is usually the most convenient. (c) By numbering, as shown by the numbers below the designs given at J, K, and L in Fig. 20, which refer to the number of the healds (the front heald is number one). In this case the threads are successively drawn on the healds in the order indicated by the numbers.

#### SYSTEMS OF DRAFTING

There are several well-defined orders of drafting which are known by such terms as the following:—Straight-over or straight-gate, sateen, skip, broken, reversed, herring-bone, transposed, pointed, curved, combined, etc.

**Straight-over Drafts.**—These can be made upon any number of healds within the capacity of the loom. The examples given at A, B, and C, and at D, E, and F

in Fig. 20 are straight-over drafts upon four, five, and six healds respectively. In this order of drafting the number of ends in the repeat of the woven design cannot exceed the number of healds employed, but may be a measure of the number of healds; the number of picks in the repeat may be equal to, or greater, or less than the number of healds. Thus, any weave, repeating upon two ends, or upon four ends, as shown at G and J in Fig. 20, is suitable for the draft A; any weave on five ends such as H and K is suitable for the draft B, while weaves repeating on two, or three, or on six ends, as shown at I and L, can be woven on the draft C. For the purpose of illustration, in each example more than one repeat of the design and the draft are given (different marks are shown in the first repeat), but in practice it is necessary to show only one repeat. The draft is repeated in the healds across the full width of the warp (with the exception in some cases of the selvages), and if there are 2,400 threads in the warp the draft A will be repeated 600 times, the draft B 480 times, and the draft C 400 times.

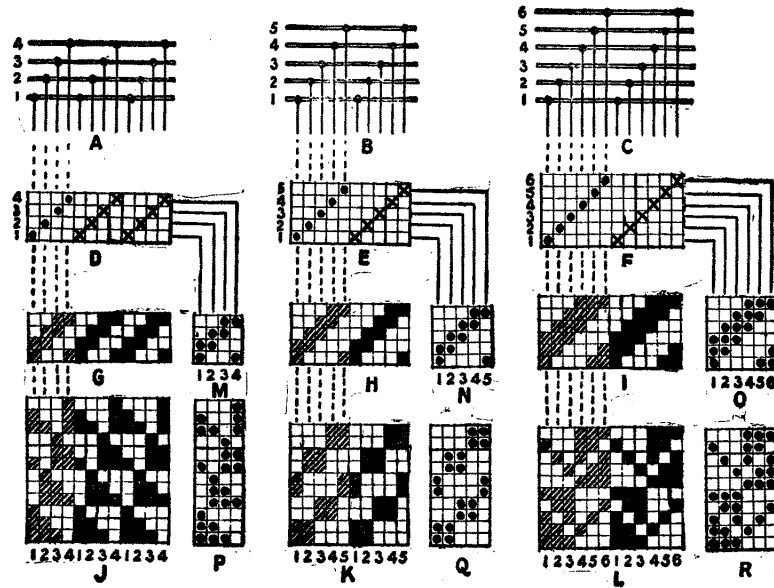


Fig. 20.

The examples M, N, O, P, Q, and R in Fig. 20 are the respective weaving or pegging plans for the designs alongside which they are placed; they indicate the order in which the healds are raised and depressed in forming the design. (Weaving plan is the more correct term to apply to M, N, and O, which are suitable for tappet shedding, the marks and blanks in the plans indicating how the tappets will be arranged. P, Q, and R are, however, correctly described as pegging plans, because they indicate how the lags will be pegged in dobbie shedding, the latter motion being necessary, although only a few healds are required, because of the comparatively large number of picks in the repeat.) The numbered vertical spaces of the weaving and pegging plans correspond with the numbers at the side of the drafts; the vertical space numbered 1 in the pegging plans indicates how the first heald is operated; that numbered 2, the second heald; that numbered 3,



the third heald ; and so on. The plans further show how the healds are raised and depressed on succeeding picks ; thus, assuming that the marks represent warp up, M indicates that on the first pick the healds 1 and 4 of the draft D are raised, and the healds 2 and 3 depressed ; on the second pick, the healds 1 and 2 are raised, and the healds 3 and 4 depressed ; on the third pick numbers 2 and 3 are raised, and 1 and 4 depressed ; and on the fourth pick numbers 3 and 4 are raised, and 1 and 2 depressed. In the same manner P indicates that on the first pick the healds 1, 2, and 3 are raised ; on the second pick, the healds 1 and 2 ; on the third pick, the heald 1 ; on the fourth pick, the healds 2, 3, and 4 ; on the fifth pick, the healds 2 and 3, and so on.

In each example given in Fig. 20 the weaving or pegging plan is exactly the same as the corresponding design, a feature, however, which only occurs in straight-over drafts. The threads of a warp may be drawn straight-over from right to left instead of from left to right (this is not commonly done), which, unless allowed for in pegging the lags, will cause the direction of the design to be reversed, while the same result may occur in a left-to-right draft if the pegging of the lags does not coincide with the arrangement of the dobby.

**Sateen Drafts.** — A sateen draft enables rather finer set healds to be employed than a straight-over draft, hence for very finely set warps it is sometimes used in preference to the latter. The principle is illustrated in Fig. 21 in reference to a sateen draft on five healds, and it will be found useful to compare these examples with those shown in connection with

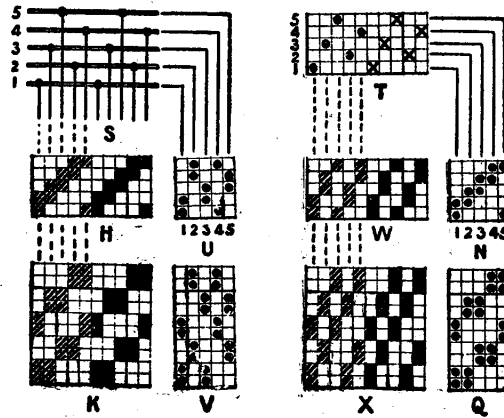


Fig. 21.

the straight-over draft on five healds given in Fig. 20. The examples which are alike in the two figures are lettered the same. As shown at S and T in Fig. 21, the threads in the order of 1, 2, 3, 4, 5 are drawn on the healds in the order of 1, 3, 5, 2, 4, therefore the threads are not lifted in the same order as the healds are raised. Thus, in order to produce the design H, the weaving plan U is required, and to produce the design K, the pegging plan V. In the same manner the weaving plan N produces the design W, and the pegging plan Q, the design X. Further, the plan N indicates that on the first pick the healds 1 and 5 are raised, which lift the first and third ends in each repeat of the design W ; on the second pick the healds 1 and 2 are raised, and lift the first and fourth ends ; on the third pick the healds 2 and 3 lift the fourth and second ends, and so on ; the design W thus resulting from the combination of the draft T and the weaving plan N. A draft is complete on the same number of ends, and a weaving or pegging plan on the same number of picks, as the design.

### CONDITIONS IN DESIGNING, DRAFTING, AND PEGGING

The three factors—the design, the draft, and the pegging-plan—may be considered from the following points of view:—

- (1) To construct the design from a given draft and pegging-plan.
- (2) To construct the draft from a given design and pegging-plan.
- (3) To construct the draft and pegging-plan from a given design.
- (4) To construct a range of designs and the corresponding drafts to suit a given weaving plan. (This is necessary in tappet shedding when the loom is mounted to give only one order of lifting.)

(5) To construct a range of designs and the corresponding pegging-plans to suit a given draft. (This is required in dobby shedding in working out effects on a warp that is in the loom.)

(6) To construct a range of designs, and the corresponding drafts and pegging-plans. (In this case the scope of the designer is almost unlimited.)

The principles involved in the first, second, and third sections should be thoroughly understood, and an intimate knowledge of the various bases upon which weaves are constructed be acquired, before the fourth, fifth, and sixth conditions are attempted.

#### Construction of Designs from Given Drafts and Pegging-Plans.—

The method of constructing the design from a given draft and pegging-plan is illustrated in stages in Fig. 22, in which A shows the draft and B the pegging-plan. The vertical spaces in B, in the order of 1, 2, 3, and 4 respectively, indicate

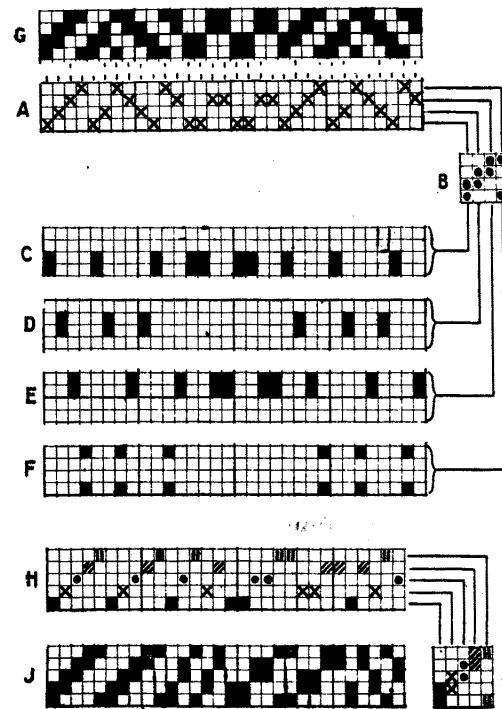


Fig. 22.

how the healds 1, 2, 3, and 4 are operated, and, assuming that the marks represent warp up, the marks of B indicate healds raised. Thus, the first vertical space of B shows that the first heald is raised on the picks 1 and 2, therefore all the threads that are drawn on the first heald will be correspondingly raised, as shown at C in Fig. 22. The second vertical space of B shows that the second heald is raised on the picks 2 and 3, all the threads drawn upon the second heald being, therefore, lifted, as shown at D. In the same manner the third heald is raised on the picks 3 and 4, and lifts the threads drawn upon it, as shown at E, while the fourth heald is raised on the picks 1 and 4, and produces the lifts indicated at F. The marks given in C, D, E, and F are shown combined at G, which thus indicates the design produced by the draft A and the pegging-plan B.

As a further illustration a 5-heald draft is given at H, and the pegging-plan at I, which produce the design shown at J; the ends upon each heald, and the corresponding order of working are represented by a different mark in order that the building up of the design J may be conveniently followed.

**Construction of Drafts from Given Designs and Pegging-Plans.**—This process is illustrated in stages in Fig. 23, in which K shows the design, and L the pegging-plan. The first vertical space of L indicates that the first heald is raised on the picks 1 and 2, therefore all the threads of the design K, which are raised on the picks 1 and 2, are drawn on the first heald, as shown at M. The second vertical space of L shows that the second heald is raised on the picks 3 and 4, therefore all the threads in the design K that lift on the corresponding picks are drawn on the second heald, as shown at N.

In the same manner, all the threads which are raised on the picks 2 and 3 to correspond with the third vertical space of L, are drawn on the third heald, as shown at O, and those that are raised on the picks 1 and 4, to correspond with the fourth vertical space of L, are drawn on the fourth heald, as indicated at P. Q shows the marks of M, N, O, and P combined, and thus indicates the draft, which will produce the design K if the pegging-plan L is employed. The design K in Fig. 23 is similar to the design G in Fig. 22, but the pegging-plan L is different from the pegging-plan B, therefore in one case the draft Q is required in producing the design, and in the other case the draft A.

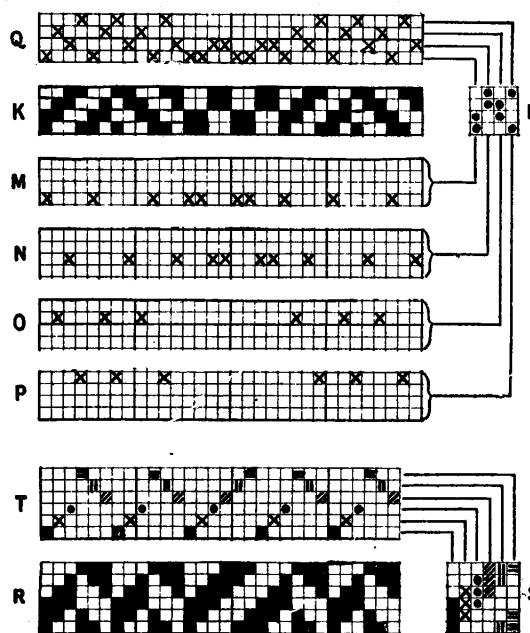


Fig. 23.

In further illustration, a design is given at R in Fig. 23 and a pegging-plan at S, for which the draft indicated at T is required; the different marks will enable the successive stages in the construction of the draft to be followed.

**Construction of Drafts and Pegging-Plans from Given Designs.**—The construction of the draft and peg-plan for a given design is illustrated in stages in Fig. 24. The rule in drafting is as follows:—The threads in a design, which are raised and depressed simultaneously—that is, are indicated the same in the design—may be drawn on the same heald; the threads that are different from each other must be drawn on different healds. As many healds are, therefore, required as there are threads working different from each other in the repeat of a design; thus a 4-thread twill requires four healds, a 5-thread twill five healds, etc. In practice it is sometimes found advantageous to use more healds than the least possible number

The design A in Fig. 24 is based upon 2-and-2 twill, and in constructing the draft the first end is indicated on the first heald, then all the ends in the design, which work the same as the first end, are also indicated on the first heald, as shown at B. The working of the first heald is copied from the design A on to the first vertical space of the pegging-plan, as shown at C. The second end in the design A works different from the first end, and is, therefore, indicated on the second heald, and all the ends, which work like the second end, are indicated on the same heald, as shown at D; while the working of the second heald is copied from the design on to the second vertical space of the pegging-plan, as indicated at E. The third end in the design A works different from either the first or the second, and is, therefore, indicated on the third heald, and also all the corresponding ends, as shown at F; then the working of the third heald is indicated on the third vertical space of the pegging-plan, as shown at G. In the same manner the fourth end of the design, which works different from either the first, second, or third, is indicated

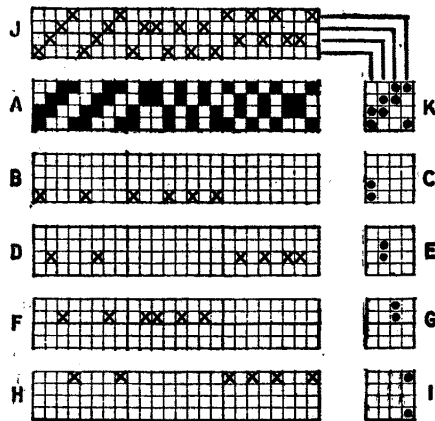


Fig. 24.

on the fourth heald, and also all the corresponding ends, as shown at H (this completes all the ends in the repeat), while the order of working is indicated on the fourth vertical space of the pegging-plan, as shown at I. B, D, F, and H are shown combined at J, and C, E, G, and I at K, which thus respectively show the complete draft and pegging-plan for the design A.

The foregoing system of constructing a draft and pegging-plan fully illustrates the principles involved, but the usual method of procedure is that represented in stages at A to O in Fig. 25, in which A shows the design.

The draft is made first, the ends of the design being taken in succession, and commencing with the first end it is indicated on the first heald, as shown at B. (It does not follow, however, that the first end of a design should in all cases be indicated on the first heald, this being shown at Q in Fig. 62). The second end is different from the first, hence it is indicated on the second heald, as shown at C in Fig. 25; the third end, is like the first, and is, therefore, indicated on the same heald as the first end, as shown at D; the fourth end is like the second, and is indicated on the same heald as the second end, as shown at E; the fifth end is like the first and third ends, and is indicated on the same heald, as shown at F; the sixth end is different from any of the preceding, and is, therefore, indicated on the next heald (the third), as shown at G; the seventh end is different again, hence it is indicated on the fourth heald, as shown at H; the eighth end is like the sixth, and is indicated on the same heald, as shown at I; the ninth end is like the seventh, and is, therefore, indicated on the fourth heald, as shown at J; while the tenth end is like the sixth and eighth, and is indicated on the third heald, as shown at K.

In constructing the pegging-plan, the healds are taken in succession from front to back, and the order of working of the corresponding ends is copied from the

design on to successive vertical spaces from left to right. Thus, the working of the ends, drawn on the first heald, is indicated on the first vertical space of the pegging-plan, as shown at L in Fig. 25; of the ends, drawn on the second heald, on the second vertical space, as shown at M; while in the same manner the working of the third heald is indicated on the third vertical space, as shown at N, and of the fourth heald on the fourth vertical space, as represented at O. The pegging-plan is complete on as many vertical spaces as there are healds in the draft, and on as many horizontal spaces as there are picks in the design. The threads are conveniently followed if the draft is placed directly above or below, and the pegging-plan alongside the design.

In drafting the ends of a design from the first to the last in successive order, it is not always advisable to indicate those which are different from each other in the same order on the healds as they are found in the design. A draft should be arranged in an order which can be easily followed and remembered by the drawer-in and weaver, and to accomplish this, in many cases, it is necessary for the order of drafting to correspond with the basis upon which

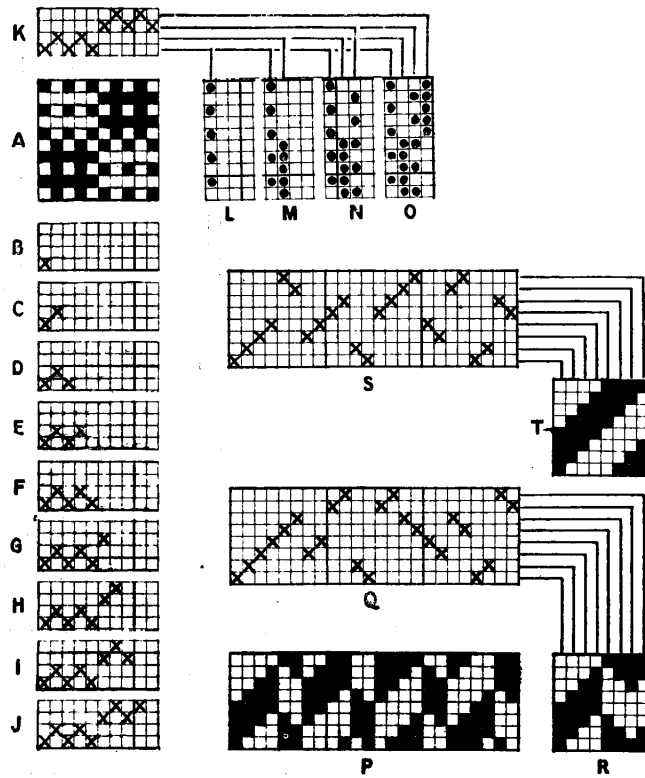


Fig. 25.

the design is constructed. For example, P in Fig. 25 shows a 4-and-4 twill design in which the threads are reversed in sections of four and two; if the threads which work different from each other are indicated on the healds successively in the order in which they are found in the design, the draft will be as shown at Q, which is too irregular to be readily remembered. By indicating the draft to correspond with the arrangement of the design, as shown at S, however, the order of drawing in is simply four to right and two to left, with a break of four healds at each change. In the latter method the weaving plan also is more regular, as will be seen by comparing the plans R and T, which respectively correspond with the drafts Q and S. Certain designs can be drafted in different ways, but a change in the order of drafting necessitates a corresponding change in the pegging-plan.

The healds for designs in which different weaves and different yarns are combined, may usually be divided into two or more distinct sections, which are put together to form the complete set of healds. The different sections should be placed in such positions relative to each other as will most contribute to successful weaving. There is no fixed rule that can be practised, but, generally, the healds should be placed nearest the front, which (a) carry the weakest yarn, (b) carry the threads which are subjected to the most strain (are most frequently interlaced), and (c) are the most crowded with the threads.

### REDUCTION IN FINENESS OF HEALDS

In weaving finely set fabrics which require a small number of healds it is customary to use more healds than are actually necessary for the weave, in order

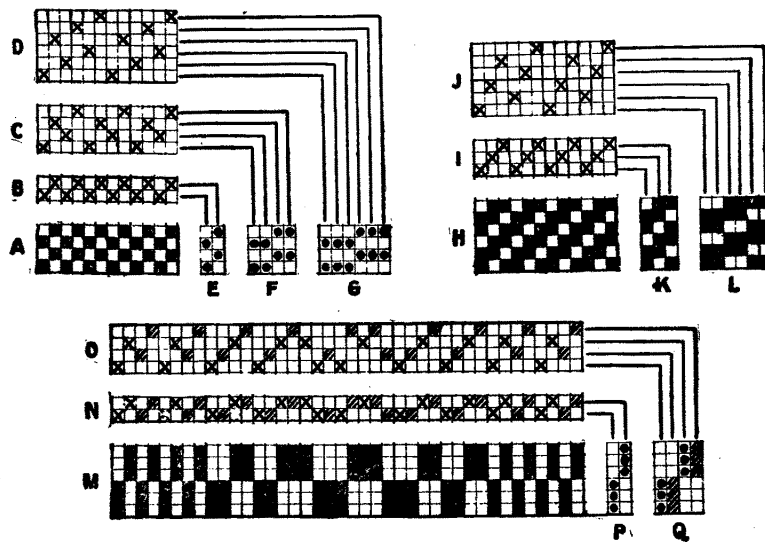


Fig. 26

that the leashes will not be too crowded on the shafts. For example, the plain weave indicated at A in Fig. 26, may be drawn on two healds, as shown at B, if the cloth is coarse; or on four healds, as shown at C, if the cloth is of medium fineness; or on six healds, as indicated at D, if the cloth is very fine. Assuming in each case that there are 20 leashes per inch on each shaft, draft B will give 40 ends per inch; draft C, 80 ends per inch; and draft D, 120 ends per inch. In tappet shedding, with the draft C the first and second healds are tied together, and the third and fourth together; and with the draft D the first, second, and third together, and the fourth, fifth, and sixth together. The operation of two plain tappets then lifts the odd threads on one pick, and the even threads on the next pick. In dobby shedding, the pegging-plans for the drafts B, C, and D are as shown at E, F, and G respectively.

The 3-thread twill, given at H in Fig. 26, may be drawn on three healds as shown at I, or on six healds, as shown at J. In the latter case the healds 1 and 2 are coupled together, and 3 and 4, and 5 and 6, if ordinary 3-thread twill tappets

are employed ; but in dobby shedding the pegging-plans for the respective drafts are as shown at K and L.

The method of arranging a draft upon an increased number of healds is further illustrated by the examples M to Q in Fig. 26. M shows a stripe design, composed of 3-and-3 warp rib and hopsack, which may be drafted upon two healds, as shown at N. In doubling the number of healds the threads of each heald of the draft N are indicated alternately (as shown by the different marks) on two healds, in the manner represented at O. A 3-and-3 tappet plan may be employed for the drafts, or the respective pegging-plans P and Q.

## HEALD CALCULATIONS

In constructing tappet and dobby designs, the draft that will be required should be considered, in order to avoid needlessly complicating the healds ; a good design, however, should not be sacrificed in order to simplify the arrangement of the healds. It is necessary for the ends to occupy the same width in the healds as in the reed, and for each end a mail or eye must be provided in the healds in the proper position relative to the position that the end occupies in the reed. An ideal draft, so far as regards the healds, is obtained when (a) an equal number of ends is drawn on each heald, and (b) the mails on each heald are evenly distributed across the width. The first point is illustrated by the examples given in Fig. 27, in which two rather similar designs are given at A and C, each of which repeats on 42 ends, while the respective drafts are indicated at B and D. The design A is constructed in such a manner that in the repeat the same number of

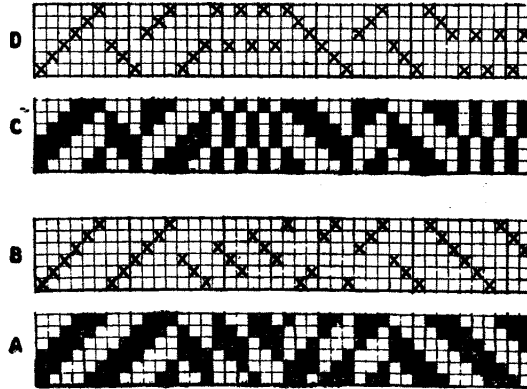


Fig. 27.

ends—viz., 7—are drawn on each heald, as indicated in the draft B, hence all the healds are alike. Assuming that there are 84 ends per inch in the reed, each heald will have  $(84 \text{ ends} \div 6 \text{ healds}) = 14$  mails per inch, and if the healds are 40 inches wide, each will contain  $(40 \times 14) = 560$  mails. In the design C, however, the conditions are different, as will be seen from an examination of the draft D, in which in the repeat of 42 ends, 8 ends are indicated on each of the healds 1, 3, 4, and 6, as compared with 5 ends on each heald 2 and 5. Assuming, again, that there are 84 ends per inch in the reed, each of the healds 1, 3, 4, and 6 will require  $(84 \times \frac{8}{4}) = 16$  mails per inch, while each of the healds 2 and 5 will require  $(84 \times \frac{5}{4}) = 10$  mails per inch. If the healds are 40 inches wide, each of the shafts 1, 3, 4, and 6 will contain  $(40 \times 16) = 640$  mails, and each heald 2 and 5  $(40 \times 10) = 400$  mails.

In reference to the second point, while the distribution of the ends on each heald, in the drafts B and D in Fig. 27, is not perfectly uniform, it is near enough

to allow each heald to be knitted at a uniform rate. It is usually in rather broad stripe designs that the healds require to be knitted in stripe form to coincide with the pattern. This condition, of course, is not necessary in the case of wire or sliding healds in which the leashes are loosely mounted on the shafts. In the latter type the number on a shaft may be readily increased or decreased, while the mails assume the correct position when the threads are tautened in the loom. The construction of a heald knitting plan for a stripe draft is illustrated in Fig. 137.

**Casting-out in Healds.**—This is a process by which healds are adapted to weave cloths which are coarser in sett than the mails on the shafts. For instance, assuming that the six healds for the equal draft given at B in Fig. 27 have been knitted with 84 mails per inch, and that they are required to weave a cloth which contains 60 ends per inch in the reed;  $(84 \text{ mails} - 60 \text{ ends}) = 24$  mails per inch will be cast out. That is, for every 60 ends drawn upon the healds 24 mails require to be left empty. The 24 mails are equal to four rows or "gates" of the six healds, and in drawing in the warp the empty rows of mails are distributed as evenly as possible across the width. As 60 ends require to be drawn in and 24 mails cast out, the proportion is 5 gates filled to two gates cast out, while a better distribution is 3 gates filled, 1 gate cast out, 2 gates filled, 1 gate cast out.

As a further illustration, it has previously been shown that in weaving the draft D in Fig. 27 with 84 ends per inch, each of the healds 1, 3, 4, and 6 requires 16 mails per inch, and each heald 2 and 5, 10 mails per inch. Six healds, each containing 16 mails per inch, could readily be adapted to the draft by casting out the healds 2 and 5 in the proportion of 10 mails filled and 6 mails cast out, or 5 filled and 3 cast out. A still more uniform distribution of the mails on the two healds would be 2 filled, 1 cast out, 2 filled, 1 cast out, 1 filled, 1 cast out.

## CHAPTER III

### ELEMENTARY WEAVES AND THEIR BASES

*Weaves constructed upon Sateen Bases*—Sateen Re-arrangements of Ordinary Twills—Origination of Designs on Sateen Bases—Extension of Sateen Weaves. *Angle of Inclination of Twill Weaves*—Construction of Elongated Twills from Ordinary Twills—Origination of Elongated Twills. *Broken Twills*—Transposed Twills. Construction of Small Weaves by Reversing. *Combinations of Twill Weaves*—Combination Twills running at 45 deg. Angle.

#### WEAVES CONSTRUCTED UPON SATEEN BASES

IN addition to being extensively used in their pure form, sateen weaves are very largely employed as bases in the construction of new weaves, to which the term "sateen derivative" is applied. A sateen, as well as many other bases, can be used in two ways in the construction of new designs—viz., (a) in producing a re-arrangement of the threads of a given weave, usually a twill; and (b) in originating new interlacings.

**Sateen Re-arrangements of Ordinary Twills.**—In this system of construction the threads (either warp or weft) of a given twill are arranged in the new design



in the order of a sateen that repeats upon the same number of threads as the twill. The method is illustrated in Fig. 28, in which A and B represent two sateen re-arrangements of the ends, and C and D two similar re-arrangements of the picks, of a 9-thread twill with which they are shown connected by lines. The shaded squares show the bases of the designs. In A the 9-thread sateen base counting 2 outwards is employed, and in B counting 2 upwards, hence the ends, which in the twill are in the order of 1, 2, 3, 4, 5, 6, 7, 8, 9, are arranged in A in the order of 1, 6, 2, 7, 3, 8, 4, 9, 5, and in B in the order of 1, 3, 5, 7, 9, 2, 4, 6, 8. In the same manner, in C the picks of the twill are arranged in the order of 1, 3, 5, 7, 9, 2, 4, 6, 8, and in D in the order of 1, 6, 2, 7, 3, 8, 4, 9, 5.

A convenient method of re-arranging a twill in sateen order is illustrated at E to H in Fig. 28. The sateen base is first inserted, as shown at F, then each sateen mark is taken to be one mark of the twill, and to it the other marks of the twill are added in regular order. In re-arranging the ends of the twill the marks are added above and below the base marks, as shown at G, whereas if the picks are re-arranged the marks are added alongside the base

marks, as indicated at H. In each design G and H the marks and blanks are alike; also the weaves appear very similar on paper, but they yield quite different effects in the cloth because in G the principal floats are in the warp, and in H in the weft.

In some cases, a re-arranged weave produces a much looser structure than the original twill, as will be evident from a comparison of the twill I in Fig. 28, and the sateen re-arrangement given at J. G and H, on the other hand, are quite

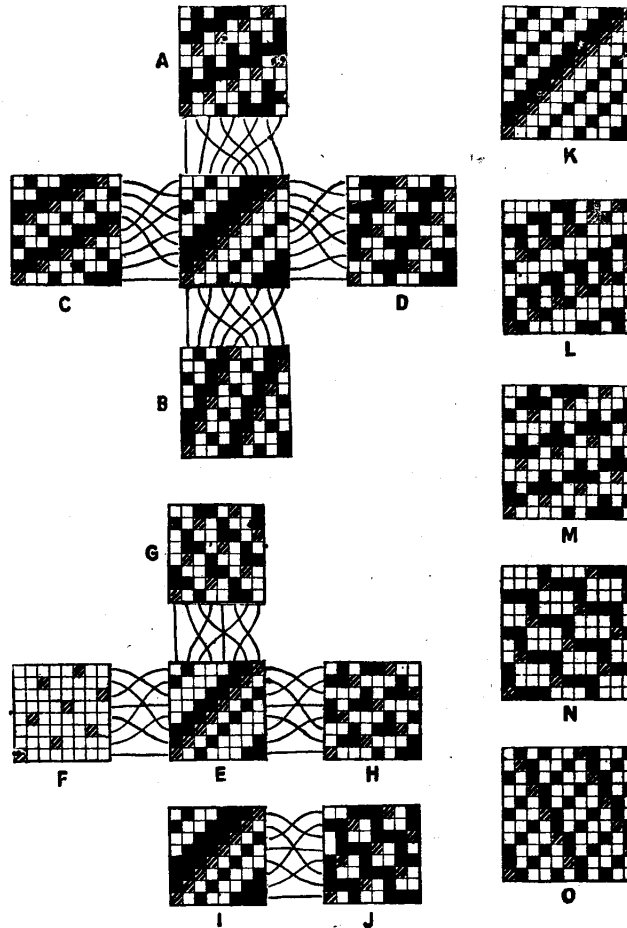


Fig. 28.

as firm as the original twill E, on account of the manner in which the floats cut with each other. The original twills E and I, however, are similar in firmness, the only difference between them being that the latter contains more marks than the former, but this is sufficient to affect the firmness of the re-arranged weave very considerably. It will, therefore, be evident, from a comparison of the examples E, G, and H with I and J, that the re-arrangement of twills which are equally firm may result in structures being formed that differ materially in firmness. Certain twills, of which I in Fig. 28 is an example, produce the same design whether they are re-arranged in the warp or in the weft.

Four sateen re-arrangements in the warp of the 11-thread twill K, are given in Fig. 28 at L, M, N, and O, in which the count is 2, 3, 4, and 5 respectively; it will be seen that the design O is much firmer than the others. By turning the designs one-quarter round, so that the vertical spaces become horizontal, four

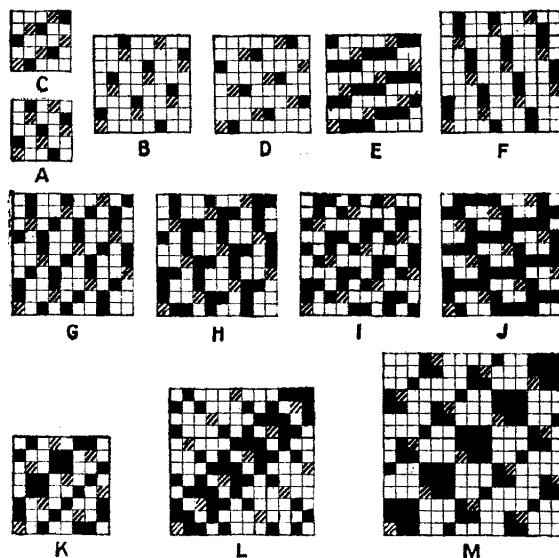


Fig. 29.

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

The chief disadvantage of constructing a new design by re-arranging the threads of a *given* twill is that the order of interlacing is governed by the twill, and the resulting design may be quite unsuitable for the cloth for which it is intended. The system, however, is useful,

because a twill and a sateen re-arrangement in the warp can be woven in the same heads by means of straight and sateen drafting.

**Origination of Designs on Sateen Bases.**—In this system the sateen base is first inserted on the required number of threads, then the new design is built up (according to the kind of weave and structure required) by adding marks in the same relative position to each base mark. Thus, the “Venetian” weave, given at A in Fig. 29, is produced by adding one mark to each mark of the 5-thread sateen, while the “Buckskin” weave, shown at B, is similarly constructed by adding one mark to each mark of the 8-thread sateen. The weaves A and B—taking the marks to indicate weft—produce a warp surface, but similar designs may be constructed, as shown at C and D, which form a weft surface, the marks in this case being taken to indicate warp. The latter class of weave is used in the production of heavy weft-faced cotton fabrics that are employed for workmen’s clothing,

and are known by such terms as "imperial," "swansdown," and "lambskin." By introducing comparatively few ends per inch a very large number of picks can be inserted, and a compact, strong cloth is produced, which generally has a soft, downy surface, formed by "raising" the weft. A cloth may be woven with 56 ends per inch of 2/30's cotton warp, and from 150 to 200 picks per inch of from 16's to 20's cotton weft. The design E in Fig. 29 is reversible, and if heavily wefted the cloth has a dense weft surface on both sides.

The examples F to J in Fig. 29 are constructed on a 10-thread sateen basis. It is usually convenient to commence a design by adding a few marks to each base mark, as shown at F, and to then add other marks in stages (if considered necessary), as indicated in the designs G, H, I, and J.

As a rule, in constructing small weaves the marks should be added in the same order to the base marks, in the manner represented at A to J in Fig. 29. In the case of a few sateens, however, such as the 8, 12, and 15-thread weaves, in which

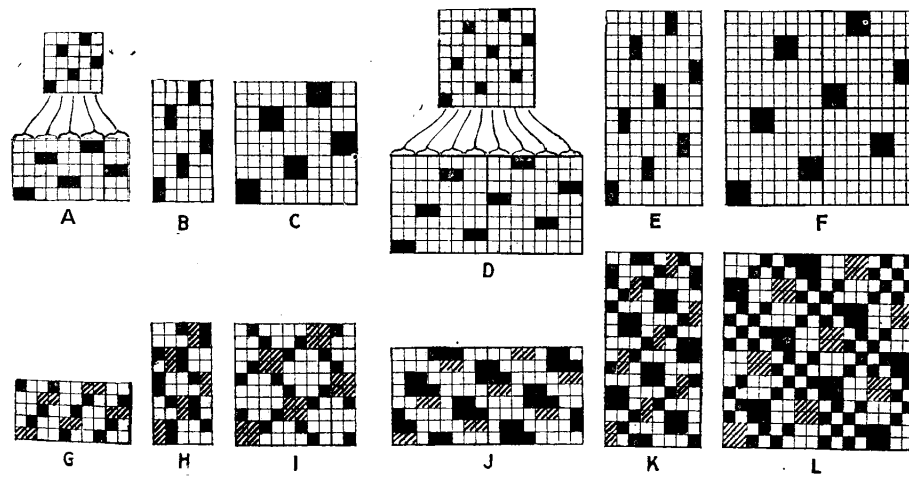


Fig. 30.

the sateen marks run in line with each other at 45° angle, and join with each other in succeeding repeats, the method may be deviated from. Thus K, L, and M in Fig. 29 show interesting designs which result from the addition of marks in irregular order to the 8, 12, and 15-thread sateens respectively. (Examples of larger and more elaborate sateen derivatives are given in Fig. 47, p. 49).

**Extension of Sateen Weaves.**—Sateen weaves may be extended horizontally, as shown at A and D in Fig. 30; or vertically, as indicated at B and E; or both horizontally and vertically, as represented at C and F; the examples illustrating the system in reference to the 5 and 8-thread sateens. Their chief value, when used in the forms shown at A to F is that with the same number of healds longer floats are formed on the surface of the cloth than is the case with ordinary sateens. For instance, the design B, which requires five healds, has a warp float of 8 (taking the marks to indicate weft), and is a very suitable weave for displaying a lustrous warp stripe prominently on the surface of a cloth if only a small number of healds are available.

The extended sateens may be readily employed as bases in the construction of new weaves, which are usually of a bolder character than those produced upon ordinary sateen bases. Marks are added systematically to the base marks, as shown in the designs G to L in Fig. 30, which respectively correspond with the plans A to F.

### ANGLE OF INCLINATION OF TWILL WEAVES

The angle formed in the cloth by a twill weave varies according to the relative number of ends and picks per unit space. (The angle of a twill is taken as that formed by the twill line and the weft.) If the ends and picks per unit space are equal an ordinary twill, in which one is counted, as shown at A in Fig. 31, runs at an angle of  $45^\circ$ . If, however, there are more ends than picks per inch in the cloth, the line of an ordinary twill more nearly approaches the vertical, or becomes

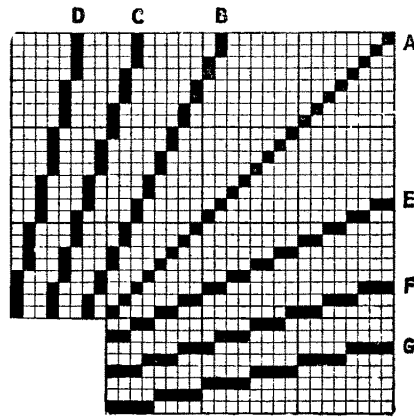


Fig. 31.

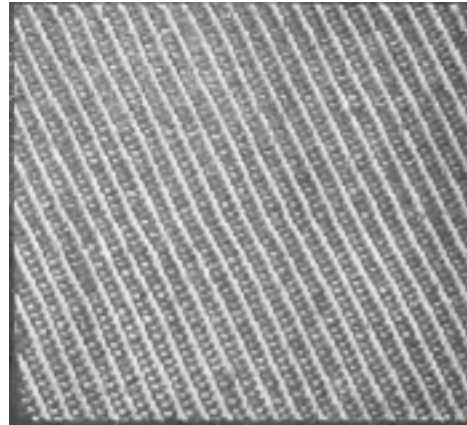


Fig. 32.

steeper; while if the picks exceed the ends the line more nearly approaches the horizontal, or becomes flatter. A fabric, in which a steep twill is formed, is represented in Fig. 32, which, if turned one-quarter round, will also show the appearance of a flat twill.

Elongated twills, running at various angles, are constructed by moving the points of intersection two or more threads in one direction to one thread in the other direction, as shown at B to G in Fig. 31. If the cloth contains the same number of ends as picks per unit space, by counting 2 upward to 1 outward, as shown at B, a twill line running at the angle of  $63^\circ$  is formed; by counting three upward to 1 outward, as shown at C, the angle is  $70^\circ$ ; and by counting 4 upward to 1 outward, as indicated at D, the angle is  $75^\circ$ . Further, by counting 2 outward to 1 upward, as represented at E, the twill runs at  $27^\circ$  angle; whereas counting 3 upward to 1 upward, as shown at F, produces the angle of  $20^\circ$ ; and counting 4 outward to 1 upward, as indicated at G, the angle of  $15^\circ$ . As in ordinary twills, however, the actual angles formed in the cloth are modified from those shown on the square design paper according to the proportion of ends to picks per unit space. Thus a twill

designed at the angle indicated at B, will run at the angle shown at D if there are twice as many ends as picks in the cloth.

**Construction of Elongated Twills from Ordinary Twills.**—One method of designing elongated twills consists of selecting, or re-arranging the threads of a given ordinary twill in certain orders, as illustrated by the examples given in Fig. 33. Each thread in the elongated twills is shown connected by a line with the corresponding thread in the original twill,

and the four designs made from each twill correspond with the bases indicated at B, C, E, and F in Fig. 31. Commencing with the first end of the given twill, the steep twill H is constructed by inserting every second end of the twill, and the steep twill I, by inserting every third end. Then, commencing with the first pick, the flat twill J is constructed by inserting every second pick of the given twill, and K by inserting every third pick. As the number counted is in each case a measure of the number of threads in the given twill, the repeat of the new design in one direction is proportionally less.

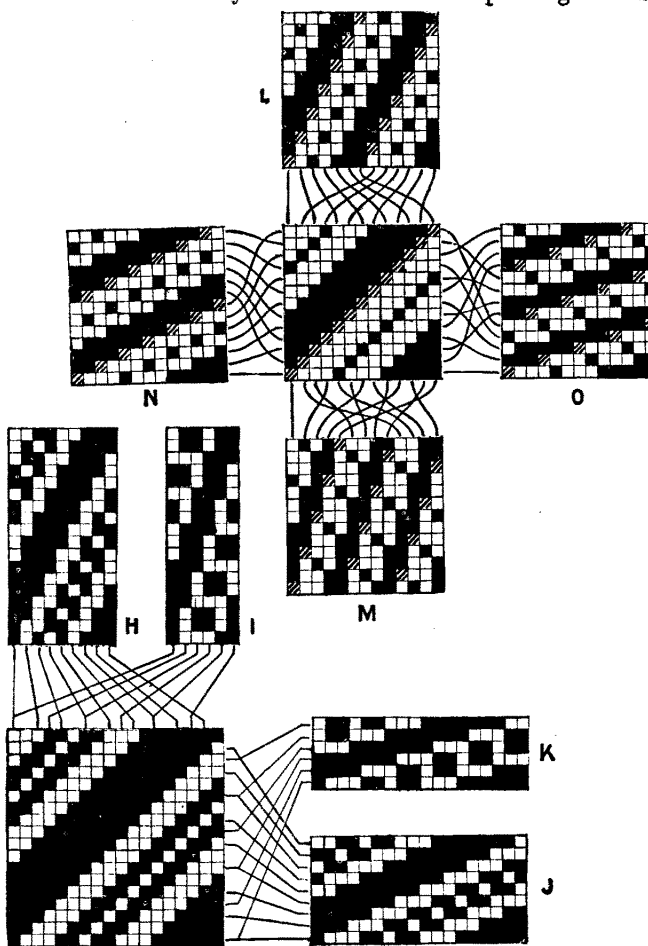


Fig. 33.

The examples L to O illustrate the method of procedure when the number counted is not a measure of the number of threads in the given twill. The twill repeats on 13 threads, therefore, in counting 2, it is necessary to go through the weave twice, and to arrange the threads in the order of 1, 3, 5, 7, 9, 11, 13, 2, 4, 6, 8, 10, 12, as shown at L and N; while in counting 3, the twill is gone through three times; the threads being ultimately arranged in the order of 1, 4, 7, 10, 13, 3, 6, 9, 12, 2, 5, 8, 11, as indicated at M and O. It should be noted that in this case exactly

the same designs would result from re-arranging the twill in sateen order, counting 2 and 3.

**Origination of Elongated Twills.**—The foregoing method has the limitation stated in reference to the sateen re-arrangement of given twills. In originating elongated twills, a base line of marks is first inserted running at the desired angle, and repeating upon the required number of ends and picks. Other marks are then added systematically to the base marks, in the manner illustrated at P to Y in Fig. 34. P, Q, and R are steep twills on 5, 6 and 8 ends respectively, counting 2 upward to 1 outward. The fabric, represented in Fig. 32, corresponds with the design R. S and T are steep twills on 6 and 7 ends respectively, counting 3 upward to 1 outward; while U is a flat twill on 7 picks, counting 2 outward to 1

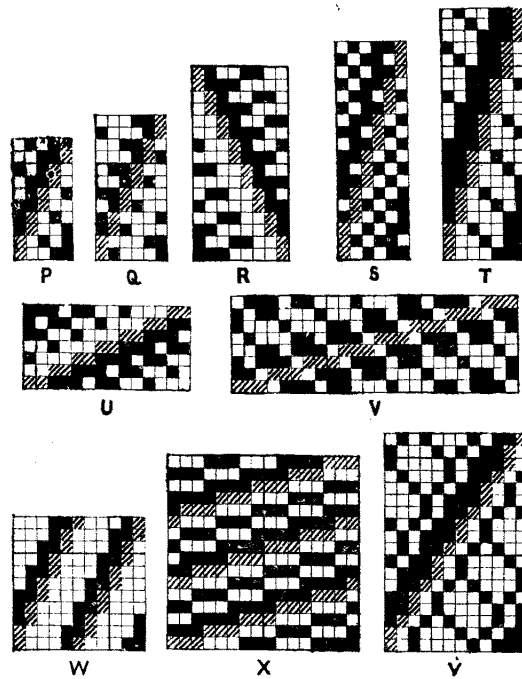


Fig. 34.

upward, and V a flat twill on 8 picks, counting 3 outward to 1 upward. W and X illustrate how the base marks are carried through a design, in order to obtain correct repetition, when the number counted is not a measure of the number of threads in the repeat. The design Y, in which the count is 2 and 1 alternately, will serve to illustrate how the angle of the twill line may be still further varied.

In steep twills the warp should, as a rule, show more prominently on the surface than the weft, and *vice versa* in flat twills; hence, in the steep twills, given in Figs. 33 and 34, the marks should be taken to indicate "warp up," and in the flat twills, "weft up." Steep twills, which produce distinct twill lines of warp in the cloth

are termed "whip cords." The addition of marks to the edges of a line of warp float, as shown in Q and R, develops the prominence of the line.

Unless the cloth is firmly set the threads are liable to slip in elongated twill weaves. Firmness of texture can be obtained to some extent by inserting a suitable firm weave between the floating twill lines; thus 2-and-1 twill naturally fits a weave in which the count is 2, as shown at P in Fig. 34, and plain weave, or 1-and-3 twill, when the count is 3, as shown at S and T. (Other examples of steep and flat twills are illustrated in Figs. 43, 44, and 47.)

### BROKEN TWILLS

The term "broken twill" is applied to a large variety of weaves that are modifications of ordinary twills. A very useful system of construction, which

is particularly applicable to twills that are composed of equal warp and weft float, consists of "filling-and-missing" the threads of an ordinary twill. Any number of threads may be filled and missed respectively at a place, but generally the most suitable number of threads to miss is one less than half the number of threads in the repeat of the twill. If the latter condition is observed in certain equal-sided twills, the warp and weft floats oppose each other, and a fine line or "cut" is made where the twill is broken.

The method of procedure in filling-and-missing is illustrated in Fig. 35, in which three repeats of 2-and-2 twill are given at A, while at B the threads of A are shown arranged in the order of 2 filled and 1 missed. C shows the draft for B, if a 2-and-2 twill weaving plan is employed; and it will be noted that the order of drawing in is 2 healds drawn and 1 heald missed or skipped, and thus coincides with the basis upon which B is constructed.

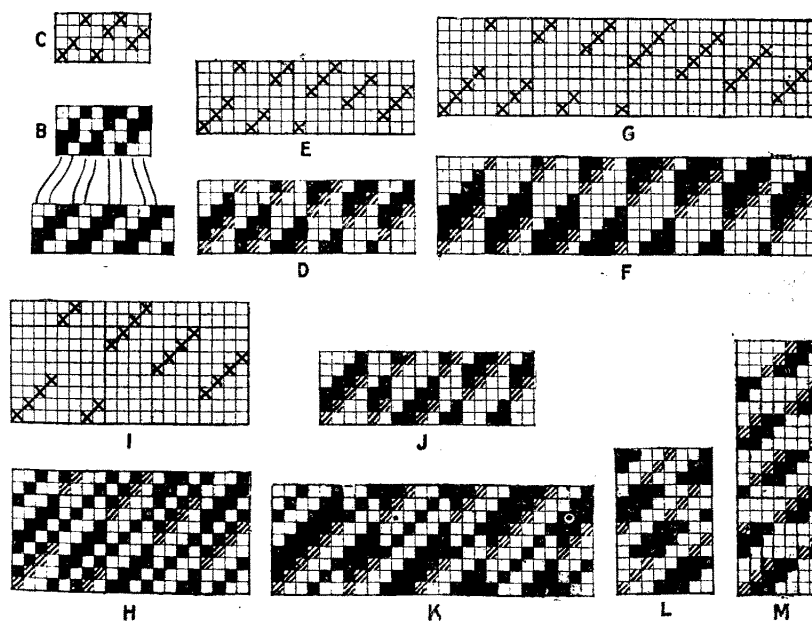


Fig. 35.

D in Fig. 35 shows the 3-and-3 twill arranged in the order of 3 filled and 2 missed; F the 4-and-4 twill arranged 4 filled and 3 missed; and H a 10-thread twill arranged 4 filled and 4 missed; while E, G, and I represent the bases of construction, and the drafts for the respective designs. The number of threads in the repeat of a design can be ascertained by noting the number of squares that corresponding positions of the weave are distant from each other. Thus, in F corresponding positions move one square downward and four squares outward each time; and as there are 8 picks in the weave there are:— $4 \times 8 = 32$  ends in the repeat. In H there are 10 picks in the weave, and the move is 2 downward and 4 outward; therefore in the repeat there are:— $(10 \div 2) \times 4 = 20$  ends.

The designs may be varied by filling unequal numbers of threads, as shown

at J in Fig. 35, in which the 3-and-3 twill is arranged 4 filled, 2 missed, 2 filled, and 2 missed. In the same manner, K shows a 9-thread twill arranged 6 filled, 3 missed, 3 filled, and 3 missed, and this example also illustrates that the system of construction is by no means limited to twills which are composed of equal warp and weft float, but can be used with good results in re-arranging the threads of almost any type of twill.

Designs can also be constructed by filling and missing the picks, as shown at L and M in Fig. 35; the former of which consists of an 8-thread twill arranged 3 picks filled and 3 picks missed, and the latter of a 7-thread twill arranged 3 picks filled and 2 picks missed. Further, in either the warp or weft method, if the base marks are inserted first, as shown by the shaded squares in the designs given in Fig. 35, marks may be added to them in any desired order.

In another method of constructing broken twills, a small effect, which is based on the twill, is inserted at intervals and is arranged either to cut or to join with the twill. For instance, N in Fig. 36 shows a 2-and-2 twill with a 2-and-2 mat effect

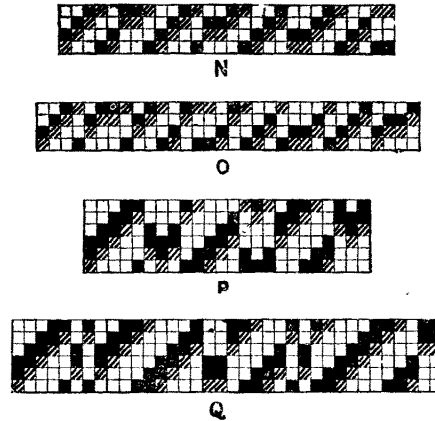


Fig. 36.

introduced at intervals, which cuts at one side and joins at the other side with the twill. In the design O in Fig. 36 there are four threads of 2-and-2 twill cutting with four threads of the 2-and-2 twill modified; while P shows the 3-and-3 twill arranged five threads of straight twill cutting with three threads of the weave modified. In the same manner in Q the 3-and-3 twill is cut at irregular intervals with two threads forming warp rib, and two threads working together. Threads which are different in colour or material may be effectively introduced at the places where a weave is broken. Also an advantage of the broken twill system

of construction is that variety of design is produced with little or no effect upon the firmness of the structure, so that the yarns and set which are suitable for an ordinary twill are equally suitable for the same twill broken.

**Transposed Twills.**—The term transposing can be used in describing various methods of reversing a weave, but here it is applied to the construction of broken twills by transposing or reversing the threads of a given twill in groups of 2, 3, or more, as illustrated by the examples A to L in Fig. 37. The base line of a 12-thread ordinary twill is indicated at A, while at B the marks are transposed in groups of 2, at C in groups of 3, and at D in groups of 4. In E, F, G, and H, and in I, J, K, and L, the shaded squares correspond with the base marks indicated in A, B, C, and D, respectively. At F, G, and H respectively the twill E is re-arranged in the warp according to the transposed bases B, C, and D; while J, K, and L similarly show the twill I re-arranged in the weft. A comparison will show that the ends of the ordinary twill E, taken consecutively from 1 to 12, are arranged in F in the order of 2, 1; 4, 3; 6, 5; 8, 7; 10, 9; 12, 11; in G in the order of 3, 2, 1; 6, 5; 4; 9, 8, 7; 12, 11, 10; and in H in the order of 4, 3, 2, 1; 8, 7, 6, 5; 12, 11, 10, 9.



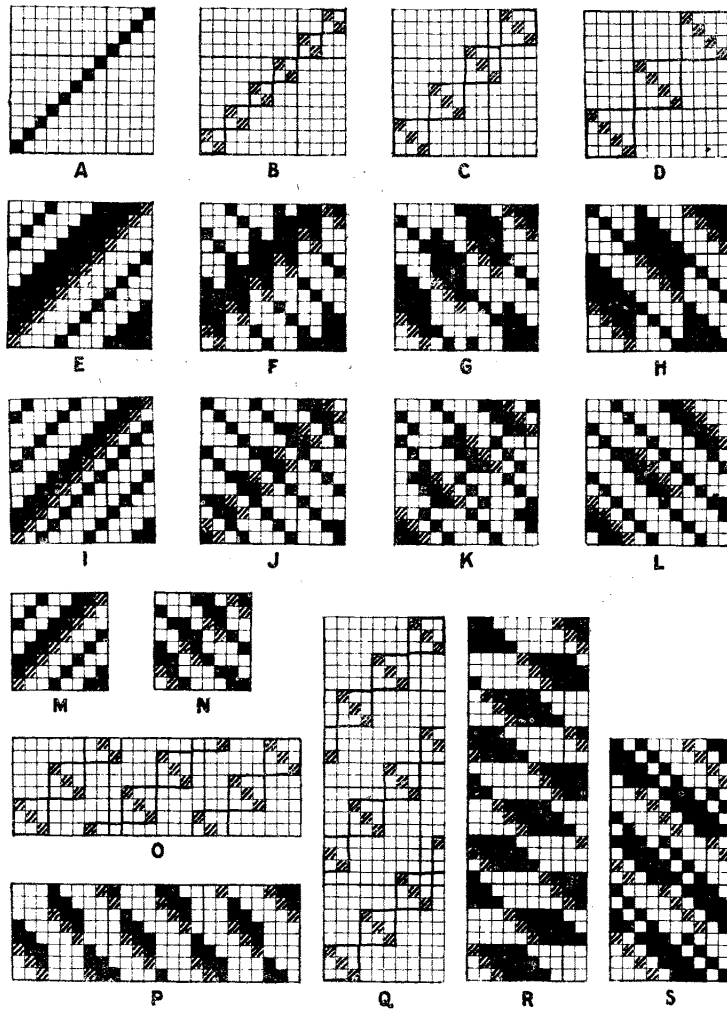


Fig. 37.

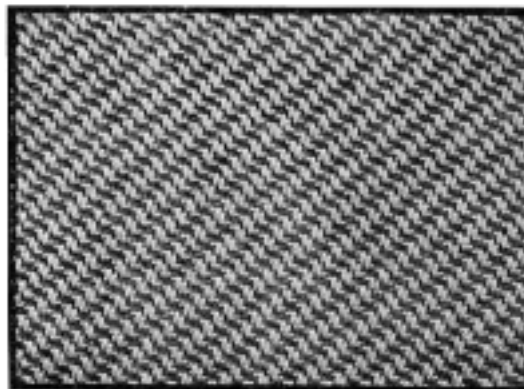


Fig. 38.

In J, K, and L respectively the picks of the twill I are arranged in corresponding orders.

The design given at N in Fig. 37 corresponds with the fabric represented in

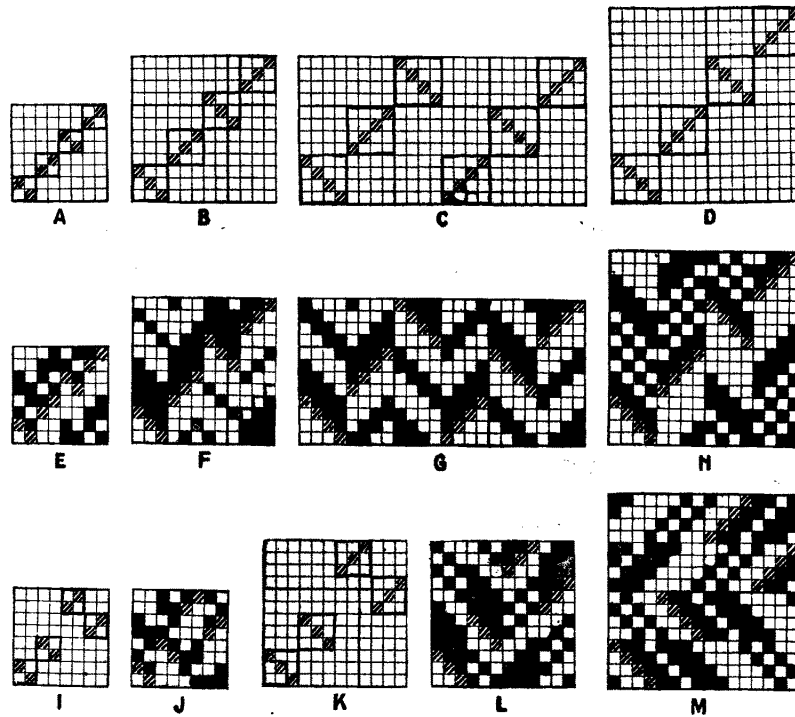


Fig. 39.

Fig. 38. The weave is termed the Mayo or Campbell, and is formed by transposing the ends of the 8-thread twill M in 2's. O and P illustrate the transposition of the

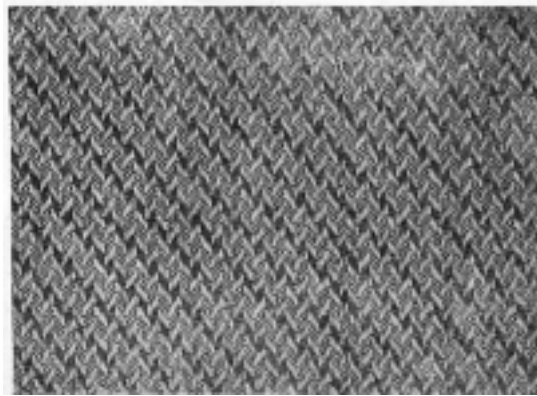


Fig. 40.

ends of a 3-and-5 twill in 3's, in which it is necessary to extend the design over a number of ends, which is the L.C.M. of 8 and 3—viz., 24. The ends of the twill are thus arranged in the order of 3, 2, 1; 6, 5, 4; 1, 8, 7; 4, 3, 2; 7, 6, 5; 2, 1, 8; 5, 4, 3; 8, 7, 6. In the same manner in transposing the picks of a 10-thread twill in 3's, as shown at Q and R, the repeat extends over 30 picks—the L.C.M. of 10 and 3; while in transposing a 10-thread twill in 4's, as shown at S, the repeat extends over 20 picks—the L.C.M. of 10 and 4.

A variation of the foregoing method consists of arranging the groups of threads in transposed and straight order alternately, as shown at A to D in Fig. 39, and the corresponding designs E to H. The design H coincides with the fabric represented in Fig. 40. In another method the groups of threads are arranged in 4-sateen order; thus the design J in Fig. 39 corresponds with the base I, and the design L with the base K. The design M is arranged similarly to J and L, but the repeat is on 16 threads, and the marks of the weave are added at the side of the base marks.

In constructing transposed designs the base marks should be inserted first, and it will be found convenient to previously indicate the squares in groups of  $2 \times 2$ ,  $3 \times 3$ , etc., as shown, for instance, by the thick lines in B, C, and D in Figs. 37 and 39. It will be understood that the base marks, may not only be used in re-arranging the threads of a given twill, but as a base to which marks may be regularly added in any desired order.

By drafting the ends in the healds in transposed orders, transposed warp effects are produced by employing straight twill pegging-plans; but for transposed weft effects, straight drafts are required with transposed weaves for the pegging-plans.

### CONSTRUCTION OF SMALL WEAVES BY REVERSING

The reversing of equal-sided twill weaves in very small sections, as shown at A, B, C, and D in Fig. 41, produces neat designs which are too little to show as definite stripes. In the design A the 3-and-3 twill is arranged alternately two ends to right and two ends to left, and in B three ends to right and three ends to left. In C the 4-and-4 twill runs four ends to right and left alternately, while D shows the 2-and-2 twill arranged four to right and two to left alternately. By turning the plans one-quarter round the reversing of the picks of the twills will be illustrated.

Twills which are not equal-sided can be reversed in the same manner, and the reversal may simply apply to the direction in which the threads twill, as shown at E in Fig. 41; or it may also include the substitution of marks for blanks, and blanks for marks in succeeding sections of the design, as indicated at F. If the warp and weft are about equally on the surface, as in E and F, the reversing of a few threads at a place produces more the appearance of an all-over effect than of a stripe, although F is more distinctly stripy than E because of the manner in which the sections cut with each other. If, however, the warp predominates in one section, and weft in the other, as shown in the design G, the reversing of the threads produces a very distinct stripe, particularly if the warp and weft are different in colour.

The examples H to L in Fig. 41 illustrate a method of employing the reversing principle by which neat little check designs are formed. A small unit weave (which need not be a complete weave in itself) is first made on any suitable number of ends and picks, and the complete design is then constructed by reversing the unit vertically and horizontally. Thus, taking H as the unit weave, I is obtained by reversing the ends of H, and J by reversing the picks, while K results either from reversing the ends of J or the picks of I. Corresponding threads are connected by lines, and it will be seen that the ends of H, in the order of 1, 2, 3, 4, are the reverse of the ends of I in the order of 4, 3, 2, 1; the marks in one coinciding with the blanks in the other, while the weave is turned in opposite directions. In the same manner the

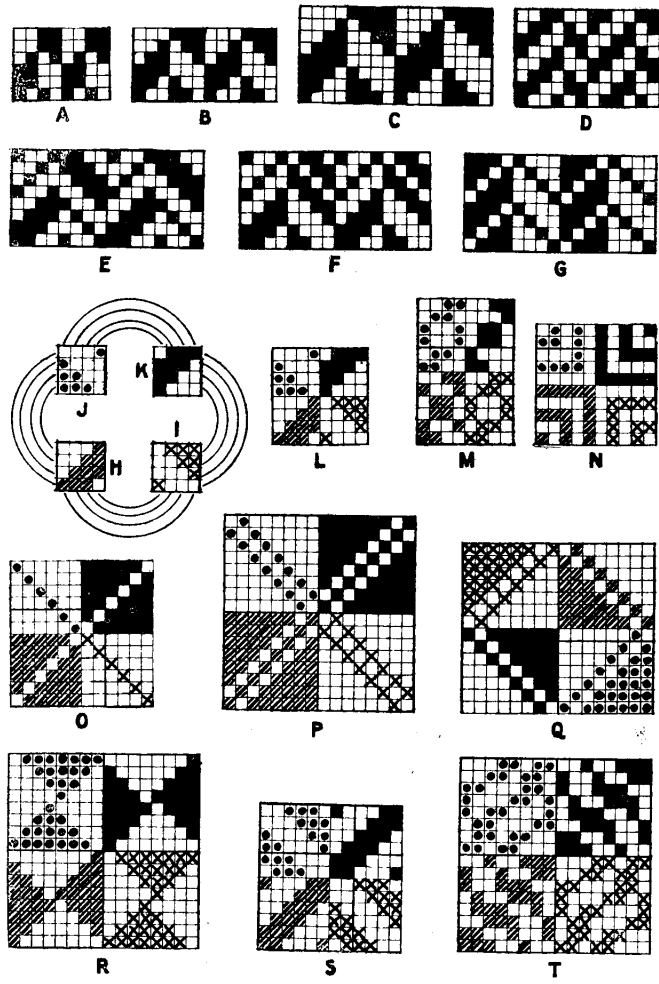


Fig. 41.

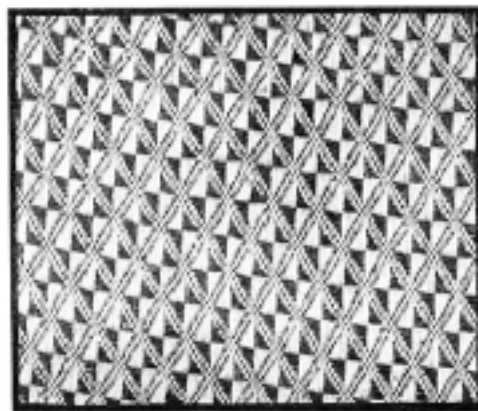


Fig. 42.

picks of H are the reverse of the picks of J, the ends of J the reverse of the ends of K, and the picks of I the reverse of the picks of K. The design L, which shows the parts H, I, J, and K put together, repeats on twice as many ends and picks as the unit weave, and consists of four sections which cut with each other where they are in contact.

The examples M to T in Fig. 41 are constructed in the same manner as L, the different stages of working being represented by different marks. The unit weave of M is on four ends and six picks, and produces a design of a "crêpe" character that repeats on eight ends and twelve picks. The design N is termed a "basket" weave, and is constructed from a 5 x 5 unit, while the designs O, P, Q, and R, to which the term "barley-corn" is applied, result from 6 x 6, 8 x 8, 8 x 7, and 8 x 8 units respectively. The fabric represented in Fig. 42 corresponds with the design P in Fig. 41.

The unit of the design S in Fig. 41 consists of one exact repeat of 3-and-3 twill, and the unit of T of one repeat of the Mayo weave, and the designs can be used in the form shown, or each section may be extended a number of times so as to form large check designs. The construction of large check designs on the reversing principle is illustrated in Fig. 115.

COMBINATIONS OF TWILL WEAVES

Different methods of constructing designs by combining small ordinary twill weaves in the order of an end or a pick of each alternately are illustrated in Figs. 43, 44, and 45. In combining the 4 and 5-thread twills, given respectively at

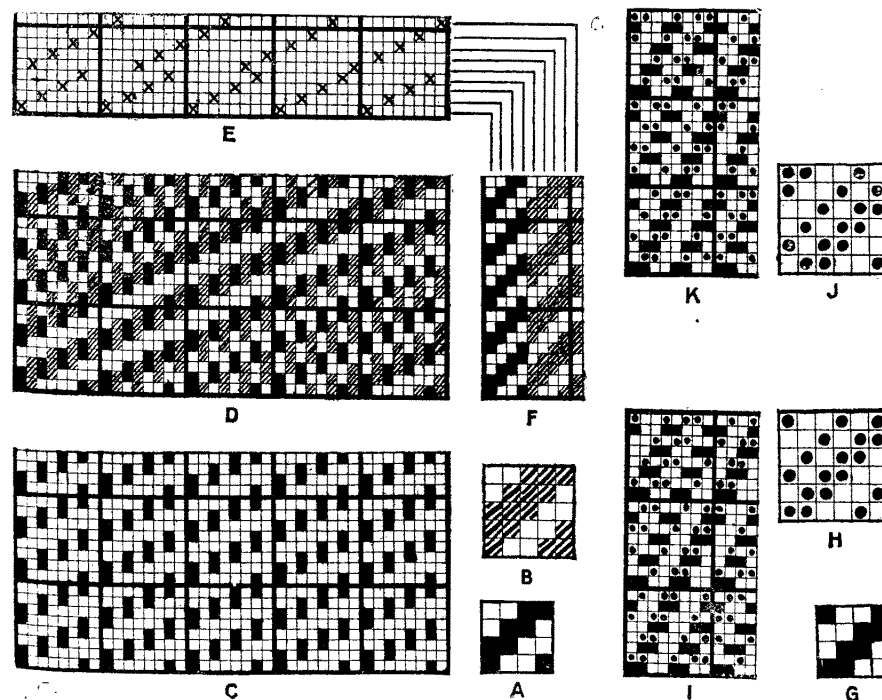


Fig. 43.

A and B in Fig 43, an end of each alternately, one twill—say A—is first indicated on the odd vertical spaces, as shown at C. Then, to complete the design, the other twill (B) is indicated on the even vertical spaces, as shown at D. Each twill must be carried out on 20 ends and picks—the L.C.M. of 4 and 5, hence the design D consists of 20 threads of A combined with 20 threads of B, and thus repeats on 40 ends and 20 picks.

The proper method of drafting the design D is illustrated at E in Fig. 43, in which the ends of the 2-and-2 twill are indicated on four healds placed at the front of the five healds upon which the ends of the 3-and-2 twill are drawn. The arrangement enables the order of drawing in to be readily followed, while the most crowded healds are placed at the front and carry the ends which interweave most frequently. The pegging-plan is given at F.

The 4- and 6-thread twills, given respectively at G and H in Fig. 43, are shown combined—a pick of each alternately—at I, the 2-and-2 twill being inserted on the odd horizontal spaces, and the 6-thread twill on the even horizontal spaces. In this case, as 12 is the L.C.M. of 4 and 6, each twill is extended over 12 ends and picks so that the design I consists of 12 picks of G combined with 12 picks of H, and repeats on 24 picks and 12 ends.

When the repeats of the twills that are combined have no measure in common only one design results in either the warp or the weft method of combination, as each twill gets into every possible relationship with the other twill. If, however, the repeats have a common measure more than one design can generally be constructed by altering the relative position of the two twills. Thus, 2 will divide into 4 and 6—the respective repeats of G and H in Fig. 43, and it is therefore possible to produce a second design, as shown at K, by commencing the 6-thread twill in the position indicated at J, while retaining the 2-and-2 twill in the original position. It will be found by experiment that any further change in the relative position of the two twills will simply produce a duplicate of either I or K.

The construction of different designs by varying the relative position of two twills can be carried still further if the twills are equal in size or if one is double the size of the other. Thus, in combining the two six-thread twills given at A and B in Fig. 44, —an end of each alternately—six designs are obtained, as shown at C, D, E, F, G, and H; and, as 6 ends of one twill are combined with six ends of the other, each design repeats on 12 ends and 6 picks. One twill—say A—is inserted in the same position on the odd vertical spaces of each design, then the twill B is indicated on the even vertical spaces; commencing in the design C with the first end of B; in D with the second end; in E with the third end; in F with the fourth end; in G with the fifth end; and in H with the sixth end. The twills can be combined—a pick of each alternately—in the same manner, and the latter method has the advantage that each design only requires six healds, whereas each design C to H in Fig. 44 requires 12 healds.

The twills I and J are shown combined—a pick of each alternately—at K, L, M, and N in Fig. 44, only four changes being possible in this case as J is on four threads. It is necessary, however, to use 8 threads of the weave J to conform with the repeat of I, hence the complete designs repeat on 16 picks and 8 ends. The weave I is indicated in the same position on the odd horizontal spaces of K, L, M, and N; then the weave J is inserted on the even horizontal spaces commencing with the picks in turn in succeeding designs.

A still further development, which is illustrated by the examples O to S in Fig. 44, consists of using the same twill for both the odd and the even threads. The weave O is indicated on the odd vertical spaces of the designs P, Q, R, and S, commencing each time with the first end; but in inserting the weave on the even vertical spaces, P commences with the first, Q with the third, R with the fourth, and S with the fifth end of O. In this weave any further change of position will produce a duplicate of one of the preceding. In end-and-end combinations the method has the advantage that only half as many healds are required as there are

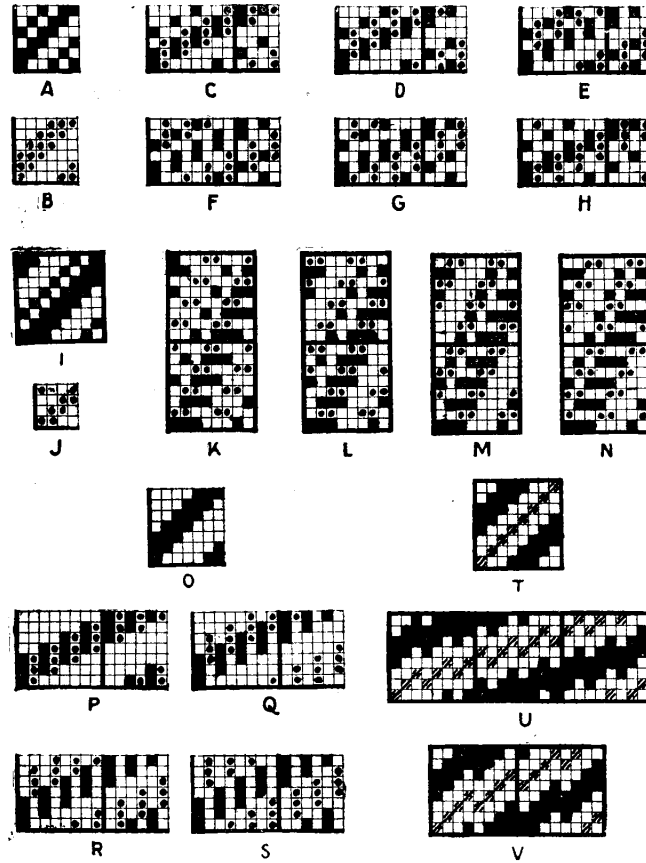


Fig. 44.

ends in the repeat. The picks of a twill may be combined in the same manner as the ends. Also the principle of combining the threads of a twill may be extended to include such designs as those shown at U and V in Fig. 44, which are produced from the twill T.

**Combination Twills running at 45° angle.**—In the foregoing combinations, flat or steep twills are respectively produced according to whether the ends or the picks are combined. The examples given in Fig. 45 illustrate methods of combining twills by which designs—twilling at the angle of 45°—are formed. The designs C to J are constructed by first indicating *alternate* ends of the twill A on the odd

vertical spaces in the same position in each design. Then *alternate* ends of the twill B are inserted on the even vertical spaces, commencing with the following end in each succeeding design. Thus C commences with the first end of B, D with the second end, E with the third end, and so on.

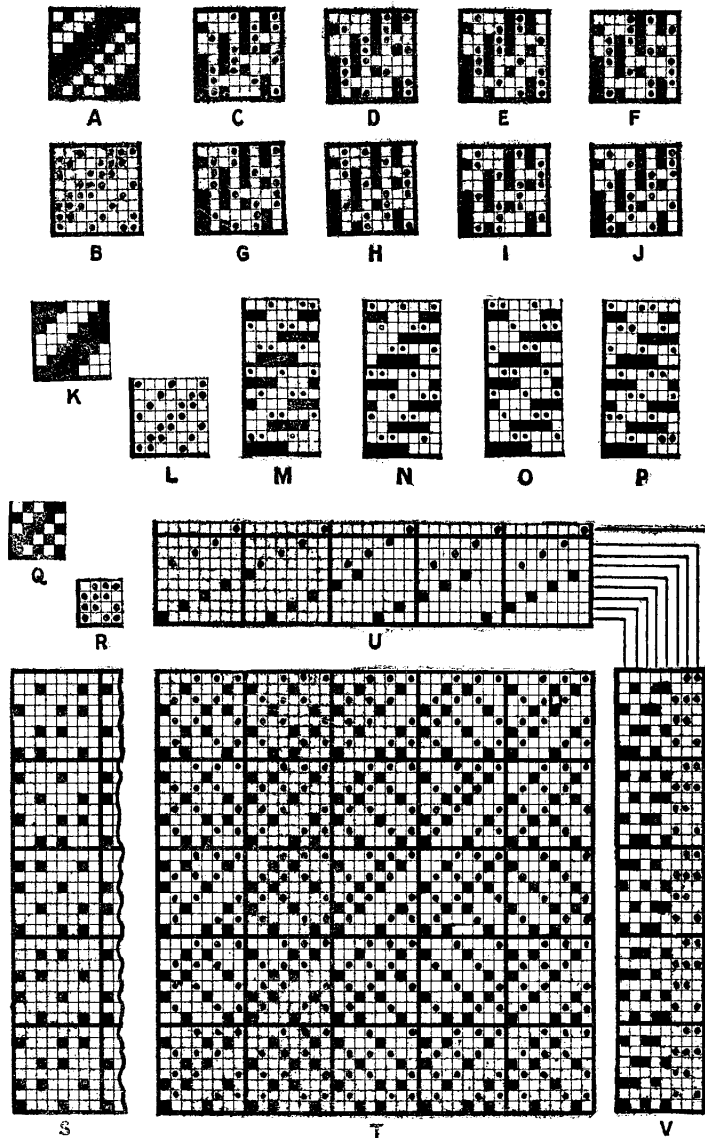


Fig. 45.

In the same manner, the designs M, N, O, and P in Fig. 45, are constructed by inserting alternate picks of the twill K in the same position on the odd horizontal spaces; then alternate picks of the twill K, commencing each time with a different



pick, are inserted on the even horizontal spaces. In this case as each twill repeats on an odd number of picks, all the picks must be combined, and the resulting designs therefore repeat on 14 picks and 7 ends. All the positions in which the twill L can be placed are not shown, as the remaining positions simply produce duplicates of M, N, and P; it will be found that duplicate designs result when the marks of the original twills are arranged symmetrically.

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

## CHAPTER IV

### FANCY TWILLS AND DIAMOND DESIGNS

*Fancy Twills*—Large Diagonals—Shaded Twills—Diagonals on Sateen Bases—Spotted and Figured Twills—Pointed Waved, or Zig-zag Twills—Curved Twills. *Diamond and Diaper Designs*—Construction of Diamond Designs upon Pointed Drafts—Diamond Designs that are not Pointed.

#### FANCY TWILLS

**Large diagonals.**—A method of constructing ordinary twills or diagonals by combining two or more small twills in diagonal form is illustrated at A and B in Fig. 46. These diagonals, however, cannot be drafted on to a small number of healds. A is composed of 3-and-1 and 1-and-3 twills, while B is a compound of 3-and-3, 2-and-1, and 1-and-3 twills, the last twilling in the opposite direction to the diagonal. The chief points to note in constructing the weaves are that the twills are joined together in a suitable manner, that they are sufficiently different from each other, and that each is allotted enough space to give the large twill a distinctly diagonal appearance. By reversing one of the twills, as shown in B, the diagonal form is developed very clearly.

**Shaded twills.**—These are designed, as shown at C, D, and E in Fig. 46, by combining a number of small twills in which the floats increase or decrease in size. C is composed of five twills on six threads, which are arranged 5-and-1, 4-and-2, 3-and-3, 2-and-4, and 1-and-5. The term “single-shading” is applied to this style because each kind of float shades in one direction only. “D is a double-shaded”

style which is composed of the 1-and-4, 2-and-3, 3-and-2, and 4-and-1 twills, the floats of which are arranged to shade in both directions. E is composed of 5-and-1, 4-and-1, 3-and-1, and 2-and-1 twills, which are so arranged as to form distinct warp and weft sections each of which is single shaded. The last style can be readily modified to produce warp and weft sections which are double-shaded.

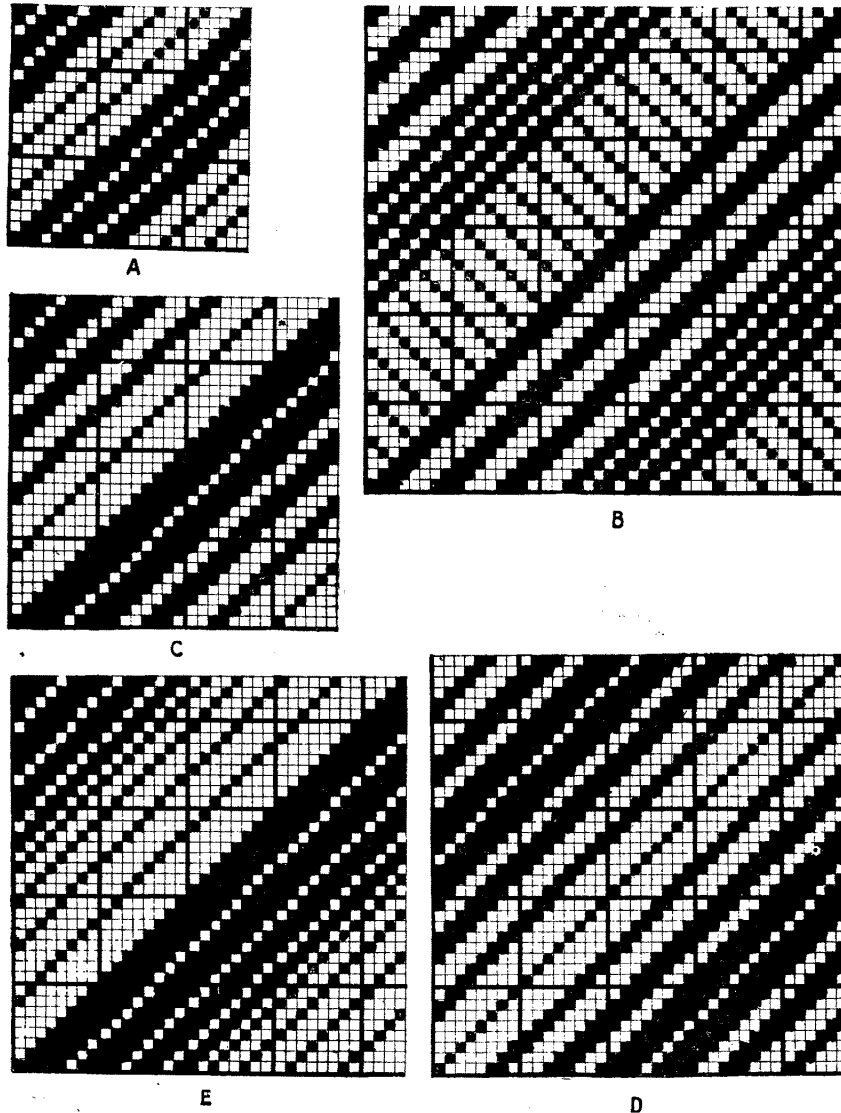


Fig. 46

**Diagonals or Sateen Bases.**—These are constructed by combining two or more sateen derivatives, in the method illustrated in Fig. 47. Certain sateens, such as the 8, 10, and 15-thread weaves, can be used in constructing diagonal designs

running at  $45^\circ$  angle. An example is shown at F in Fig. 47, which is based on the 8-thread sateen counting 5. Sateens can also be selected which will yield steep twills, as shown at G, or flat twills, as shown at H. G is based on a 10-thread sateen counting 3, and H on a 7-thread sateen counting 2. According to the angle in which the diagonal is required to run the sateen base is inserted over an equal or an unequal number of ends and picks; thus in F the ends and picks are equal; G is on three times as many picks as ends; and H on twice as many ends as picks. The number

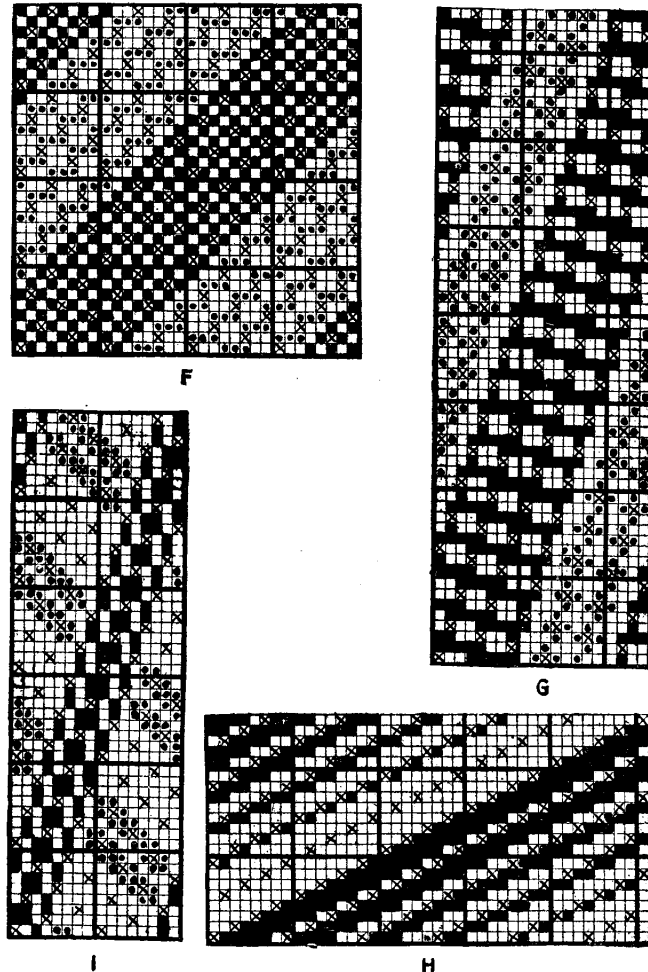


Fig. 47.

of ends and picks in a design must be a multiple of the number of threads in the repeat of the sateen. In adding marks to the sateen marks the weaves in the respective sections should be made sufficiently different from each other to show clearly, except when a shaded diagonal effect is formed, as shown at H, in which the weave is changed very gradually. Diagonal lines may be arranged to run at different angles in a design as shown at I, which is constructed on the 8-thread sateen basis.

**Spotted and Figured Twills.**—The examples, given at A, B, C, and D in Fig. 48, illustrate the arrangement of small spots or figures in conjunction with, and running at the same angle, as ordinary twills. A spot may be repeated diagonally one or more times in each repeat of the twill lines; and in finding the repeat of a spot it is necessary to count the spaces diagonally. For example, in the design A the crosses, which indicate corresponding positions of the spots, occur on every third space—counted diagonally, and in order to show this clearly, dots are indicated between the crosses. The complete repeat of the twill is upon 12 threads or diagonal spaces,

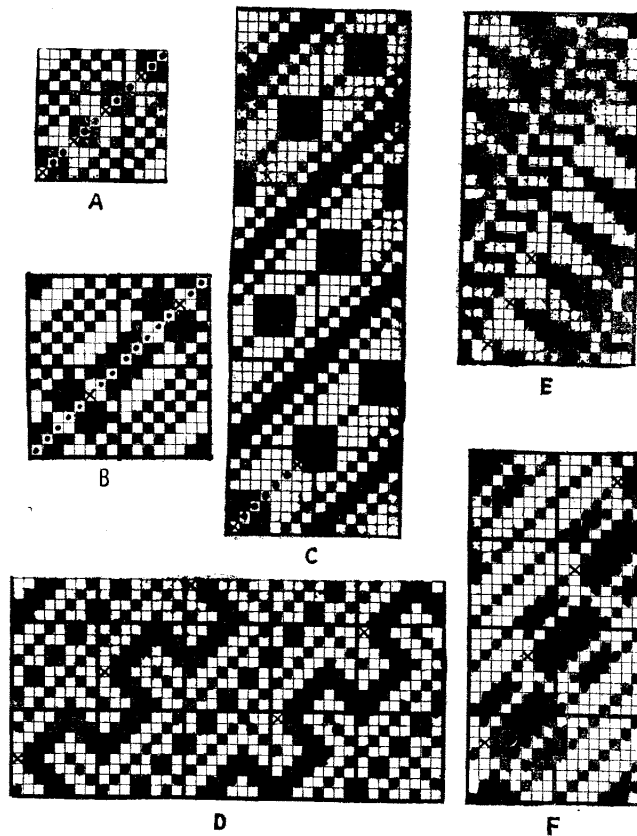


Fig. 48.

and the spot is therefore repeated four times. A representation of the design A, in the woven fabric, is given in Fig. 49.

The twill in the design B in Fig. 48 repeats on 16 threads, and as the figure repeats on 8 diagonal spaces, as indicated by the crosses and dots, it is inserted twice in the complete design. In C the twill lines repeat upon 16 threads, but in this case the spot repeats on 6 spaces—counted diagonally, hence the complete repeat extends over 48 packs—the L.C.M. of 16 and 6. The design C could be arranged similarly to repeat upon 48 ends and 16 picks by extending the weave horizontally, and in the design D a figured twill is shown thus arranged. The twill repeats

upon 20 threads, and the figure on 8 diagonal spaces, hence the complete design occupies 20 picks and 40 ends, the latter number being the L.C.M. of 20 and 8. In doobby shedding it is necessary to extend the designs vertically, but in Jacquard weaving the horizontal method has the advantage that a saving of cards is effected. In designing spotted twills it is convenient to first insert lightly a diagonal line of marks as a basis; the spaces occupied by the figure and the twill then require to be adjusted to the size of the repeat, or *vice versa*.

Small figures may be arranged in combination with steep or flat twills, and an example is given at E in Fig. 48 in which the twill repeats on 16 ends and 32 picks, while the distance between corresponding parts of the figure is two spaces outward, and four spaces upward. The design F is inclined at the same angle as E, the distance between corresponding parts of the figure being four outward and eight upward, but in this case the space between the figures is simply filled in with 1-and-3 ordinary twill.

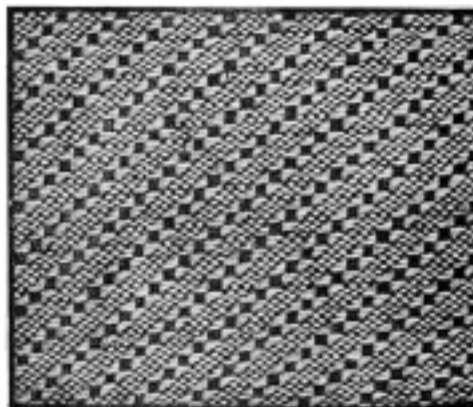


Fig. 40.

**Pointed, Waved, or Zig-zag Twills.**—Twills which run to right and left alternately, and turn upon one thread, produce pointed, waved, or zig-zag effects in the cloth. Sometimes the term “herring-bone” is used, but this term is also applied to twills in which the floats oppose each other where the weaves reverse, in the method illustrated at C in Fig. 111. Small twills, such as the 2-and 2, when turned upon one thread, have more of a herring-bone than a waved appearance, but twills which contain a distinct line of float, form prominent zig-zag lines running horizontally or vertically in the cloth. The horizontal waved line effects are economically produced in pointed or V drafts, and good styles may be



Fig. 50.

woven on a few healds by means of twill tappets. The vertical line effects, however, mostly require a doobby shedding motion, because of the comparatively large number of picks in the weaving plan. Fig. 50 illustrates a horizontal waved line pattern that corresponds with the weave given at D in Fig. 51,

while by turning Fig. 50 one-quarter round a vertical effect is shown that corresponds with the weave O in Fig. 51.

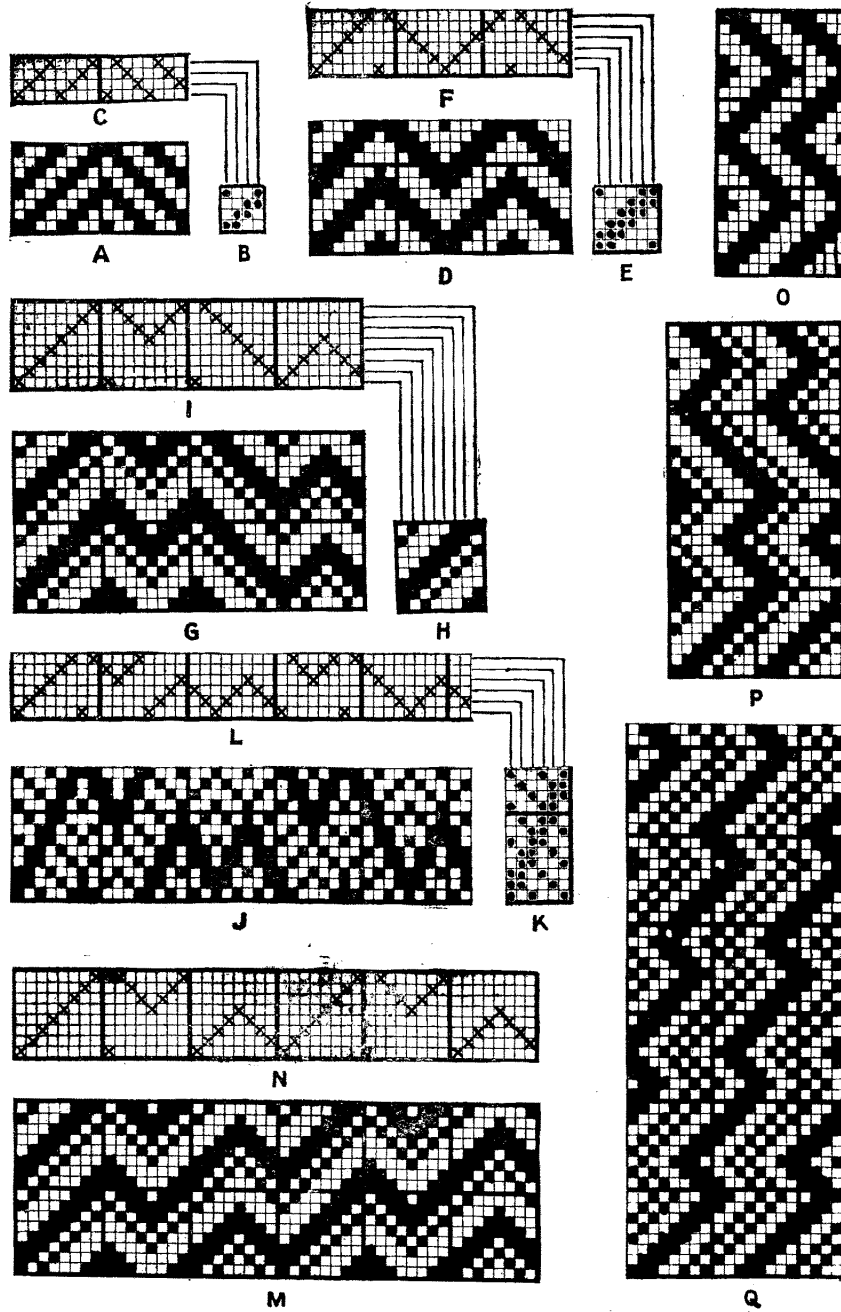


Fig. 51

A in Fig. 51 shows the 2-and-2 twill given at B, arranged 8 ends to right and 8 ends to left, turning on the first and ninth ends, whilst D shows the 3-and-3 twill E running 6 ends to right and 6 ends to left, turning on the first and seventh ends. A more complex arrangement is illustrated at G, in which the 8-thread twill H is turned on the ends 1, 9, 13, 17, 25, and 29. In each case the design is, for convenience, so arranged that an equal number of ends is drawn on each heald, as shown in the pointed drafts C, F, and I, which respectively correspond with the designs A, D, and G.

A further variation of the pointed system of drafting is indicated on six healds at L in Fig. 51, but in this case the healds are more complicated, because the number of ends drawn upon each is unequal. Any twill repeating on 6 ends, can, of course, be used as the weaving plan for the draft L; and, in order to show how other twills than ordinary twills can be arranged on the pointed principle a zig-zag steep twill is given at J for which K is the pegging plan and L the draft.

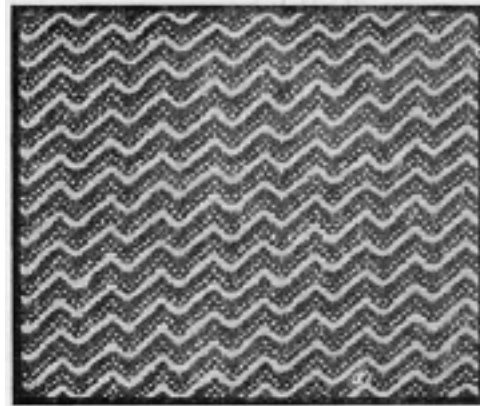


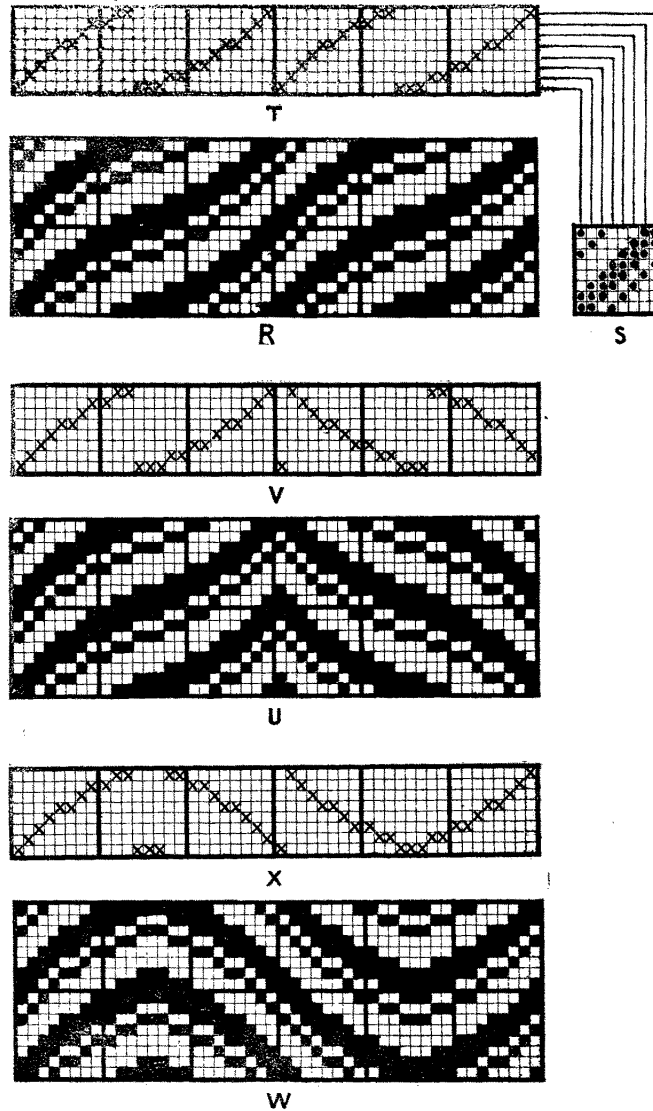
Fig. 52.

In the designs A, D, G, and J, the twills run for as many threads to the right as to the left, so that each twill line returns to the level at which it commenced. In the design M, however, for which N is the draft, the twill H is arranged to run 8 ends to the right and 4 ends to the left alternately, so that the zig-zag line gradually rises and runs at a flat angle from side to side of the cloth, as shown in the corresponding fabric represented in Fig. 52.

The designs O and P in Fig. 51, which correspond with D and G, illustrate the method of producing vertical waved lines in the cloth. In the former the twill turns on the picks 1 and 7, and in the latter on the picks 1, 9, 13, 17, 25, and 29. The design Q shows a 10-thread twill arranged to run seven picks to right and three picks to left alternately, a zig-zag twill, running at a steep angle, being produced. A defect of the pointed twill arrangement is the formation of an increased float where the weave turns, the long float occurring in the weft in the horizontal waved effects, and in the warp in the vertical patterns. Occasionally, two threads are worked alike at the turning points; but this is liable to give a defective appearance.

**Curved Twills.**—The principle of construction of curved twills will be understood from an examination of the design R in Fig. 53, which is constructed from the

8-thread twill given at S on the basis of the curved draft indicated at T. This class of design is only used to a limited extent, as there is the disadvantage that the length of the weft float and the firmness of the cloth vary in different parts of the twill line.



W  
Fig. 53.

Curved twills may be reversed in direction so as to form zig-zag effects in which each curve terminates in a point, as shown at U in Fig. 53, and the corresponding draft V; or a rounded zig-zag twill may be made, as indicated at W and the corresponding draft X.



DIAMOND AND DIAPER DESIGNS

**Construction of Diamond Designs upon Pointed Drafts.**—Point-drafted diamond and diaper effects may be constructed in the following two ways :—(1) By employing a twill for the pegging-plan, which is reversed vertically to coincide with the horizontal pointed arrangement of the draft. (2) By indicating a diamond base and building up the design in the same manner on each side of the centre ends.

In the first method the design really results from employing horizontal and vertical zig-zag twills in combination. This is illustrated at A, B, C, and D in Fig. 54

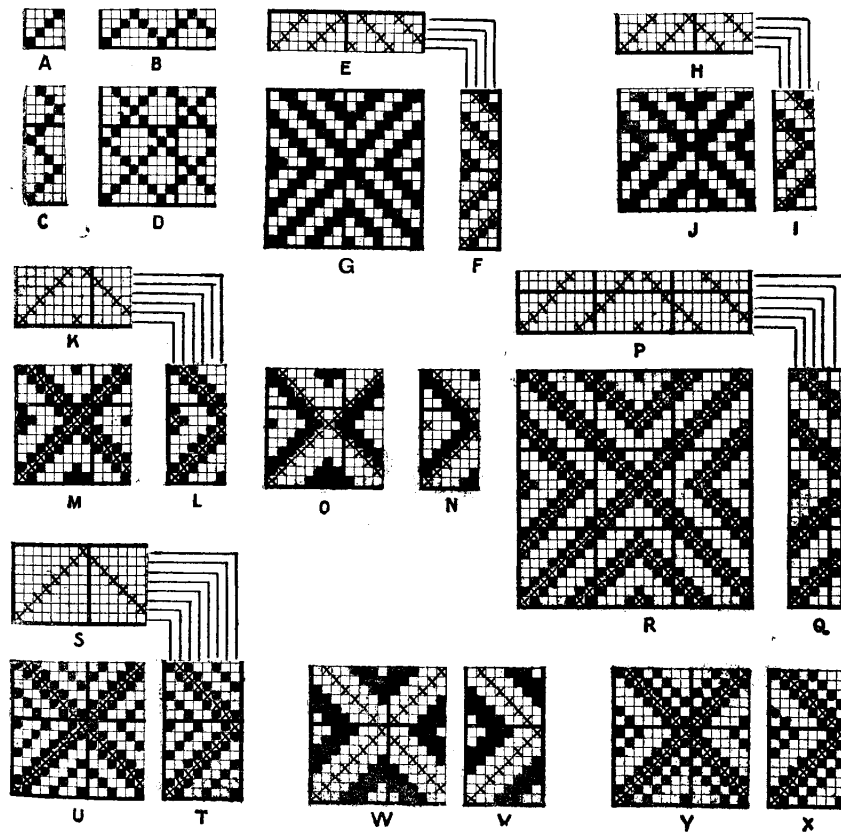


Fig. 54.

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

In the same manner E, F, and G in Fig. 54, illustrate the construction of a diamond design based upon 2-and-2 twill. The draft E (which is similar to C in Fig. 51) turns in the first and ninth ends, and the pegging-plan F, which, as shown by the crosses, runs in the same order vertically as the draft is arranged horizontally.

turns on the first and ninth picks. The combination of E and F produces the diamond design given at G, in which, however, it will be noted that the diamond spaces are not alike. This is due to the additional mark of the 2-and-2 twill being necessarily placed at one side of the base marks in the pegging-plan. It is possible, however, to produce similar diamond spaces in the 2-and-2 twill by making the repeat two threads larger in one direction than in the other, as shown at H, I, and J in Fig. 54. The design J corresponds with the woven pattern represented in Fig. 55.

The construction of three diamond designs, based upon 3-and-3 twill weave, is illustrated at K to R in Fig. 54. The draft K turns upon the first and seventh ends, and the corresponding pegging-plan L upon the first and seventh picks. In the latter the base line (indicated by the crosses) forms the centre of the float of three, and the arrangement results in the formation of a perfectly symmetrical diamond design, as shown at M. A pegging-plan for the draft K is given at N, however, in which the base line

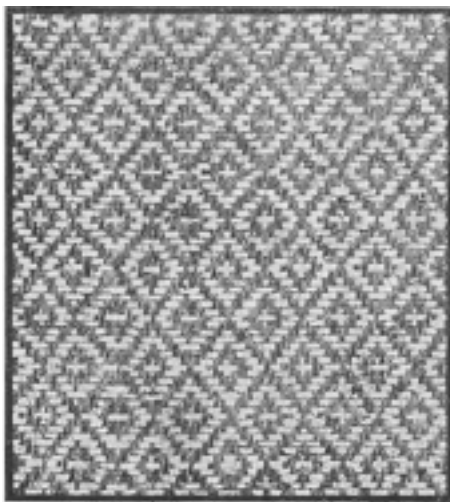


Fig. 55.

does not form the centre of the 3-and-3 twill weave, and this results in the production of a design, as represented at O, in which the diamond spaces are not alike. By employing more than one repeat of the twill in each direction, as shown at P, Q, and R in Fig. 54, a larger diamond design is produced. If the base line of the pegging-plan forms the centre of the marks of the twill weave, a continuous line of marks in each direction is formed which enclose the diamond spaces. The marks may, of course, indicate either warp or weft up.

The drafts E, K, and P in Fig. 54 turn on the same heald (the first) each time, and the arrangement has the advantage that the same number of ends is drawn upon each heald. Pointed drafts, however, are frequently made to turn on the first and last healds, which thus require half as many mails as the centre healds, as shown at S in Fig. 54. In order to illustrate certain features in the designs, three pegging-plans are given at T, V, and X, in each of which an 8-thread twill weave is reversed in the same order as the draft S, while the corresponding designs are indicated at U, W, and Y. The same twill weave is used in both T and V, and in both cases the base line of marks forms the centre of the twill. In the plan T, however, the base line is in the centre of the float of three, whereas in V it coincides with the single line of marks. The difference in the position of the twill results in the formation of two quite different designs, as will be seen from a comparison of U and W. In the pegging plan X the base line of marks is in the centre of the float of three, but the single line of marks is not in the centre of the space between, hence in the resulting design, given at Y, the two diamond spaces are dissimilar. This, however, is not necessarily a disadvantage.

Fig. 56 shows the construction of a more elaborate diamond design than any of the foregoing, and also illustrates a method of using straight and pointed twills

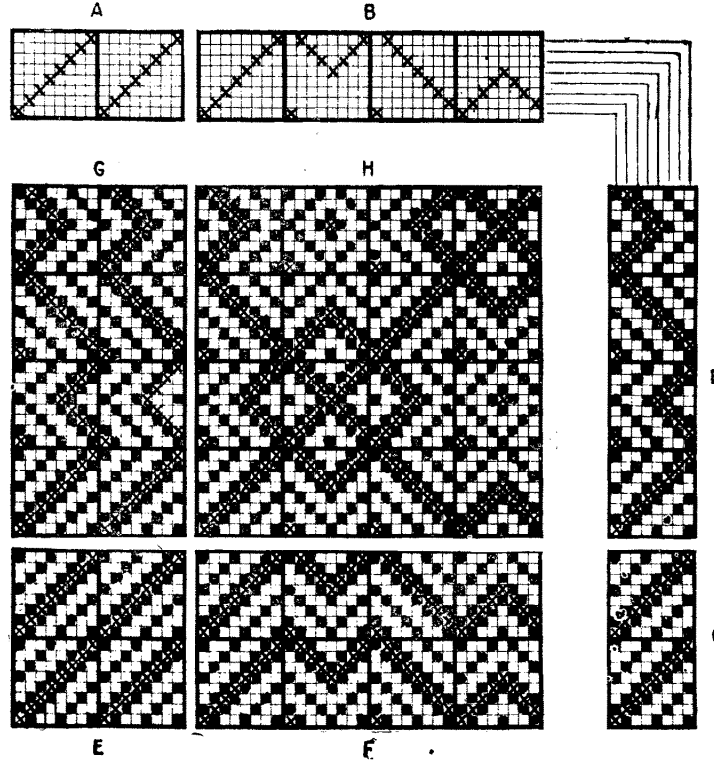


Fig. 56.

in the production of bordered fabrics. A shows a straight draft, and B a fancy pointed draft (the latter is the same as I in Fig. 51) on 8 healds, while C and D represent straight and pointed twill pegging-plans to correspond. The straight twill, given at E results from the combination of A and C; the horizontal zig-zag twill F from the combination of B and C; the vertical zig-zag twill G from the combination of A and D; and the diamond design H from the combination of B and D. By suitably repeating the respective sections a number of times a bordered fabric may be formed in which E forms the corners,

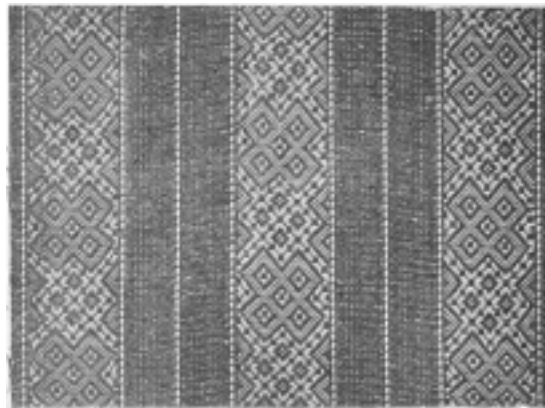


Fig. 57.

F the cross-borders, G the side-borders, and H the centre. A diamond figure that is arranged on the same principle as H in Fig. 56, but which requires 16 healds, is shown arranged in stripe form with another weave in Fig. 57, while the corresponding draft is indicated at A in Fig. 138.

Fig. 58 shows another form of diamond figure which repeats upon 90 ends and picks, and can be woven in 18 healds. The order of drafting is indicated by the black squares on the first 18 horizontal spaces of K, the ends being drawn to right

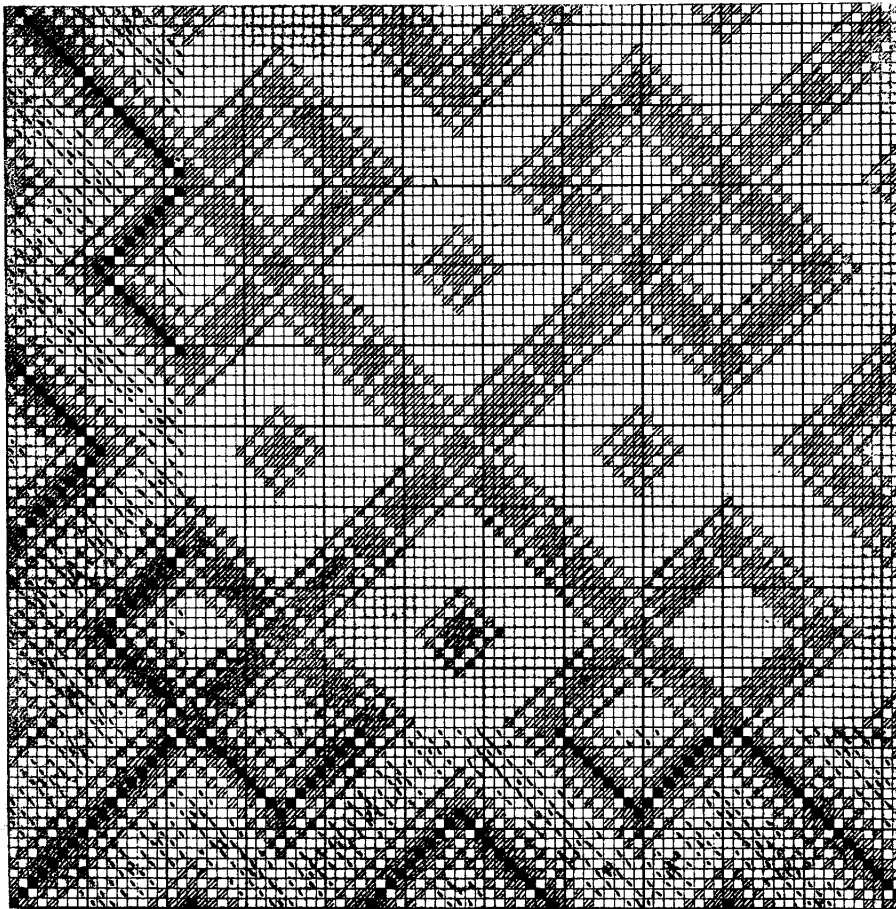


Fig. 58.

and left alternately in the order of 18, 9, 18, 18, 9, 18. The pegging-plan, which is based on the weave given at L in Fig. 59, is indicated on the first 18 vertical spaces of Fig. 58; and, as shown by the solid marks, the order of reversing is the same as in the draft. A method of preventing the formation of an increased float where the twill reverses (which is common to pointed twills) is illustrated by the example. The draft is arranged to turn always on the first, or the tenth heald, and the pegging-plan on the first or the tenth vertical space. The squares, where the first and tenth

ends and picks intersect in the weave L in Fig. 59, are therefore taken as centres, and the twill line of float is cut across as shown. Therefore, instead of the floats

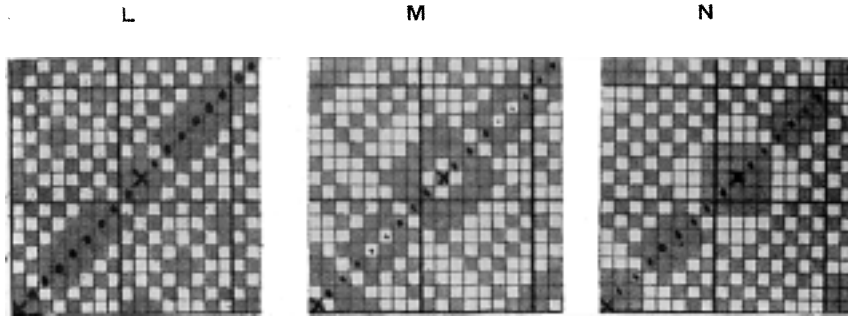


Fig. 59.

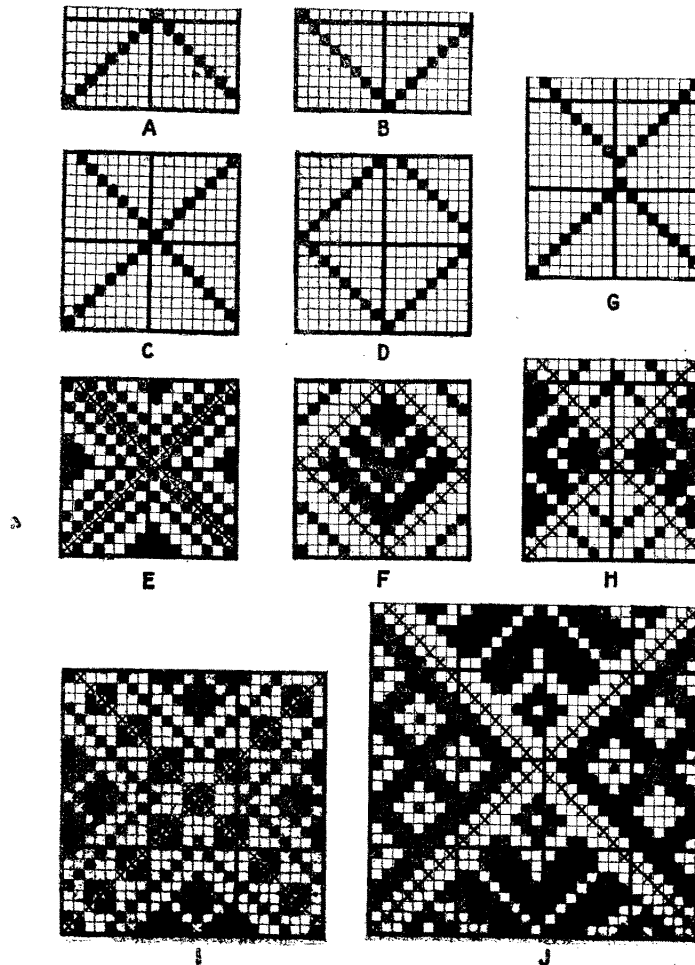


Fig. 60.

joining together small spots are formed at each place where the twill lines cross one another in Fig. 58. In order that the form of the design may be clearly seen the complete weave is shown only on the first 18 ends and picks of Fig. 58.

It is very necessary for the weave, which is used as the basis of the pegging-plan, to be systematically constructed in order to ensure that a symmetrical design will result. For the purpose of further illustrating this point two fancy twill weaves are given at M and N in Fig. 59 which are suitable for the draft of Fig. 58. A single line of marks is first inserted diagonally, as shown by the dotted squares in M and N, then the first and tenth threads (on which the draft reverses) are taken as centres, and a weave is built up which will reverse either in the direction of the warp or the weft without forming an increase in the float. Also the remainder of the weave is constructed in the same manner on each side of the centre line of marks.

In the second class of point-drafted diamond designs, a woven example of which is illustrated in Fig. 61, a pointed draft is first indicated on the required

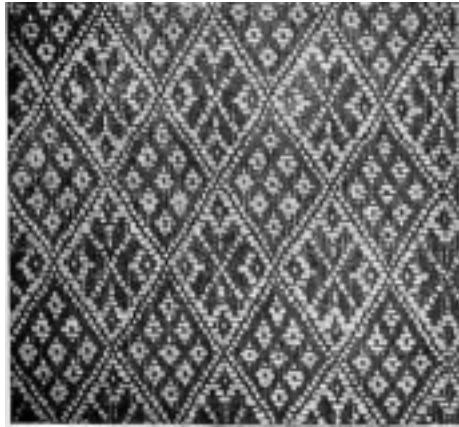


Fig. 61.

number of healds, as shown at A or B in Fig. 60, which are arranged on nine healds. Marks are then inserted in reverse order, as shown at C or D, and the repeat, which is on two threads less than twice the number of healds in the draft, is thus divided by the base marks into two diamond spaces. The base marks, which serve as a guide in building up the design, may be converted into distinct lines that cross one another, as shown at E; or a weave may be indicated only in the diamond spaces, as represented at F. The two diamond spaces may be filled in in the same manner, as shown in E, or different effects may be inserted, as

indicated in F, which shows one diamond space in weft float, and the other in warp float. In each case, however, it is necessary for the threads to work alike on each side of the centre ends.

In constructing diamond designs in which the sections are equal in size and exactly the reverse of each other, the repeat should be made two threads larger in one direction than the other. The method is illustrated at G and H in Fig. 60; G showing how the diamond base is arranged, and H a design in which the warp float in one space exactly corresponds with the weft float in the other space.

If a hopsack weave is employed, the small squares should be arranged to reverse properly from the centre, as shown in the design given at I in Fig. 60, which is constructed on the basis of a pointed draft on 13 healds.

The design J, which corresponds with the pattern represented in Fig. 61, shows an elaborate style that is weavable on a 16-heald pointed draft. (Other examples of point-draft diamond designs are given in Figs. 309, 310, and 311.)

**Diamond Designs that are not Pointed.**—The construction of diamond designs that are not weavable on pointed drafts, gives greater freedom to the designer, as

compared with the foregoing, but in dobby shedding the size of the repeat is more limited. For convenience diamond base marks may be first indicated in the same manner as in the construction of point-drafted designs. Very interesting interlacing twill designs are produced in this system, and a convenient method of working is illustrated at K and L in Fig. 62. From the centres where the diamond base lines intersect, lines of marks are inserted running to right and left alternately, as indicated by the solid squares in K. Marks are then added to the base lines to give the required length of float, as shown at L, but blank squares are left where the twills cross one another in order to break the continuity of the lines.

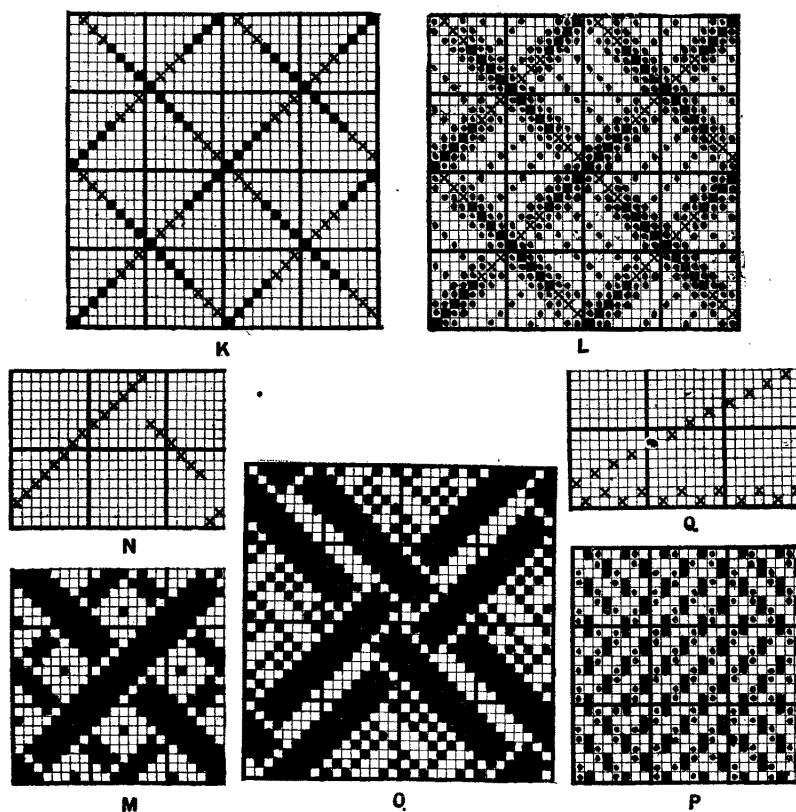


Fig. 62.

In dobby shedding, in order to obtain a larger number of threads in the repeat than the number of healds employed, an interlacing twill design may be arranged to suit a modified form of pointed drafting. An example is given at M in Fig. 62, which repeats on 22 threads but can be drafted on 16 healds, as indicated at N.

The design O in Fig. 62 illustrates a method of interlacing the twills when two or more lines are introduced; this design cannot be drafted on to less than 29 healds, and is therefore beyond the capacity of the ordinary type of dobby.

The diamond design given at P in Fig. 62 illustrates a principle by which comparatively large effects can be woven on a small number of healds. The even

ends work continuously in 2-and-2 order, as indicated by the solid marks, and can be drawn upon two healds, as shown in the draft Q. The 2-and-2 twill weave is caused to run to left or to right in the design according to the position in which the marks are inserted upon the odd ends. Effects can be produced in 1-and-3 twill weave in the same manner.

Two examples of large diamond designs are given in Figs. 230 and 231, which are different from the preceding, but no difficulty will be found in following the bases of construction.

## CHAPTER V

### CONSTRUCTION OF SIMPLE SPOT FIGURE DESIGNS

Methods of drafting Spot Figures—Distribution of Spot Figures—Reversing Spot Figures—Irregular Sateen Bases—Calculations relating to Spot Figure Designing.

DESIGNS in which the ornament consists chiefly of small, or comparatively small, detached spots or figures are employed in nearly all classes of yarn and yarn combinations, for dress fabrics, fancy vestings, and other textures in which elaborate figure ornamentation is not desired. Spotted effects are produced in cloths in different ways—*e.g.*, by employing fancy threads in which spots of contrasting colour occur at intervals, and by introducing extra warp or extra weft threads which are brought to the surface where the spots are formed. In the following, however, only the system of producing spot figures is considered in which the spots are formed by floating the ordinary weft or warp threads on the surface of the cloth in an order that is in contrast with the interlacing in the ground. (The examples will be found useful as an introduction to the designing of figured fabrics, which is fully dealt with in subsequent chapters.) The figures show most prominently when the warp and weft threads are in different colours or tones; but if the two series of threads are alike the difference in the reflection of the light from the different weave surfaces is sufficient to render the figures clearly visible. Other things being equal, the weft usually forms brighter and clearer spots than the warp: (1) because it is more lustrous on account of containing less twist; and (2) because cloths generally contract more in width than in length, the weft thus being brought more prominently to the surface than the warp.

**Methods of Drafting Spot Figures.**—Simple spot figures are readily designed directly upon point paper, and the outline may be first lightly indicated in pencil, as represented at A in Fig. 63. The squares are then filled in along the outline, as indicated at B, and this is followed by painting the figure solid, as shown at C. If the ground weave is plain, in painting the outline, the moves should be in odd numbers of squares, as shown at D in Fig. 63, in order that the edge of the figure will fit correctly with the plain marks. If only short floats are required in the figure a simple weave (*e.g.*, a twill or sateen) may be inserted upon it in a colour of paint that is in contrast with the first colour, as represented by the blanks in the figure shown at E in Fig. 63. On the other hand, the binding marks may be inserted in such a manner as to give a special appearance to the figure as indicated at F. The



prominence of the figure is usually reduced about in proportion to the firmness of the binding weave, but, as a rule, however pronounced a figure is required to appear, a longer float than three-sixteenths of an inch in the cloth should not be made, or the structure will be too loose.

In producing a given size of figure in the cloth the number of small spaces, or

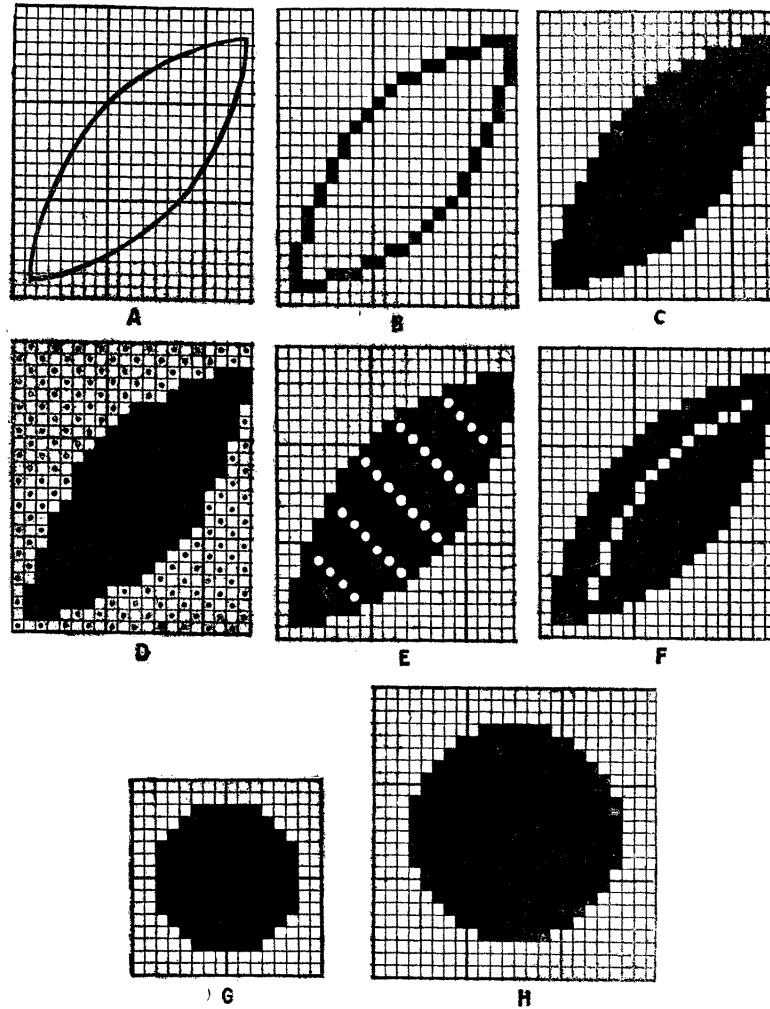


Fig. 63

threads, upon which it is designed, varies according to the sett of the cloth. For instance, if a spot three-sixteenths of an inch in diameter is required: For a cloth containing 64 ends and 64 picks per inch, the spot will be designed upon 12 squares in each direction, as shown at G in Fig. 63; whereas for a cloth counting 96 ends and 96 picks per inch it will be designed upon 18 squares, as indicated at H. If the ends and picks per unit space are unequal, to enable the figure to be drawn in

proper proportion, design paper should be used which is ruled to correspond. (see Fig. 258).

Spot figures which are rather intricate may be sketched upon plain paper, and then be drafted upon design paper in the manner illustrated at I, J, and K in Fig. 64. As shown at I, two lines are drawn at right angles to each other to correspond with the direction of the warp and weft threads, the position of the lines in relation to the figure determining the angle at which the latter will be inclined in the cloth. The area over which the figure extends is then divided into equal spaces, as shown at J, each space corresponding to a number of ends and picks in the cloth, or of small spaces of the design paper. The figure is then drawn to the required scale upon the point-paper, as shown at K in Fig. 64, in which one large square, or eight ends and picks, correspond to one space of the sketch J. If the figure is required to appear the same size in the cloth as in the sketch, the ruling of the sketch and the number of small spaces of the design paper that each space in the sketch represents, are

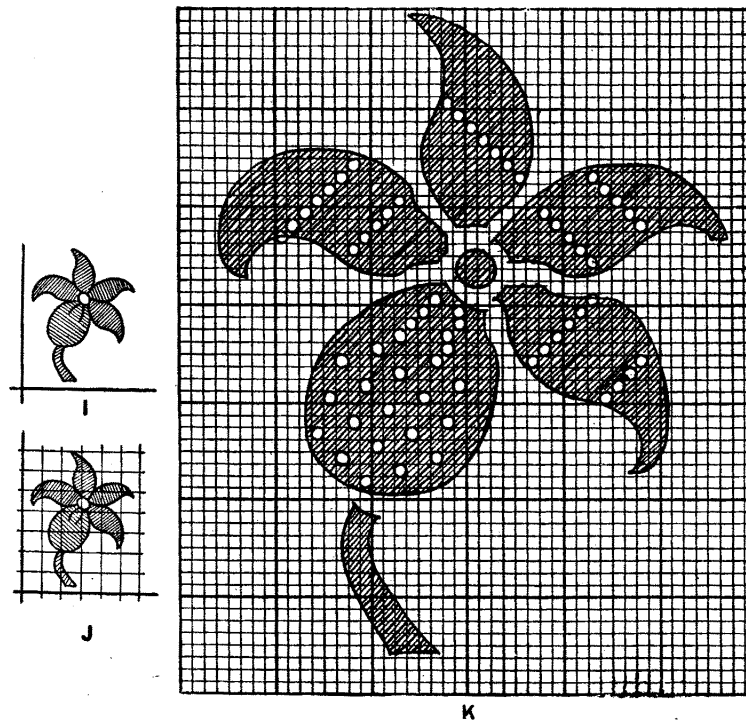


Fig. 64

determined by the number of ends and picks per inch in the finished cloth. It is generally convenient, in designing small figures, to rule the lines at such a distance apart in the sketch that they correspond to the thick lines of the design paper.

**Distribution of Spot Figures.**—It is only in special cases, as for instance, when a spot is arranged to fit in the centre of a coloured check, that a figure is used only once in the repeat of a design. Generally, two or more figures are contained in the repeat, and it is necessary for them to be placed at a suitable distance apart, and

evenly distributed over the repeat area. The repeat must be at least so large that the figures do not encroach upon each other, and the factors which influence the

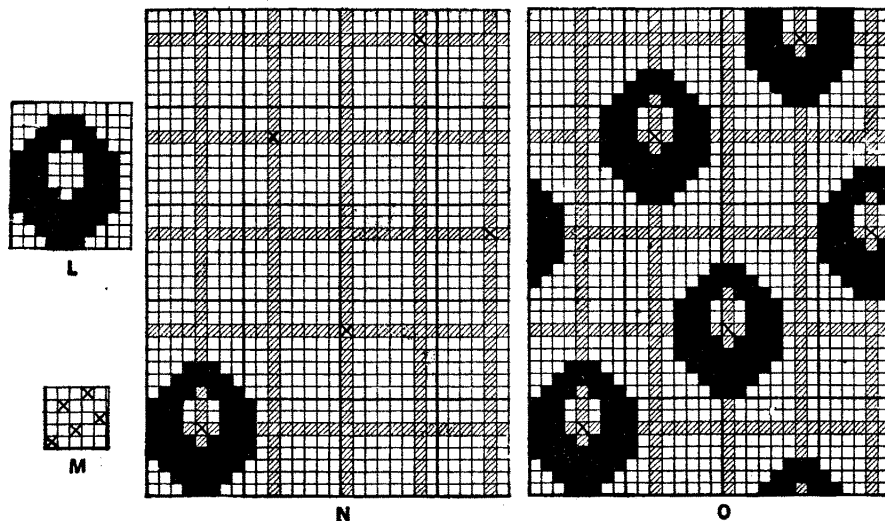


Fig. 65.

number of ends and picks in a design are as follows:—(a) The size and shape of the figure; (b) the number of figures; (c) the amount of ground space required; (d) the number of threads in the repeat of the ground weave. Even distribution of the figures is secured by employing a simple weave—such as plain and certain sateens—as the basis of the arrangement.

A method of distributing figures upon design paper, that will be found applicable to any shape of figure, is illustrated in Fig. 65, which shows the spot L arranged in the order of the 5-sateen base given at M upon 30 ends and 40 picks. As shown at N, the figure is first painted in near the bottom left-hand corner of the sheet of point paper, and the square which is nearest its centre is marked, as indicated by the cross on the fifth end and sixth pick. From the marked end and pick the repeat is divided

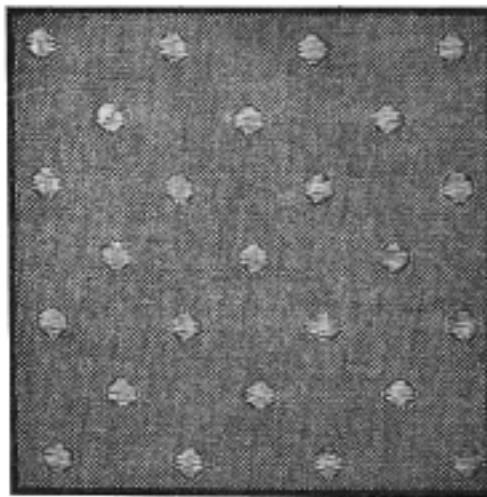


Fig. 66.

in both directions into as many parts as figures to be used—in this case five; and lines are lightly ruled in pencil on the spaces, as represented by the shaded

lines in N. It will be seen that the vertical lines occur at intervals of six ends and the horizontal lines at intervals of eight picks to correspond with the division into five parts each way of the repeat of 30 ends and 40 picks. Then, as indicated by the crosses in N, the squares where the divisional lines intersect are marked in

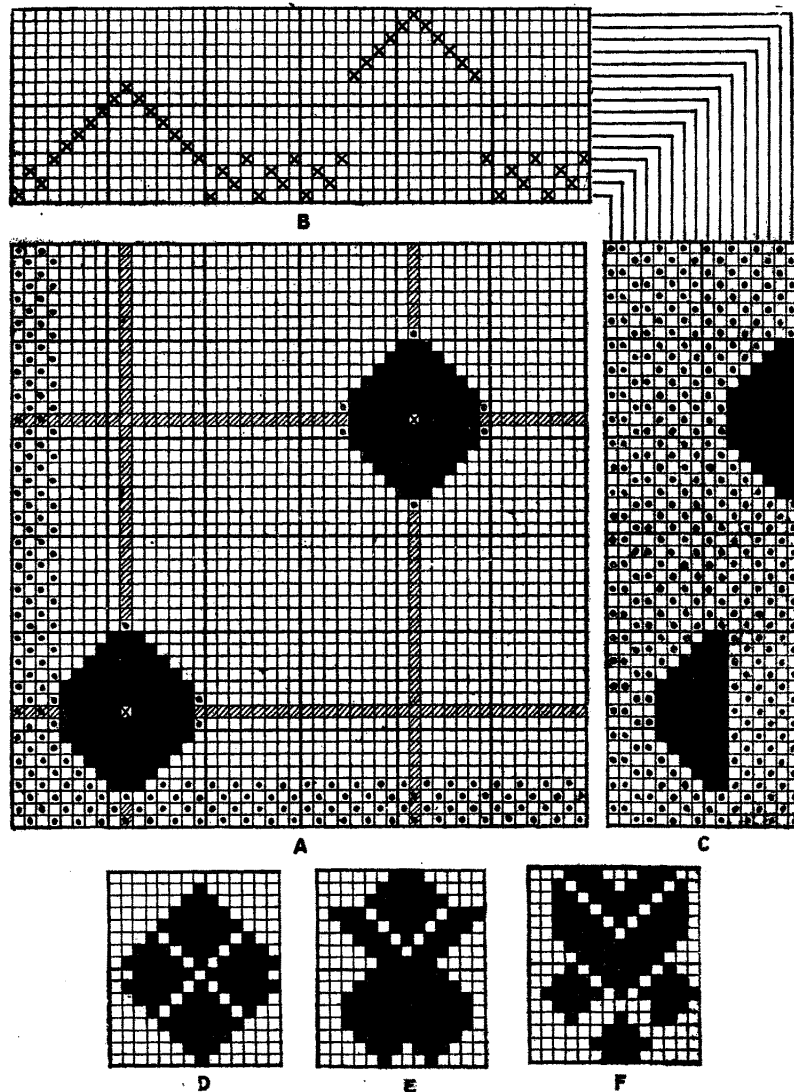


Fig. 67.

the order of the sateen base. The final stage in designing the figures consists of copying the first spot square by square in the same relative position to each centre mark, as shown at O in Fig. 65.

In the plain weave basis the figures are arranged in alternate order, as shown

in the example given in Fig. 66 and the corresponding design indicated at A in Fig. 67.

In this case, as there are two figures in the repeat, the number of ends and picks in the design are divided into two parts from the tenth end and pick which form the centre of the first spot.

In dobby weaving pointed drafts enable spot figures to be produced with comparatively few healds. Thus, as shown at B in Fig. 67, the design A requires only twelve healds in addition to the four healds upon which the ends, which work in plain order throughout, are drawn. The pegging plan, to correspond with A and B, is given at C. With a given draft a variety of spots can be formed, and for the purpose of illustration examples are given at D, E, and F, which are suitable for the draft B.

#### Reversing Spot Figures.

—The figures shown in Figs. 65 and 67 are symmetrical, hence they are placed the same in each position. Figures that are not symmetrical can be turned in opposite directions to each other, and in Fig. 68 examples are given which illustrate the different ways in which figures can be placed. In each design the centres of the figures are indicated by crosses on the ninth and twenty-fifth end and pick, and the direction in which the figures are turned is represented by a diagonal row of dots from each centre. A in Fig. 68 shows both figures turned the same way,

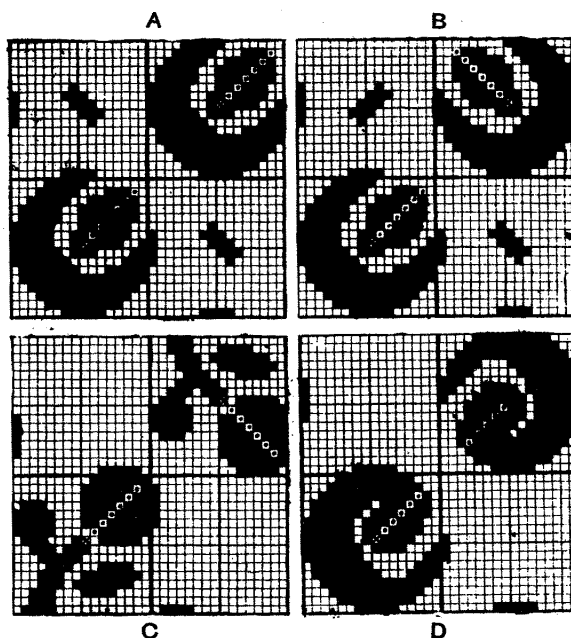


Fig. 68.

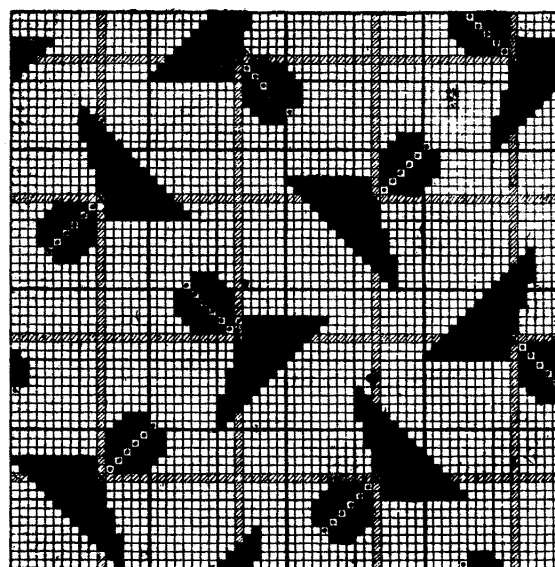


Fig. 69.

a method which imparts a monotonous appearance to a design, and is liable to cause the figures to fall into diagonal lines. In B and C the two figures are inclined in opposite directions, the second figure in the former design showing the first figure turned over horizontally, and in the latter design turned over vertically. In D the two figures are inclined in the same direction, but in the second position the figure is turned round 180°.

In Fig. 69 the figure is arranged in alternate order as in the preceding examples, but in this case it is turned in four ways, and used eight times in the repeat. The

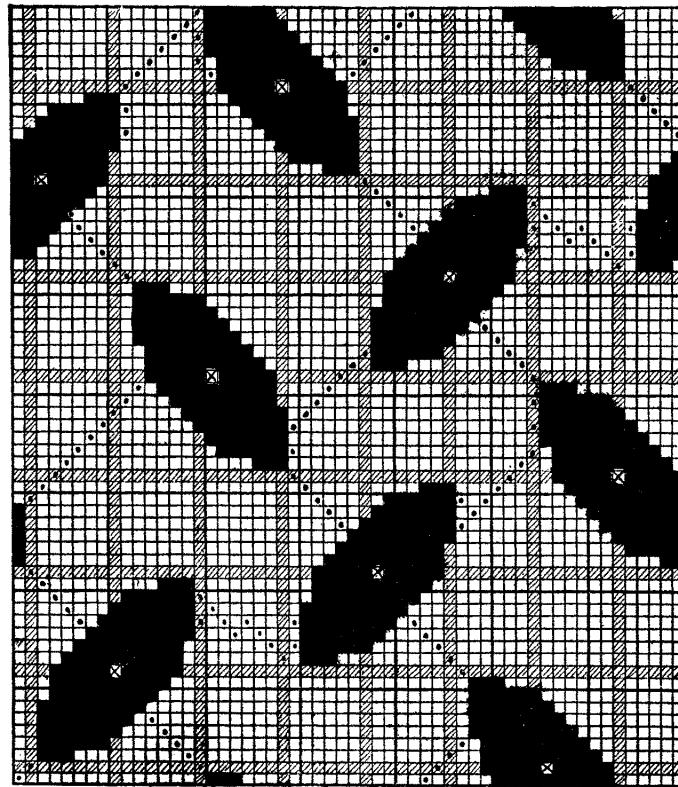


Fig. 70.

arrangement is very suitable for small effects, as a better all-over distribution is obtained than when only two figures are introduced. In order to distribute the figures regularly over the given size of repeat, the approximate centre of the first figure is found, as shown by the cross on the eleventh end and pick. From this position the repeat is divided in both directions into four equal parts, as shown by the shaded lines. Crosses are then inserted in alternate order where the shaded lines intersect, to indicate the centres of the remaining figures, and a diagonal row of dots is run in to show the inclination of the figure and to enable the outline to be more readily followed square by square. In this example the repeat is divided

into only four parts for the eight figures, because two centres are placed upon each divisional line.

In Fig. 70 an inclined spot, which can only be turned in two directions, is shown arranged in 8-thread regular sateen order upon 56 ends and 64 picks. The figure is designed to fit with plain ground, and the example illustrates that it is sometimes

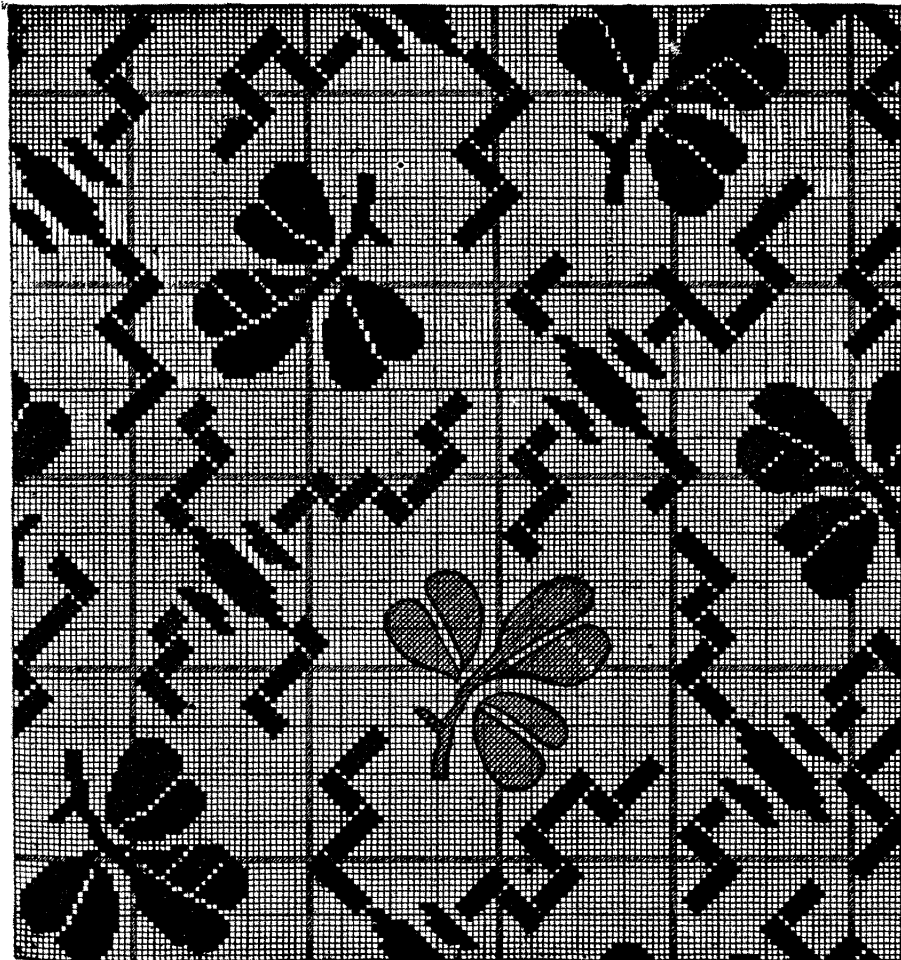


Fig. 71.

necessary to alter the position of certain of the figures in order that the outline will join correctly each time with the plain weave. Thus the centres of alternate spots in Fig. 70 are one square to the right of the places where the divisional lines intersect. The design shows the proper method of reversing an inclined figure in the 8-thread regular sateen order of distribution, two figures in one direction alternating with two in the other direction. It will be found by experiment that if the spots are reversed alternately cross twill lines are formed in each of which the figures are inclined in the same direction.

Fig. 71 shows the arrangement in 5-sateen order of a floral object which is turned in four directions, the fifth figure being placed like the second. Three of the figures are shown copied square by square from the first; but the shaded figure illustrates a system of copying the outline by "tracing." In this method the outline of the first figure is copied upon transparent tracing paper, upon which, at the same time, the position of the centre square is indicated, and a line drawn which is parallel to the horizontal lines of the design paper. The tracing is then turned

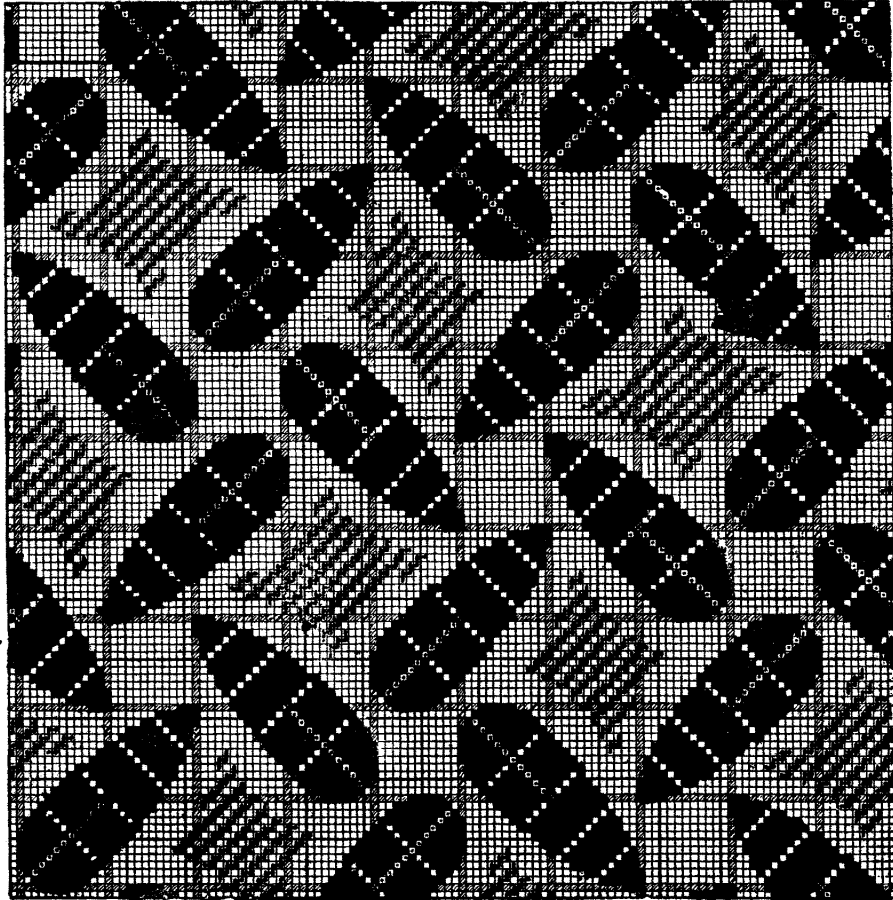


Fig. 72.

over, or round, and placed successively in the required position with the centre mark coinciding with the centres that are indicated on the design paper, and with the line on the tracing paper retained in a horizontal direction. The first copy is made by pencilling over the outline on the reverse side of the tracing paper, and simultaneously the tracing is prepared for being turned over again. Subsequent copies can be made by "rubbing" the tracing paper, either by means of the thumbnail or the back of a knife-blade. Also the figure can be distinctly copied



by placing black carbon paper between the tracing and the design paper while the outline is pencilled over. After all the figures have been traced, the outline of each is painted over independently.

In order to give a more varied appearance to the sateen arrangement, indicated in Fig. 71, small subsidiary figures, from which a trail effect branches, have been inserted in the ground spaces. The floral objects, together with the small figures, form a 10-sateen arrangement, and the example thus illustrates how certain bases enable two different shapes to be introduced in a design.

The example given in Fig. 72 also shows a figure arranged in 5-sateen order, but in this case, to enable the figure to be placed an equal number of times in each of four positions, the basis is repeated twice in both directions. The figure is, therefore, contained twenty times in the repeat, and it will be seen that the objects group in fours in such a manner that the ground spaces form definite shapes. A subsidiary effect in 2-and-1 twill is shown in the ground, which is arranged to fit with a 1-and-2 twill ground weave.

**Irregular Sateen Bases.**—The chief disadvantage of the regular sateen orders of distributing figures is that the systematic arrangement causes the objects to form continuous twill lines with each other in the cloth. A design appears less monotonous, and usually more pleasing, if the spots seem to be arranged indiscriminately, as shown in the example given in Fig. 73. An indiscriminate appearance, combined with uniform distribution,

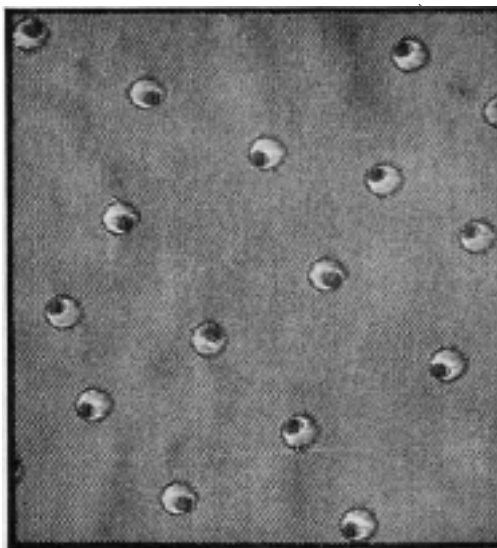


Fig. 73.

can be secured by employing an irregular sateen (see Fig. 18, p. 19) as the basis of the arrangement; the 8-, 10-, and 12-thread irregular weaves being particularly serviceable when the spots are small. (The difference in the appearance of the regular and irregular bases is illustrated by the designs given in Fig. 366.)

Fig. 74 shows a spot, similar to that represented in Fig. 73, which is arranged in the 8-thread irregular sateen order indicated in the bottom left-hand corner. The figures are formed in both weft and warp float, as indicated by the solid marks and circles. The grouping in pairs, together with the system of reversing, gives the design additional interest. (More complex examples of designs, in which the figures are arranged in sateen order, are given in Chapter XIX., while the method of inserting ground weaves, which is a very important matter, is described and illustrated in Chapter XV.)

**Calculations relating to Spot Figure Designing.**—It is sometimes necessary to arrange a given figure, or similar figures, in different orders with the same relative

amount of ground space. The number of ends and picks in the repeat of a re-arranged design can be found by the following formula :—

$$\sqrt{(\text{ends or picks in given design})^2 \times \frac{\text{figures required}}{\text{figures given}}} = \text{required ends or picks.}$$

For example, assuming that the spot given in Fig. 65 (in which five spots are distri-

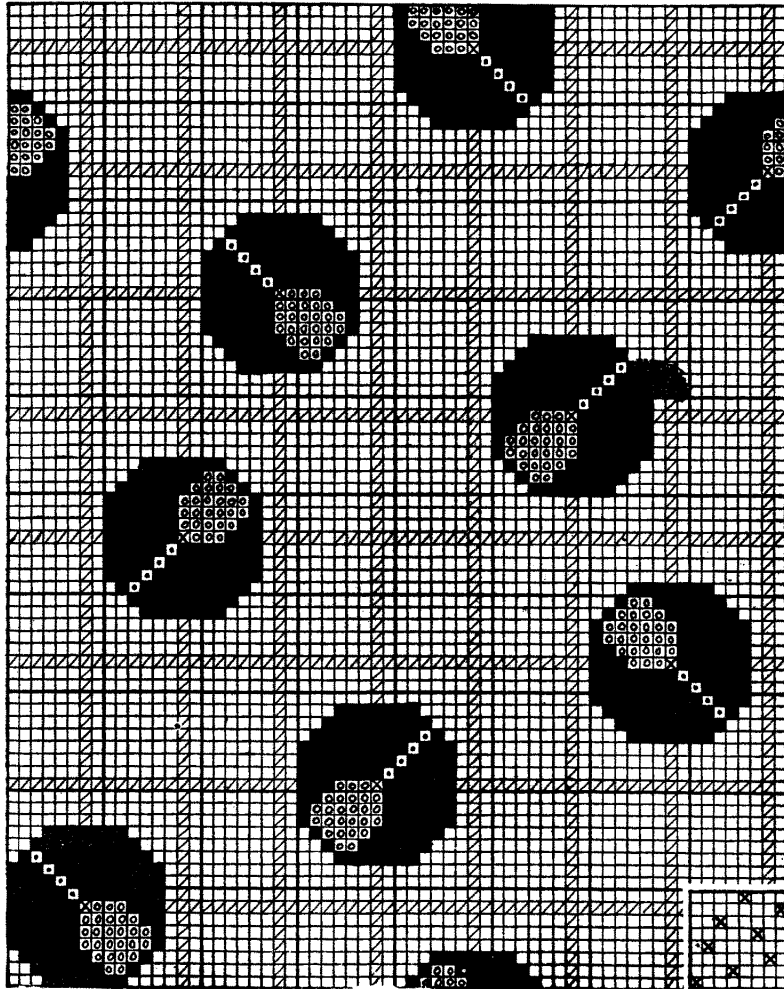


Fig. 74.

buted upon 30 ends and 40 picks) is required to be re-arranged in 8-sateen order, with the same proportion of ground space as before :—

$$\sqrt{(30 \text{ ends})^2 \times \frac{8 \text{ figures}}{5 \text{ figures}}} = 38 \text{ ends.}$$

$$\sqrt{(40 \text{ picks})^2 \times \frac{8 \text{ figures}}{5 \text{ figures}}} = 50 \text{ picks.}$$

The ascertained number of ends and picks may require to be modified to suit the repeat of the ground weave, and in some cases it may be found that the number is quite inappropriate to the new arrangement because of the change in the relative position of the figures.

## CHAPTER VI

SPECIAL CLASSES OF ELEMENTARY WEAVES  
AND FABRICS

*Derivatives of Hopsack or Mat Weaves*—Hopsack and Rib Combinations—Barley-corn Weaves—Stitched Hopsacks—Twilled Hopsacks. *Crêpe Weaves*—Construction of Crêpe Weaves upon Sateen Bases—Combinations of a Floating Weave with Plain Threads—Crêpe Weaves produced by Reversing—Insertion of One Weave over another—Armures. *Honeycomb Weaves*—Ordinary Honeycomb Weaves—Brighton Honeycomb Weaves. *Huckaback Weaves*. *Imitation Gauze on Mock Leno Weaves*—Perforated Fabrics—Distorted Thread Effects.

## DERIVATIVES OF HOPSACK OR MAT WEAVES

THE ordinary mat weaves, given at Q, R, and S in Fig. 3 (p. 5) are modified in various ways with the object of obtaining variety of pattern, and in order to make the structures firmer. Examples are given in Fig. 75, in which A shows the 3-and-3 hopsack stitched in the centre of each small square, while B and C represent two methods of stitching the 4-and-4 hopsack. The small squares are not so clearly defined as in the ordinary hopsacks, but the weaves are firmer. The design D shows a modification of A obtained by extending or doubling the latter.

The design E in Fig. 75, which is derived from the 3-and-3 hopsack, shows how a weave may be modified by reversing the float at one corner of each small square, while the design F, which is based upon the 4-and-4 hopsack, shows the floats reversed at opposite corners of each square. In both cases, the complete design results from reversing the section in which the shaded squares are indicated.

**Hopsack and Rib Combinations.**—Examples G, H, and I in Fig. 75 respectively show the 2-and-2, 3-and-3, and 4-and-4 hopsacks combined with warp and weft ribs; the latter separate the small squares in groups, so that small check affects are formed. The designs J, K, and L are also combinations of hopsack and warp and weft ribs, but in this case the small squares are separated from each other individually. The designs G to L are frequently woven with finer yarns for the rib threads and picks than for the hopsack threads. Thus, the pattern represented in Fig. 76, which corresponds with the design J, is arranged two double ends of 20's cotton (hopsack) and two ends of 40's cotton (warp rib), and two picks of 10's cotton (hopsack), and two picks of 40's cotton (weft rib).

**Barley-Corn Weaves.**—A mat weave also forms the foundation of each of the designs M, N, O, and P in Fig. 75, to which the term "barley-corn" is applied. (These effects are similar to those given at O, P, and Q in Fig. 41 (p. 42). The cross-twill in the designs gives a considerable degree of firmness to a cloth as compared with ordinary hopsacks of similar sizes, particularly when the cross-twill is in double lines of marks, as shown in O and P. In all the foregoing examples the floats of warp and weft cut with each other perfectly.

**Stitched Hopsacks.**—The designs Q and R in Fig 75 illustrate methods of imparting firmness to large weaves by the introduction of plain stitching threads. In Q the plain threads are introduced only in the warp, so that the floats in the weft sections of the design are broken. In R, however, certain threads of both series interweave plain, and similar warp and weft sections are formed.

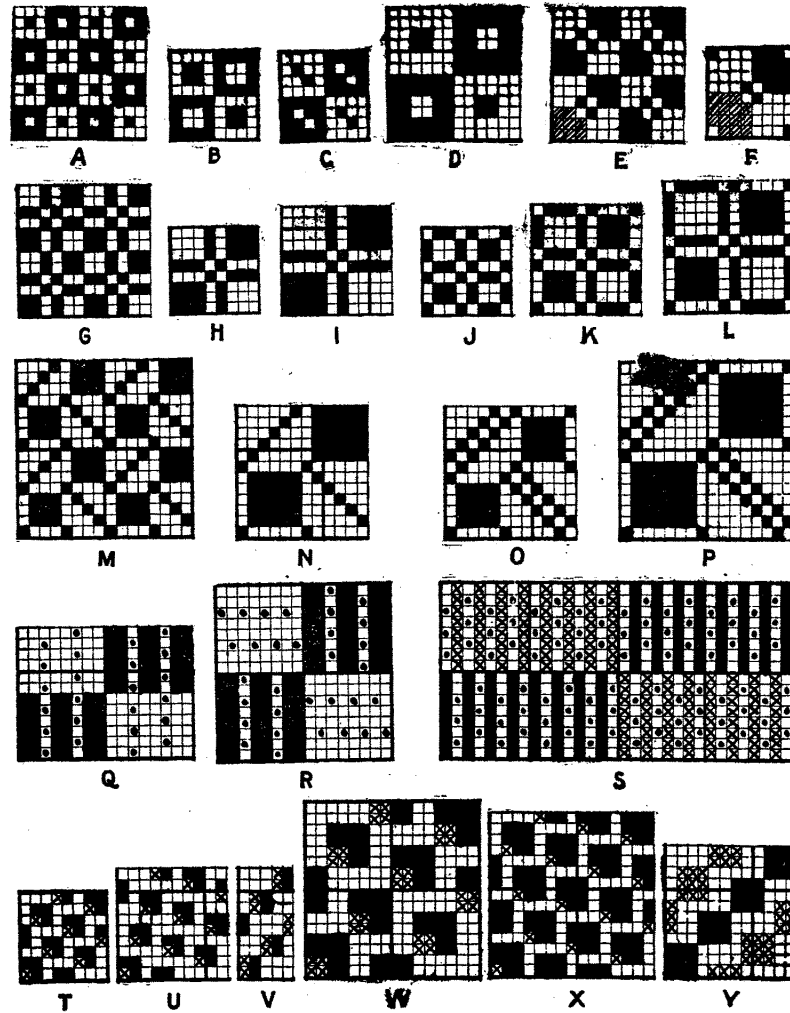


Fig. 75.

The design S in Fig 75 is really a stitched warp rib weave that repeats on four ends, and the cloth is entirely warp surface. By colouring the ends in the order indicated by the solid marks and the crosses—viz., 1 dark, 1 light, for 16 ends, and 1 light, 1 dark, for 16 ends, distinct sections in light and dark are formed. The cloth should contain about twice as many ends as picks per unit space, the sections then being square, so that the design appears like a hopsack.

**Twilled Hopsacks.**—The designs T to Y in Fig. 75 are twilled hopsacks, in

which the small squares, which are formed by only one series of threads (either warp or weft), run in twill order. The weaves are not so stiff as the ordinary hopsacks, and are generally more suitable than the latter for suitings and trouserings. The  $2 \times 2$  hopsack effect given at T, is based on an 8-thread sateen; that at U on a 10-thread sateen; and that at V on an extended 5-thread sateen. The  $4 \times 4$  effect, given at W, is constructed on an extended 8-thread sateen basis, or by doubling the weave T. X, and Y represent  $3 \times 3$  twilled hopsacks, the former being constructed on a 15-thread sateen base, and the latter by inserting two rows of squares as equally distant from each other as possible on 12 threads.

### CRÊPE WEAVES

The term crêpe is applied to weaves that contain little or no twilled or other prominent effect, and which give a cloth the appearance of being covered by

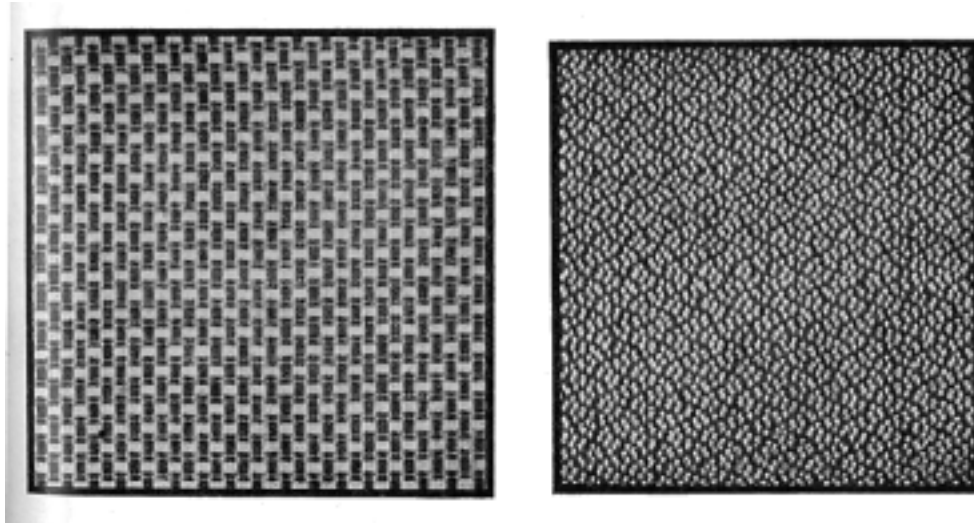


fig. 70.

fig. 71.

minute spots or seeds, as shown in the fabric represented in Fig. 77. The weaves are used alone, and in combination with other weaves in a great variety of cloths, and very frequently are employed in forming the ground of figured fabrics.

**Construction of Crêpe Weaves upon Sateen Bases.**—The weaves are constructed in a number of different ways, one of the simplest of which consists of adding marks in certain orders to some of the sateen bases. A and B in Fig. 78 are constructed on an 8-thread regular sateen base. In the former both the warp and the weft are floated, the same effect being produced on both sides of the cloth, whereas the latter, in which one yarn is brought chiefly to the surface, is arranged to suit a cloth in which one kind of yarn is better material than the other. C in Fig. 78 is constructed on a 10-thread sateen basis, and contains equal floats of warp and weft; the term "sponge" is applied to this weave.

The irregular sateens, because of the entire lack of twilliness, are particularly suitable to use as bases in the construction of crêpe weaves. D in Fig. 78 is a simple,

but very useful, crêpe which is based on the 4-thread sateen; E is constructed on a 6-thread irregular sateen, and F and G on 8-thread irregular sateen bases.

**Combinations of a Floating Weave with Plain Threads.**—In this system of constructing crêpe weaves threads that work plain are combined with threads of a floating weave which are arranged in sateen order. H in Fig. 78 illustrates one method of arrangement in which plain marks are indicated on the odd ends, as shown by the dots, and sateen marks on alternate picks of the even ends, as shown by the crosses. Marks are then added to the sateen base marks in an order which fits with the plain weave, as shown at I, in which the floating threads are arranged on the basis of a 4-thread sateen. The designs J and K are similarly constructed, the floating threads in the former being arranged upon the basis of a 5-thread sateen,

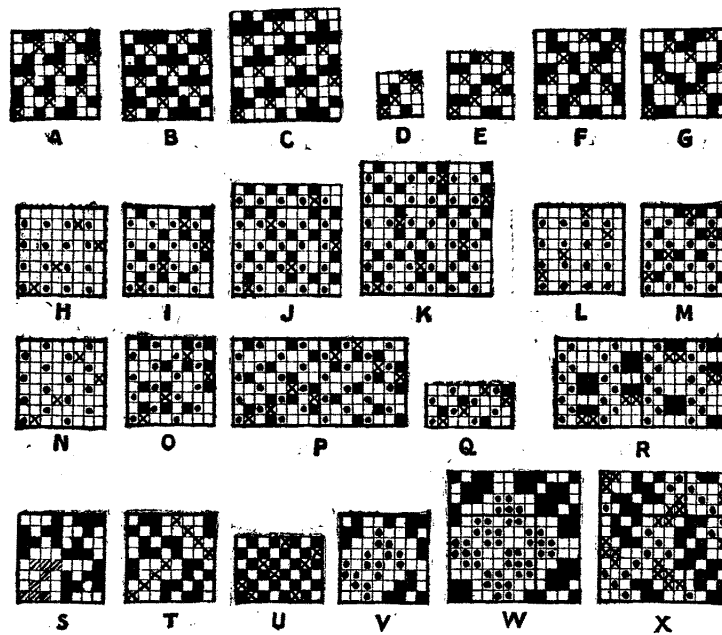


Fig. 78.

and in the latter upon the basis of a 6-thread sateen. In each case the design repeats upon twice as many ends and picks as the sateen base that is employed. The plans L and M, which correspond with H and I, show how the floating weave may be inserted horizontally. The designs appear rather different in the two methods and by comparison it will be seen that whereas in the design I the number of healds can be reduced by drafting the plain ends on to one shaft, in design M as many healds are required as there are ends in the repeat of the design.

In the designs I, J, and K all the odd ends work alike; but good crêpe designs are also produced by operating them in opposite order, as shown at N in Fig. 78, and combining the threads with similar floating weaves. Thus in the design O the floating weave is arranged in the same manner as in I, but the resulting design is quite different. A different basis of the floating weave is employed in the design P, which, however, is simply a modification of the 4-sateen, a base mark being indicated

on every pick, so that the repeat is on twice as many ends as picks. This is also the case in the design Q, which is a simple but effective crêpe that can be woven by means of a combination of 2-and-2 twill side tappets, and plain under tappets. The design R shows another variation in which two plain threads alternate with two floating threads, the latter being again arranged on a 4-sateen basis.

**Crêpe Weaves produced by Reversing.**—The reversing principle of constructing designs, illustrated in Fig. 41 (p. 42), can be employed in the construction of neat crêpe effects, and an example is given at S in Fig. 78 in which the shaded marks indicate the motive weave. Also, weaves containing minute floats are built up in stages, as shown at T, U, V, W, and X in Fig. 78, one portion being reversed or turned in the opposite direction to another portion, as indicated by the different marks in the designs. The fabric represented in Fig. 77 corresponds with the design V in Fig. 78.

**Insertion of One Weave over Another.**—This method of constructing crêpe weaves consists of inserting two different weaves one over the other. In order to produce an irregular effect one at least of the weaves should be irregular in construction, and it is usually better if both are irregular. The method is illustrated in Fig. 79, in which A shows an 8-thread regular sateen derivative, and B the 4-thread sateen; while at C the marks of both A and B are combined in the same design. As the marks of the two weaves coincide in certain places, in order to prevent confusion

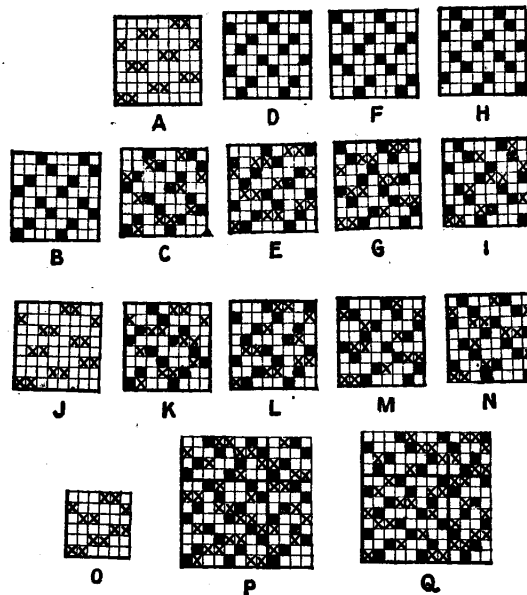


Fig. 79.

the weave that is marked in first should be indicated lightly, the second weave being then inserted in a different kind of mark. Afterwards the marked squares may be filled in solid in order to show the complete weave properly. In most cases, if the repeats of the two weaves have a measure in common different effects are formed by changing the position of one weave. Thus by inserting the weave A in the same position each time, and changing the 4-sateen to the positions shown at D, F, and H in Fig. 79, the combinations produce the designs given at E, G, and I respectively. In the same manner, the combination of the 8-thread irregular sateen derivative, given at J, with the weaves B, D, F, and H produces the designs indicated at K, L, M, and N respectively.

The number of threads in the repeat of a design is equal to the L.C.M. of the threads in the repeats of the weaves that are combined. The combination of the 4-thread sateen B with the 6-thread weave given at O in Fig. 79, thus produces a design repeating on 12 ends and 12 picks, as shown at P. The design Q shows the

weave O combined with the 4-sateen in the position indicated at D, but this is a case in which a change of position of one weave does not produce a real alteration in the resulting design, as will be evident from a careful comparison of Q and P. The method of construction can be further extended by inserting three different weaves over one another.

**Armures.**—The term “Armure” is frequently applied to weaves of a somewhat irregular or broken character which produce more pronounced effects than crêpe

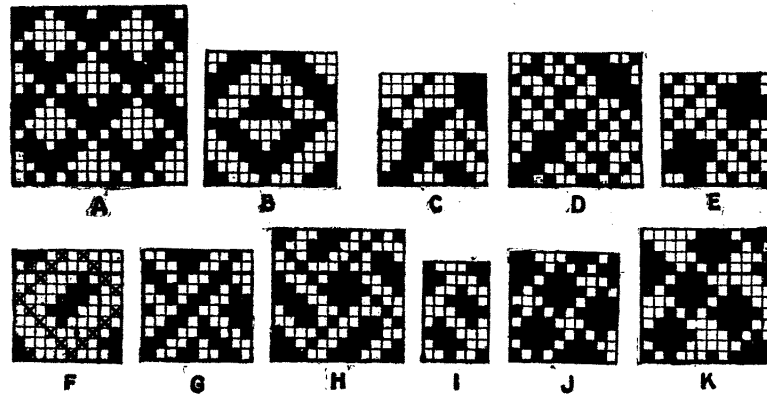


Fig. 80.

weaves. In some designs a small form is arranged twice in the repeat of a design, as shown at A and B in Fig. 80. If the form is inclined it may be turned in opposite ways, as shown at C, D, and E, in each of which it will be seen that the ground weave and the figure are arranged to fit very neatly with each other. F, G, and H in Fig. 80 are arranged on small diamond bases. The form may be indicated several times in the repeat of a design; thus in the design I a small spot occurs three times in the repeat; in J, five times; and in K, six times.

### HONEYCOMB WEAVES

In the cloths produced in honeycomb weaves the threads form ridges and hollows which give a cell-like appearance to the textures. Both the warp and the weft threads float somewhat freely on both sides, which, coupled with the rough structure, renders this class of fabric readily absorbent of moisture. The weaves are, therefore, very suitable for towels; and they are also used in various forms for bedcovers and quilts, and in combination with other weaves for fancy textures. The weaves are of two classes—viz., (1) ordinary honeycombs which give a similar effect on both sides of the cloth; (2) Brighton honeycombs which produce the cellular formation on one side of the cloth only.

**Ordinary Honeycomb Weaves.**—In most cases these can be woven in pointed drafts, and a method of constructing the designs on this principle is illustrated at A, B, and C in Fig. 81. A pointed draft is indicated on the required number of heads—in this case, five, as shown at A; then the marks are reversed, as indicated at B. Afterwards, one of the diamond spaces is filled in while the other is left blank, as represented at C. D shows a similar honeycomb design which is weavable



on six healds, and E a design that requires seven healds. In the foregoing system of arrangement either diamond space may be filled in, as will be seen from a comparison of D with C and E, but one yarn is floated on the surface more than the other. Thus, if the marks indicate warp up, in the design D the weft floats are 9, 7, 5, 3, and 1, as compared with floats of 7, 5, 3, and 1 in the warp. The fabric represented in Fig. 82 corresponds with the design E in Fig. 81.

The plan F shows a method of arranging the base so as to obtain equal warp and weft float; the resulting design repeating on two more picks than ends, as indicated at G. The basis may also be arranged on two more ends than picks, as shown at H, the complete design for which is given at I. The latter method, however,

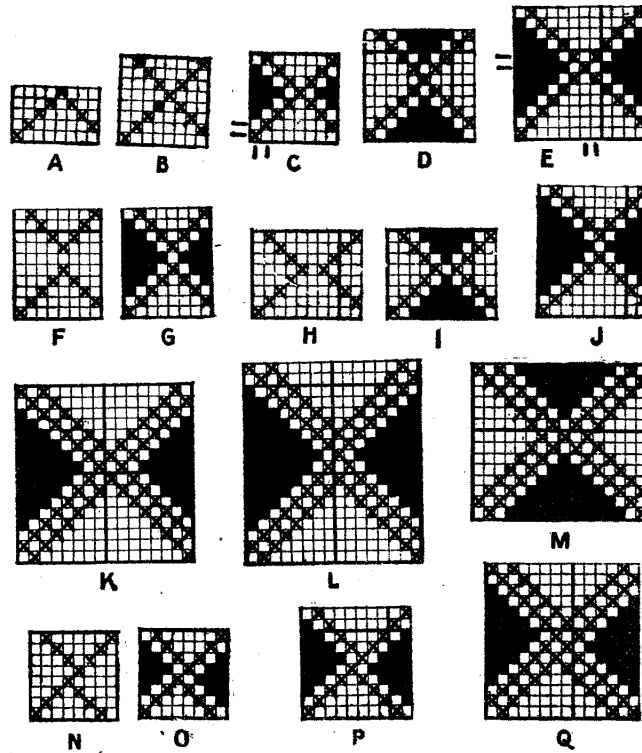


Fig. 81.

requires a heald more than the former in producing the same length of float. The design J, which is constructed in a similar manner to G, produces the same weft float as D, and the same warp float as E. In each design G, I, and J it is necessary for the marks to be inserted in the larger diamond space.

Large honeycomb weaves are liable to be loose in structure when constructed in the ordinary manner, and in order to secure firmness of texture a double row of base marks is inserted, as shown in the design K in Fig. 81, which is weavable on nine healds. The designs L and M, each of which requires the same number of healds as K, illustrate the two methods previously described, of obtaining equal warp and weft float in the firmly stitched weaves.

The plan N in Fig. 81 shows a base that is sometimes used in constructing honeycomb weaves ; but in this system a straight draft is required. One space is filled in and the other left blank, as shown at O. The design P illustrates a similar weave which repeats on a larger number of threads, and Q a firmly stitched large weave.

In the designs given in Fig. 81 the ridges occur where the long floats of warp

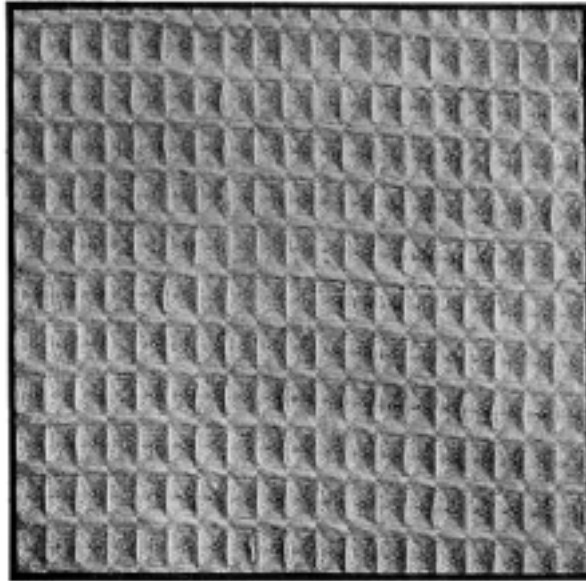


Fig. 82.

and weft are formed and the hollows where the threads interweave in plain order. Thus, taking the marks to indicate warp up, in each of the designs C, E, G, J, K, and L, a warp ridge is formed by the first end, and a weft ridge by the first pick. The plain weave, about the centre of these designs, tightens the threads, and causes a

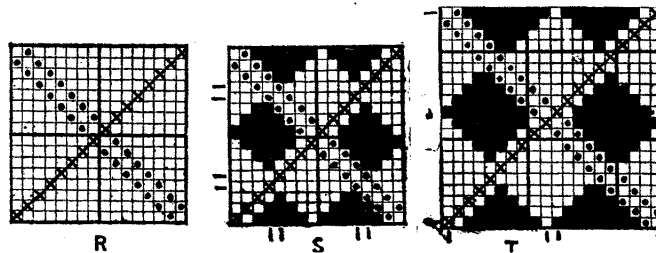


Fig. 83.

depression to be formed ; and although the weaves are constructed on a diamond basis, the cellular formation makes the patterns appear rectangular in the cloth. In the design D the ridges occur on the sixth end and pick, in I on the sixth end and fifth pick, and in M on the ninth end and eighth pick ; while in O, P, and Q, two threads

form a ridge—viz., the first and last end, and the first and last pick in each case. Suitable weaving particulars for the design D in a heavy cloth are:—2/12's cotton warp and weft, 50 ends and picks per inch; and in a lighter cloth, 24's cotton warp and 18's cotton weft, 88 ends and 80 picks per inch.

**Brighton Honeycomb Weaves.**—These are quite different in construction from the usual type of ordinary honeycomb, and require to be woven in straight drafts; also the number of threads in a repeat must be a multiple of four. The construction of a Brighton weave on 16 threads is illustrated at R and S in Fig. 83. A diamond base is first made by inserting a single row of marks in one direction, as shown by the crosses in R, and a double row in the other direction, as indicated by the dots. Taking the marks to indicate warp up, marks are then added to the double rows so as to form a small warp diamond in the right and left corners of each diamond space, as shown in S; a similar weft diamond being left in the upper and lower corners. The length of float of the centre thread of each small spot is one thread less than half the number of threads in the repeat. Thus in the design S each centre float passes over— $(16 \div 2) - 1 = 7$  threads, while in the design T, which shows a Brighton weave on 20 threads, each centre float passes over— $(20 \div 2) - 1 = 9$  threads.

In the same manner as in ordinary honeycomb weaves, the long centre floats of warp and weft form vertical and horizontal ridges; but in the Brighton weaves two sizes of hollows are formed, a

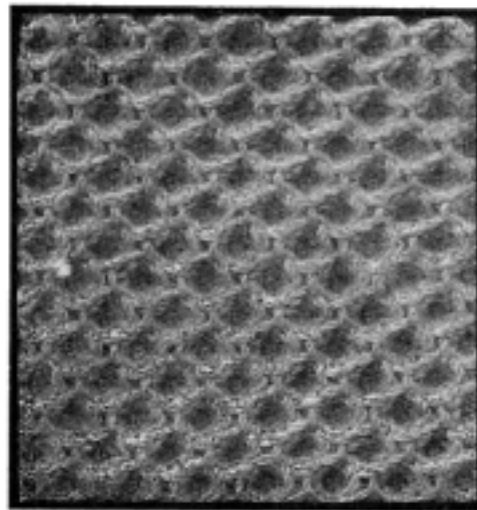


Fig. 84.

large hollow at each place where the double line of marks crosses the single line, and a small hollow in the centre of each diamond space. There is also the difference that in an ordinary honeycomb weave each repeat only forms one cell, whereas a Brighton weave produces two large and two small cells. The fabric represented in Fig. 84 corresponds with the design S in Fig. 83. About the same weaving particulars may be employed for the design S in Fig. 83 as those given for the design D in Fig. 81. The Brighton structure is sometimes made, however, with two thicknesses of yarn arranged in 2-and-2 order; the two thick threads being inserted where the longest floats are made.

In both classes of honeycombs there are two places where coloured threads may be effectively introduced: First, where the long floats are formed on the surface, as indicated by the position of the marks along the bottom and at the side of the design C in Fig. 81, and S in Fig. 83 (taking the marks to indicate warp up). Second, in the intermediate positions, as similarly indicated along the bottom and at the side of E in Fig. 81, and T in Fig. 83. In the first position the colours follow the ridges, and show very distinctly on the surface in the form of a small

check. In the second position the colours are only brought to the surface where the threads interweave plain, so that small spots of colour are formed at the bottom of the cells.

### HUCKABACK WEAVES

These weaves are largely used for linen and cotton towels, glass-cloths, etc. The foundation is plain weave, which gives the cloths firmness and good wearing qualities, while comparatively long floats are formed by the yarns, so that the fabrics are rendered capable of readily absorbing moisture. The standard weaves are given at A and B in Fig. 85; the former, which is termed the 6-pick or "Devon" huck, being used for the lower grades of cloths and the latter for fine qualities.

The draft which is generally used is so arranged that the odd threads are carried by the two front healds, and the even threads by the back two healds as shown at C. A tappet

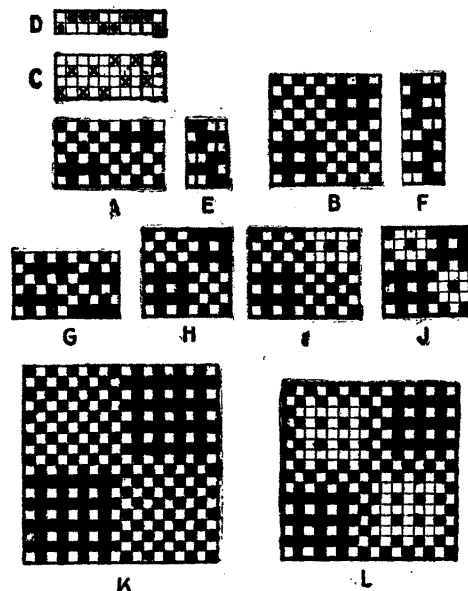


Fig. 85.

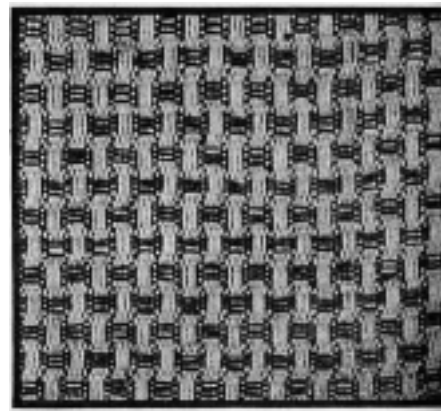


Fig. 86.

shedding motion is usually employed and the weaving plan for the design A is given at E, and for the design B at F. The purpose of the special draft is to enable plain cloth to be woven in the healds (without re-drawing the warp) by coupling the healds 1 and 2 together, and 3 and 4 together, and operating them by the first and fourth tappets.

The weaves tend to draw the ends into groups of five, and, to prevent this, it is customary to place the last end of one group in the same split of the reed as the first end of the next group, while the centre three ends are placed in one split. The threads are thus dented in the order of two and three alternately, as shown at D in Fig. 85.

The ordinary huckaback weaves are modified in various ways; thus G in Fig. 85, which is derived from A, contains four floats in the repeat; H shows a variation of B that repeats on 8 ends and picks; I repeats on 10 ends and 8 picks and produces the same effect on both sides of the cloth; while J, although not reversible, shows both warp and weft floats on each side of the cloth.