to take three, and the latter four ends (or a less number). The number of ends per mail is varied according to the ratio in which the capacity of the jacquard is required to be increased and to suit the sett of the cloth to be woven, but it is convenient to arrange them in such an order that the number to each short row of the harness is a multiple of the number of threads in the repeat of the binding weaves. Thus, for 8-sateen binding weaves a 12-row machine may be arranged with two or four ends per mail, giving respectively, 24 ends or three repeats, and 48 ends or six repeats of the weaves to each row of harness mails. If 32 ends are

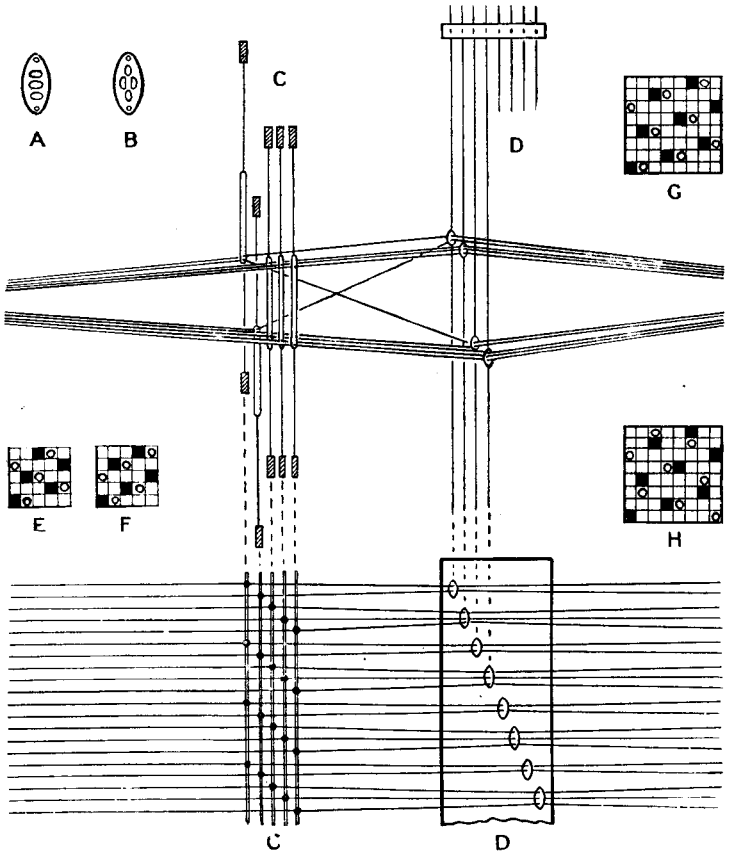

Fig. 201.

required per row, the ends may be arranged in the 12 harness mails in the order of 3, 3, 2 for four times, and for 40 ends per row in the order of 4, 3, 3 for four times. For 5-sateen binding weaves an arrangement of eleven 2's and one 3, giving 25 ends per row of twelve needles, is suitable, while 2 and 3 alternately for four times will give 20 ends per row in an 8-row machine. The last order of arrangement is illustrated in Fig. 201.

Form of the Healds.—Some distance in front of the jacquard harness as many special healds are placed as there are threads in the repeat of the binding weaves—

eight if 8-sateen weaves are employed, and five in the case of 5-sateen weaves. In Fig. 201 five healds, C, are represented in front of an 8-rowed harness, D ; the upper portion of the diagram illustrates the formation of the shed, while the lower portion shows the draft. It will be seen that the ends are drawn through the harness mails in groups of 2 and 3 alternately, and then singly upon the healds, each of which is provided with eyes that are about $2\frac{1}{2}$ inches long.

Operation of the Harness and Healds.—The jacquard lifts the threads in groups —thus, in the upper portion of Fig. 201 five threads are shown raised by the harness cords 1 and 2, and five depressed by the cords 3 and 4 ; and the jacquard remains stationary and retains the threads in these positions for as many consecutive picks as required. On each succeeding pick, however, one heald is raised and another depressed in turn, while the remainder are in the centre. As shown in the diagram the long eyes of the healds permit the ends, that pass through the healds in the centre, to retain the position in which they are placed by the jacquard ; but of the ends that are raised by the jacquard the depressed heald draws down one end to each repeat of the binding weave, and similarly, of the ends that are left down by the jacquard the lifted heald raises one end to each repeat of the binding weave. The jacquard thus lifts the ends in solid groups in accordance with the form of design that is required, while the healds operate them singly and effect the binding of both the figure and the ground.

E in Fig. 201 shows the weaving plan of the healds for 5-sateen binding weaves, the solid marks representing healds raised, and the circles healds depressed. F is similar to E, except that the sateen runs in the opposite direction. In both weaves the sateen runs in the same direction in both figure and ground, which cannot be avoided in the 5-thread weave. G in Fig. 201 shows the plan of the 8-sateen binding weaves, in which the sateen runs in the same direction in both figure and ground. This is the usual arrangement, but as shown at H, in the 8-sateen weave the order of lifting may be in the reverse direction to the order of depressing the healds, so that the figure and ground may be twilled in opposite directions. The most convenient method of operating the healds in power weaving is by means of positive box tappets, which are placed at the side of the loom.

One-fifth or one-eighth of the ends (according to the number of healds) is moved by the healds to the opposite line of the shed to that in which they are placed by the jacquard, so that at each pick a proportion of the warp is under greater strain than the remainder. This is shown in the upper portion of Fig. 201. In order that the strain will be as little as possible, shallow shuttles, which require only a small shed opening, are used ; the harness is placed about the same distance back from the healds as the latter are from the fell of the cloth, and a long stretch of warp is provided behind the harness. An advantage of the pressure system is that the number of ends per unit space can be changed simply by varying the number drawn through each harness mail, and using healds of corresponding fineness. The number of picks to each card can also be varied, and it is therefore possible, in the same machine, to use a set of cards in weaving a design in different qualities of cloth.

Method of Designing.—A simple example of a damask fabric is represented in Fig. 202, while K in Fig. 203, which shows one-fourth of the repeat of the figure, illustrates the method of painting out a design. The figure is painted solid, and no binding weave is indicated upon either the figure or the ground. If five ends

are drawn through two harness mails, as represented in Fig. 201, and the binding weaves are as shown at E, while each card acts for three picks, the complete weave in the cloth of the first 20 ends and 16 picks of K will be as indicated at L in Fig. 203. Taking the marks to indicate warp, the blanks in the figure represent ends that are raised by the harness and lowered by a depressed heald, and the crosses in the ground, ends that are left down by the harness and lifted by a raised heald. In comparison with a full harness mount the number of cards required for the foregoing arrangement is in the proportion of $\left(\frac{2 \text{ mails}}{5 \text{ ends}} \times \frac{1 \text{ card}}{3 \text{ picks}}\right)$ to 1, or as 2 to 15 ; which gives a saving in cards of 86⅔ per cent.

Fig. 202.

M in Fig. 203 shows the complete weave of the picks 1 to 16 of K assuming that eight healds are operated in the order indicated at G in Fig. 201, and that two ends are drawn through each harness mail, and each card acts for two picks. In this case a saving of 75 per cent. in cards is effected.

A fault of the pressure system, which will be readily seen by comparing L and M with K in Fig. 203, is that the figure runs in steps at the edges, so that it has a somewhat broken and rough outline. The steppy edge of the figure is also clearly apparent in Fig. 202. In fine cloths the defect is not very pronounced, but it increases in prominence in proportion to the reduction in fineness of a cloth and the increase in the number of ends per mail and picks per card.

The Self-Twilling Jacquard.—In power weaving this type of machine has very largely superseded the pressure harness system which is more particularly adapted to hand-loom work. The increase in the capacity of a self-twilling machine is obtained by connecting each needle to two or more consecutive hooks (instead of drawing two or more ends through each harness mail). Each end in the repeat of a design is controlled by a separate hook, and one end only is drawn through each harness mail; the shed is formed in the ordinary manner without undue strain upon the warp threads.

Arrangement of Needles, Hooks, and Lifting Bars. — The principle of the

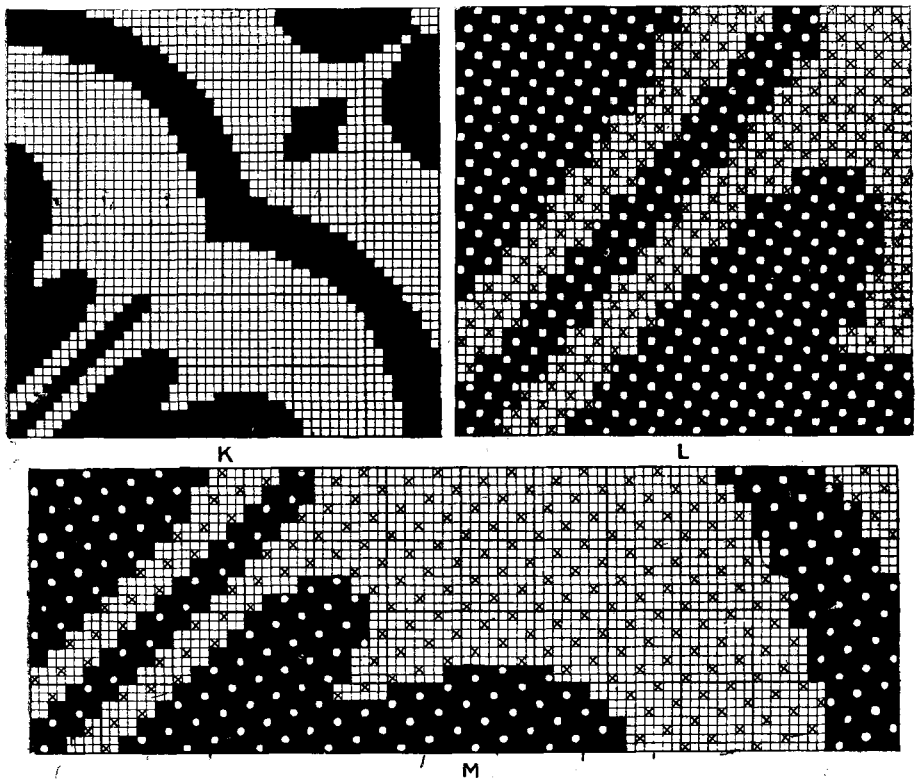

Fig. 203.

machine is illustrated in Fig. 204, in which the diagram X shows the connection in a 12 row machine (which is the usual size) of two figuring hooks A to each needle B, the capacity of the machine in this case being doubled. Each figuring hook A is made at the lower end in the form of a loop C which is rather longer than the depth of the shed, and when in their lowest position the hooks rest upon oblong bars D, one of which extends right through each long row of hooks. The bars D offer no obstruction to the lifting of the figuring hooks by the jacquard. At each side of the figuring hooks, a special row of strong twilling hooks E—shown in diagram Y, Fig. 204—is provided, each of which form a loop F round a bar D, so that the

bars are supported at both ends. A plate G at each side serves as a rest for the twilling hooks E when the latter are in their lowest position, and the plates are

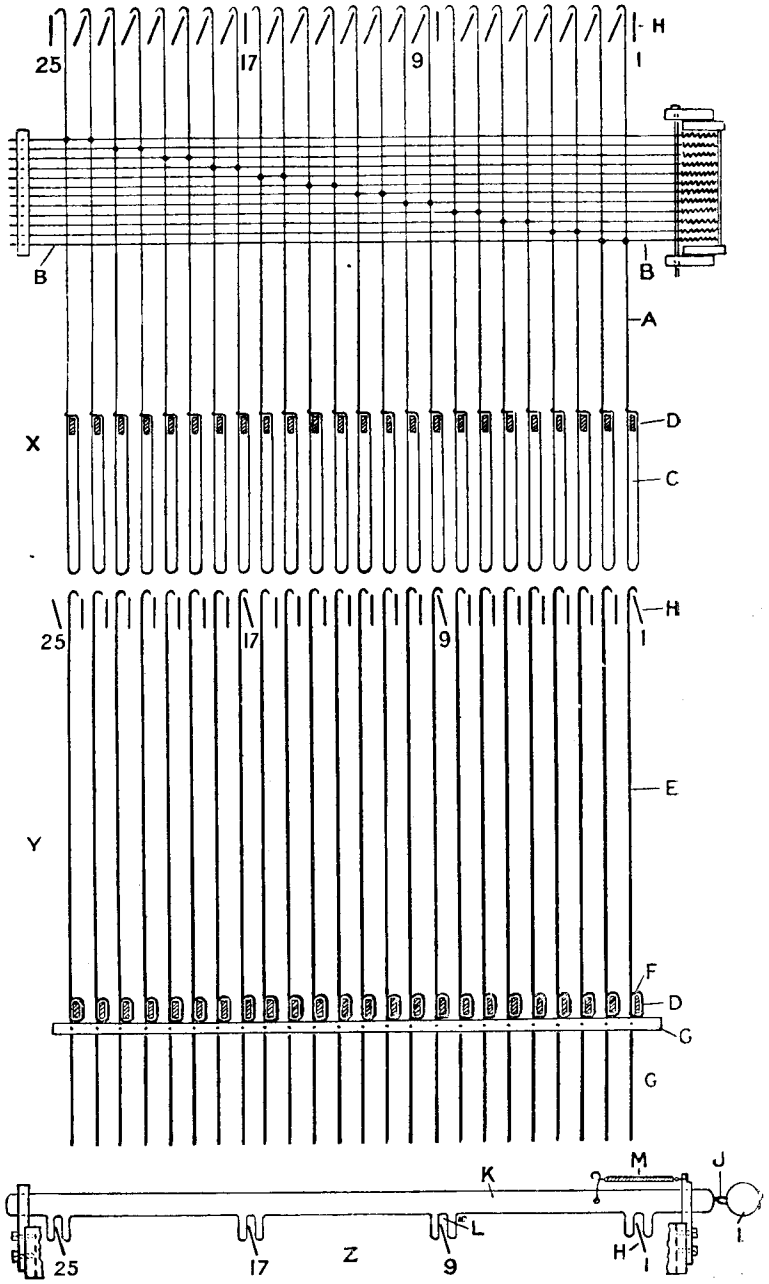

Fig. 204.

pierced with guide holes through which the straight lower ends of the hooks pass. The heads of the figuring hooks A are turned towards the card cylinder in the ordinary manner, but those of the twilling hooks E are turned in the opposite direction.

When in their ordinary position the lifting blades H are inclined towards the figuring hooks A in the usual way, but where the blades are in line with the twilling hooks they are twisted to a vertical shape so that they are clear of the upper end of the twilling hooks E. Each blade H is capable of being rocked upon its lower edge in such a manner that its upper edge is clear of the corresponding figuring hooks, as shown by the blades 1, 9, 17, and 25 in diagram X, Fig. 204. At the same time the upper edges of the blades, where they are in line with the twilling hooks, are moved under the bent ends of the latter, as shown by the blades 1, 9, and 17 in diagram Y. (It will be noted that the arrangement necessitates the use of one blade more than there are hooks in a short row.)

Operation of Twilling Needles.—The rocking movement of the blades H is obtained from a small revolving cylinder I in which projections J are fixed, each of the latter acting upon the end of a twilling needle K, as shown in the diagram Z in Fig. 204. The upper edge of each blade H, towards one end, fits within a recess L formed on the underside of a twilling needle K. As many needles K are provided as there are threads in a repeat of the binding weave, and each, by means of the recesses L, controls every fifth or every eighth blade H, according to whether the binding weave repeats upon five or eight threads. The pressure of a projection J moves a twilling needle K (each of which is acted upon for one pick in every five or eight picks, as the case may be) so that the blades to which the latter is connected assume the position shown by those numbered 1, 9, 17, and 25 in Fig. 204. These blades are thus put out of engagement with the figuring rows of hooks 8, 16, and 24, as shown in diagram X, and into position for engaging the rows of twilling hooks numbered 1, 9, and 17, as shown in diagram Y. When the griffe rises on the following pick the figuring hooks in each long row 8, 16, and 24 will thus be automatically left down. The twilling hooks 1, 9, and 17, however, will be raised and lift up the corresponding bars D, and as each bar supports a long row of figuring hooks, the rows 1, 9, and 17 will be automatically lifted. The arrangement causes one long row of figuring hooks to be left down, and one long row to be raised to each repeat of the binding weave, quite independently of the figuring cards; and each hook that is left down is next to a hook that is raised. That is, the jacquard lifts the ends in solid groups in forming the design, except that one end in each repeat of the binding weave is left down through the action of the twilling motion, while of the ends that are left down by the jacquard the same proportion is raised. A spiral spring M is used to return each twilling needle to its normal position after the pressure of the projection J has been removed.

Proportions of Hooks to Needles.—In Fig. 204, which shows a row of 12 needles connected to 24 hooks, the twilling needles K are arranged to produce 8-sateen binding weaves. Sometimes a machine is provided with 25 hooks to each row of 12 needles, by connecting one needle to three hooks, in order that it may be conveniently adapted for either 5 or 8-sateen binding weaves. The number of hooks per row of 12 needles ranges up to about 48 for 8-sateen weaves, in which case there are four hooks to each needle. For 40 hooks per row the needles are connected to the hooks in the order of 4, 3, 3 for four times, and this size can be used

for either 5 or 8-sateen weaves; 32 hooks per row for 8-sateen weaves are arranged 3, 3, and 2 per needle for four times; and 30 hooks per row for 5-sateen weaves, 2 and 3 per needle alternately. With 5-sateen weaves and 30 hooks per row, the twilling needles, taken in the order in which they are acted upon, are connected to the blades in the order of—first needle to blades 1, 6, 11, 16, 21, 26, and 31; second needle to blades 3, 8, 13, 18, 23, 28, etc. With 8-sateen weaves and 32 hooks per row, the first twilling needle controls blades 1, 9, 17, 25, and 33; the second needle, blades 4, 12, 20, and 28, etc.

Operation of Card Cylinder.—One defect of this machine is that although each card may act for several successive picks, the operation of the twilling motion on every pick makes it necessary for the jacquard to be actuated continuously. The card cylinder is, therefore, pressed against the needles on every pick, but a motion is applied which prevents it from being turned except at the required intervals. The turning catch of the cylinder is put into and out of engagement in any desired order by means of a revolving disc upon which a stud rests that is fastened to the catch. The disc is provided with recesses into which the stud enters when the catch has to operate on the cylinder, and the disc can be so shaped that each card will act for 2, 3, or 4, etc., picks, or for an irregular number, such as 3, 3, and 2, or 4, 3, and 3.

Changing the Capacity and Sett.—The number of picks per card can be readily changed, but it is more difficult than in the pressure harness to alter the number of ends controlled by each needle in a machine. A reduction from the full capacity of a machine can be effected by taking from each row a number of hooks that is equal to or a multiple of the number of threads in the repeat of the binding weave, and connecting the needles to the hooks to correspond. Thus, a 40-row machine may be changed to 32 or 24 hooks per row, or to 35 or 30 hooks per row, etc. Smaller changes can also be made, as, for instance, a 32-row machine, arranged to produce 8-sateen binding weaves, can be altered to the equivalent of a 28-row machine by taking eight hooks off two rows—four off the end of one row and four off the beginning of the next row—which reduces the sett and capacity of the jacquard by one-eighth. The machine would then be refilled with 12 needles connected to the hooks in the order of 3, 2, 2, for four times. A set of cards, which had been used for the 32-row machine could be used in weaving the same design in a cloth one-eighth lower in the sett. A machine arranged to produce 5-sateen binding weaves requires the hooks to be taken off in fives consecutively—thus, in reducing from 30 hooks per row to the equivalent of $27\frac{1}{2}$, three are taken off the end of one row and two off the beginning of the next row. The first row is then connected to the needles in the order of 3, 2, 2, 2 for three times, and the next in the order of 3, 2, 2 for four times. It is possible to obtain any number of hooks per row between 12 and the original capacity, and to thus use the same set of cards in weaving a design in different qualities of cloths. The ordinary method of casting out can, of course, also be employed, but this necessitates that the design be made upon a less number of threads than the number of needles in the machine.

System of Designing.—The method of painting out designs is exactly the same for the twilling jacquard as for the pressure harness, and a similar structure, with a steppy outline, is formed. Thus, a design is painted solid as shown at K in Fig. 203, and if the needles are connected to 2 and 3 hooks alternately, and the twilling motion

produces 5-sateen binding weaves, while each card acts for three picks, the full weave of the first 20 ends and 16 picks will be as shown at L in Fig. 203. In the same manner, M in Fig. 203 shows the full weave of 16 picks of the design K, assuming that each needle is connected to two hooks, the twilling motion produces 8-sateen binding weaves, and each card acts for two picks. Taking the marks to indicate warp, the blanks in the figure represent ends that are left down on account of the lifting blades being made vertical and missing the figuring hooks, while the crosses in the ground indicate the lifts produced through the figuring hooks being operated by the bars that are raised by the twilling hooks.

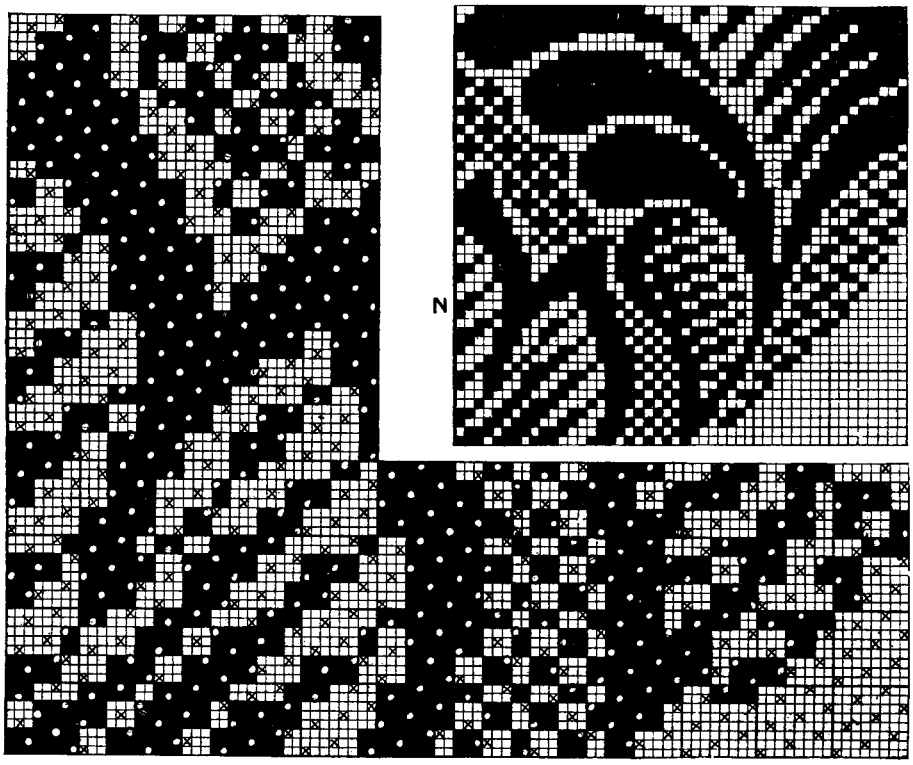

Fig. 205.

Production of Diversity of Effect in Damasks.—In both the pressure harness and the twilling jacquard systems the figure and the ground can only be woven in opposite sateen weaves, so that no variety of weave development can be produced. It is possible, however, to diversify the ornamentation of a fabric by painting a design in various ways, as shown at N in Fig. 205, in which a few effects are indicated to illustrate how a figure may be brought up in different tones. The finer the cloth, and the fewer the ends to each needle and picks to a card, the nearer the effects are to those that can be woven in a full-harness mount; and it should be kept in mind that very fine lines of figure may be indicated in the solid design, since each small square represents a group of threads. O in Fig. 205 shows the full weave

of a portion of the design N, assuming that the hooks are connected to the needles in the order of 3, 3, 2; successive cards act for 3, 3, and 2 picks; and 8-sateen binding weaves are formed.

In designing for the twilling jacquard the counts of the design paper is in the proportion of—

$$\frac{\text{ends per inch}}{\text{hooks per needle}} : \frac{\text{picks per inch}}{\text{picks per card}}$$

For example, assuming that a cloth contains 96 ends and 140 picks per inch, and that 32 hooks are connected to 12 needles, and there are 10 picks to three cards—

$$\frac{96 \text{ ends}}{32 \div 12} : \frac{140 \text{ picks}}{10 \div 3} = 12 \times 14 \text{ design paper.}$$

The best qualities of damask cloths are generally woven with more picks than ends per inch, and the following are typical weaving particulars:—Warp—50's lea linen, 90 ends per inch; weft—70's lea linen, 130 picks per inch. 5-sateen binding weaves are only employed in the lower and cheaper qualities of cloths.

CHAPTER X

TAPESTRY AND UPHOLSTERY CLOTHS AND INGRAIN CARPETS

TAPESTRY AND UPHOLSTERY CLOTHS—Figured Double and Treble Plain Cloths—Combinations of Double Plain and Weft or Warp Figure—*Weft-Face Tapestry Cloths*—Figuring with the Harness Threads—Diversity produced by Mixing the Wefts—*Specially Stitched Weft Tapestry Cloth*—Special Weft Tapestry Mounting—Warp-Face Tapestry Cloth. SCOTCH, KIDDERMINSTER, OR INGRAIN CARPETS—*Double Plain Cloth Jacquard*—Operation of the Jacquard and Comber-Boards—Method of Designing—Limitation of the Mounting—*Weft-Face Ingrain Carpets*—Reversible Four-Ply Weft Structure—Methods of Producing Variety.

TAPESTRY AND UPHOLSTERY CLOTHS

ALMOST every class of fabric structure is used for tapestry and upholstery purposes ranging from cloths composed of one warp and one weft to those in which two or more series of threads are introduced in one or both directions. Some of the textures are mono-coloured, and the designs range from simple but striking effects to the boldest and most intricately developed styles of figures. Elaborate figure ornamentation is also combined with diversity of colour, whilst in certain textures the design is entirely due to colour—the figure being formed chiefly for the purpose of displaying different hues and tones.

Illustrations of various classes of the fabrics are included in the foregoing. Thus, extra warp structures are shown in Fig. 145 (p. 132), and Fig. 167 (p. 145), and an extra weft cloth is represented in Fig. 125 (p. 117). Multiple weft figured fabrics, woven on the principle illustrated by Figs. 131 to 138 (pp. 121-125), and Fig. 189 (p. 166), form an important class, and warp pile figuring (see Chapters XIX and XX) is largely employed; while certain special classes of the textures and the systems of loom mounting are described and illustrated in the following:—

Figured Double and Treble Plain Cloths.—A style of tapestry texture, which is composed of two series of warp and two series of weft threads, arranged in 1-and-1 order, is constructed by combining double plain weaves, two separate fabrics being formed in every part of the cloth, which are united by the threads changing from one side to the other. All, or any of the weaves, illustrated at A to H in Fig. 176 (p. 152), may be employed in a design. If the weft is in the same two colours as the warp, a solid dark, a solid light, and a mixed colour effect can be formed as represented in Fig. 175, but as shown at C to H in Fig. 176 the colours can be intermingled in a variety of ways. By having one or both of the weft colours different from the warp colours a still greater variety of intermingled

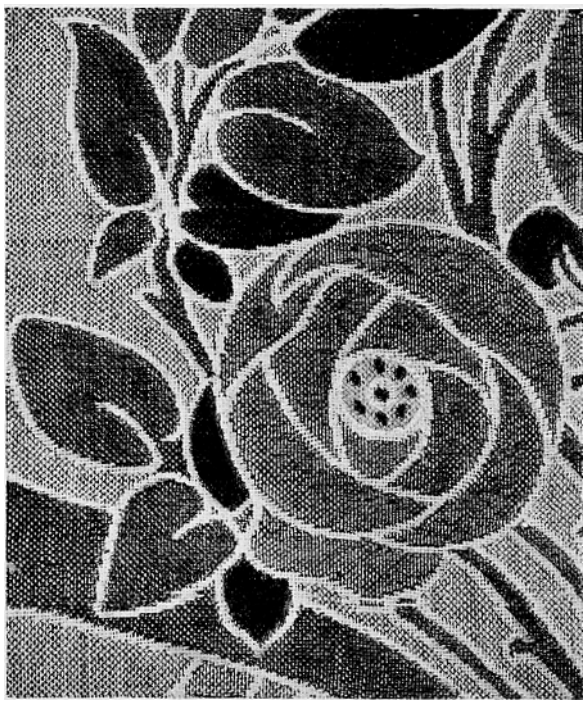

Fig. 206.

colour effects may be produced. It is usual, however, to combine not more than four of the double plain weaves in a design. For convenience in the point-paper designing, a sectional harness arrangement, as represented in Fig. 183 or Fig. 184, should be employed, as then it is only necessary to paint out the various effects solid in different colours. The method in which four double-plain effects are designed and cut will be understood from the plans given in Fig. 185 and the accompanying description.

More elaborate cloths of a similar character to the double plain styles are woven with three series of threads in one direction and two series in the other direction, or with three series in both directions. Fig. 206 illustrates a fabric of the last type in which the weft is arranged 1 pick yellow silk, 1 pick blue silk, and

1 pick white cotton; and the warp, 1 end red cotton, 1 end green cotton, and 1 end white cotton. Seven effects are formed in the design, as indicated by the different marks in the corresponding sectional plan given in Fig. 207, which illustrates the method of designing for the texture. The weaves are so arranged that the yellow and blue silk wefts are chiefly brought to the surface, full use thus being made of the expensive threads.

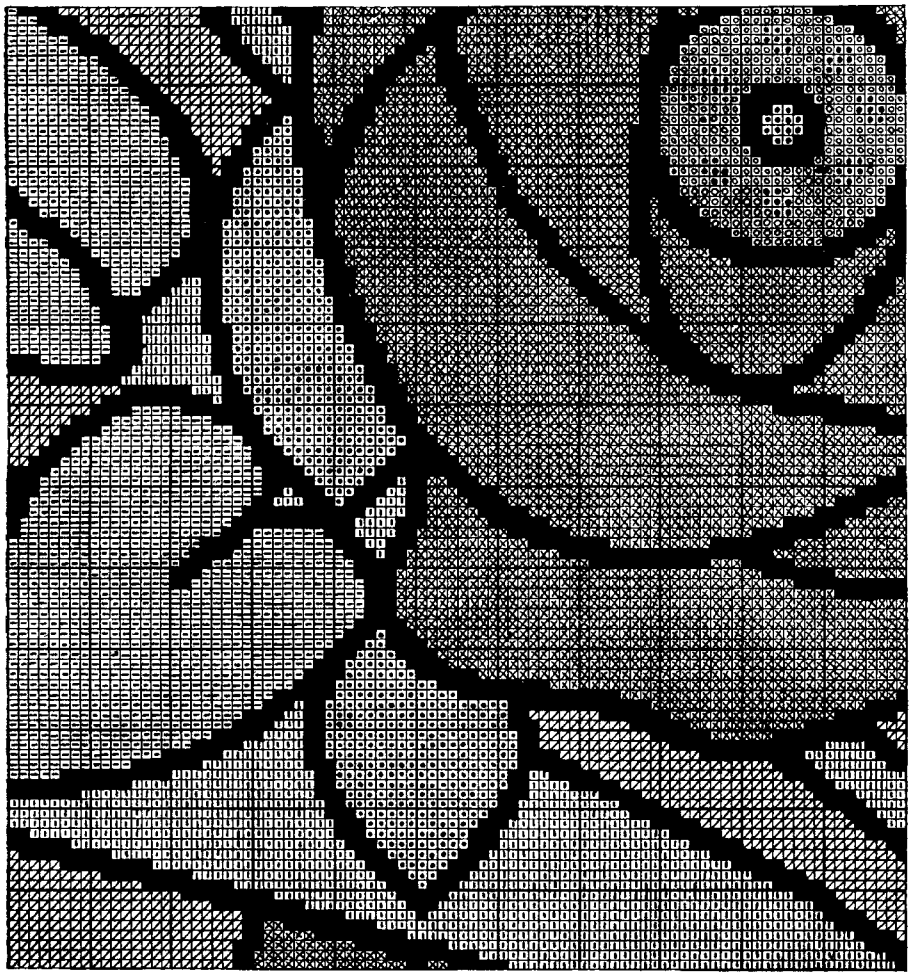

Fig. 207.

The seven weaves that are combined are illustrated in full at A to G in Fig. 208 in which the weave marks indicate warp. The lower part of each plan shows the arrangement of the threads as to their position in the cloth, the centre threads being represented by horizontal strokes, and the back threads by diagonal strokes. Linked with the face threads of the weaves a plan on 2 × 2 squares is shown in

which the marks coincide with the corresponding effect in Fig. 207. The positions which the threads occupy in the different sections of the cloth, represented by the respective weaves A to G in Fig. 208, are indicated in the following list :—

Weave.	Face.	Back.	Centre.
A.	First weft and first warp.	Second weft and third warp.	Third weft and second warp.
B.	Second weft and second warp.	Third weft and third warp.	First weft and first warp.
C.	Third weft and third warp.	Second weft and first warp.	First weft and second warp.
D.	First weft and third warp.	Second weft and first warp.	Third weft and second warp.
E.	Second weft and third warp.	First weft and first warp.	Third weft and second warp.
F.	First and second wefts and first warp.	Third weft and third warp.	Second warp.
G.	First and second wefts and second warp.	Third weft and third warp.	First warp.

Plain weave is produced on both sides of the cloth, but in F and G two wefts are intermingled on the face, so that there are no weft threads in the centre. In A, B, C, D, and E there are both weft and warp threads in the centre which, however, do not interlace with each other, but simply serve as wadding threads, the picks passing over the ends.

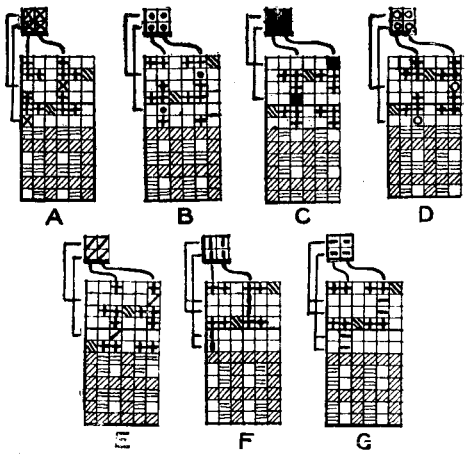

Fig. 208.

The jacquard and harness should be arranged in three equal sections to correspond with the three series of warp threads, and three cards (one for each weft) are cut from each horizontal space of the design given in Fig. 207. Assuming that the different effects in the design are represented by the letters A to G, to coincide with the lettering of the corresponding plans in Fig. 208, the card-cutting particulars of Fig. 207 are as follows :—

	First Warp Section.	Second Warp Section.	Third Warp Section.
First weft.	Cut A, E, and F plain.	Cut B and E solid, and G plain.	Cut C and E solid, and D plain.
Second weft.	Cut A solid, and C, D, and F plain.	Cut A, C, and D solid, and B and G plain.	Cut C and D solid, and A and E plain.
Third weft.	Cut A, B, F, and G solid.	Cut B, F, and G solid.	Cut D and E solid, and B, C, F, and G plain.

The card-cutting process is simplified by going through the design three times separately, once for each weft; and, further, if each section of the warp is controlled by a separate set of cards, the cards may be cut for each weft and each warp independently, the design being gone through nine times.

Combinations of Double Plain and Weft or Warp Figure. — In addition to forming figure by interchanging the fabrics in the double and treble structures, as described and illustrated in the foregoing, the cloths can be ornamented by floating the weft or warp threads, and in Fig. 209 a rich tapestry texture is represented in which two wefts are employed, both of which are floated on the surface.

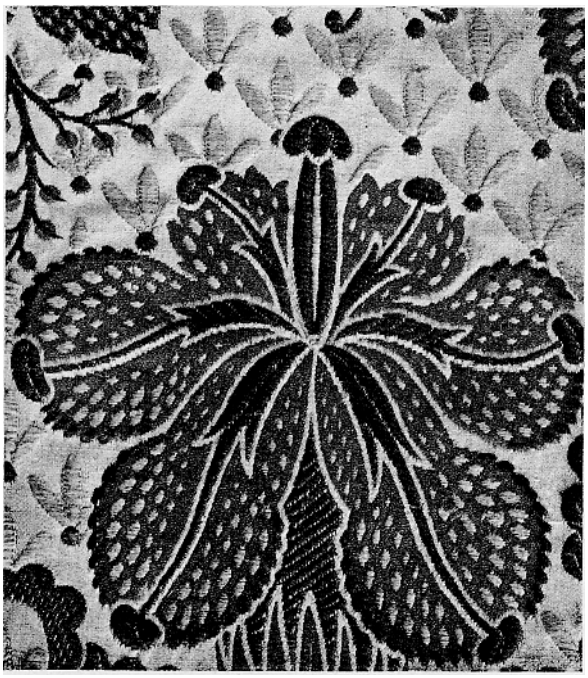

Fig. 209.

The arrangement in the weft is 1 pick dark green silk and 1 pick yellow silk, and in the warp, 1 end brown cotton and 1 end white cotton. In the corresponding sectional design given in Fig. 210 the solid marks represent a dark double-plain effect in which the first weft interweaves with the first warp on the surface, and the blanks, a similar light effect produced by the second weft interweaving with the second warp. The circles show where the first weft floats loosely on the surface, and the diagonal marks the second weft, and it will be seen that both wefts are floated upon a background formed by each double-plain effect. A feature of the example is that the cloth is perfectly reversible, a dark effect, in either double plain or weft float, on one side, having a corresponding light effect on the other side. The two fabrics are bound together:—(*a*) where the two plain structures change positions, both the ends and the picks interchanging at these places; and (*b*) where a weft is floated on a surface in which the other weft is used to form the plain weave. Where a weft forms a plain surface and then floats loosely no binding of the fabrics is made. The method in which the picks interlace will be understood from an examination of the complete weaves given in the lower portion of Fig. 210, the several sections of which are lettered A, B, C, and D. A corresponds to the solid marks in the design, B to the circles, C to the diagonal marks, and D to the blanks. The marks in the weaves indicate weft, and it will be seen that the picks interchange between A and C, A and D, and B and D, but not between A and B, nor C and D. (See also p. 154.)

With a jacquard and harnes arranged in two equal sections to correspond with the two series of warp threads, two cards are cut from each horizontal space of the design given in Fig. 210 as follows :—

	Brown Warp Section.	White Warp Section.
First card (green pick).	Cut the diagonal marks solid, and the full squares and blanks plain.	Cut the diagonal marks and the blanks solid.
Second card (yellow pick).	Cut the full squares and circles solid.	Cut the circles solid, and the full squares and blanks plain.

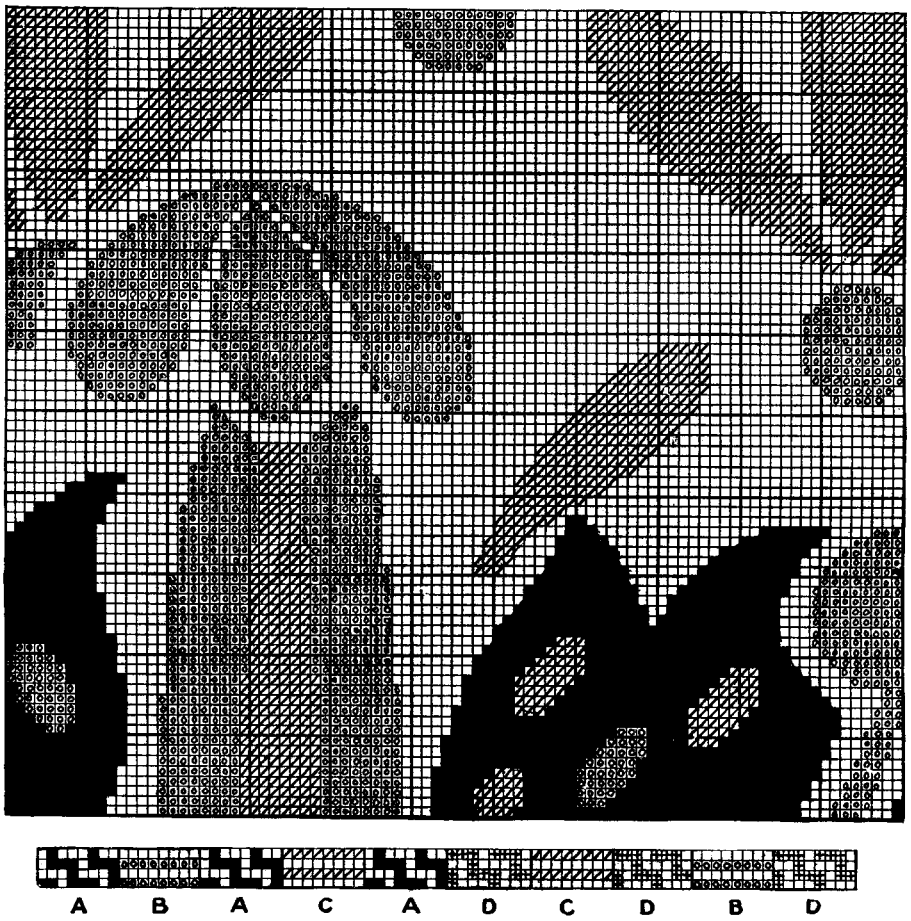

Fig. 210.

Weft-Face Tapestry Cloths.— A variety of tapestry texture is represented in Fig. 211, in which the design is due to diversity of colouring in the weft. Two series of ends are employed, arranged as follows :—2 binding ends of 2/80's cotton, 2 figuring ends of 2/20's cotton, 60 ends per inch. The weft is 2-ply 10's worsted, with 14 picks of each colour per inch. In the example there are four series of picks,

but fewer or more series may be employed according to the number of colours that are required on the surface in each horizontal line of the cloth.

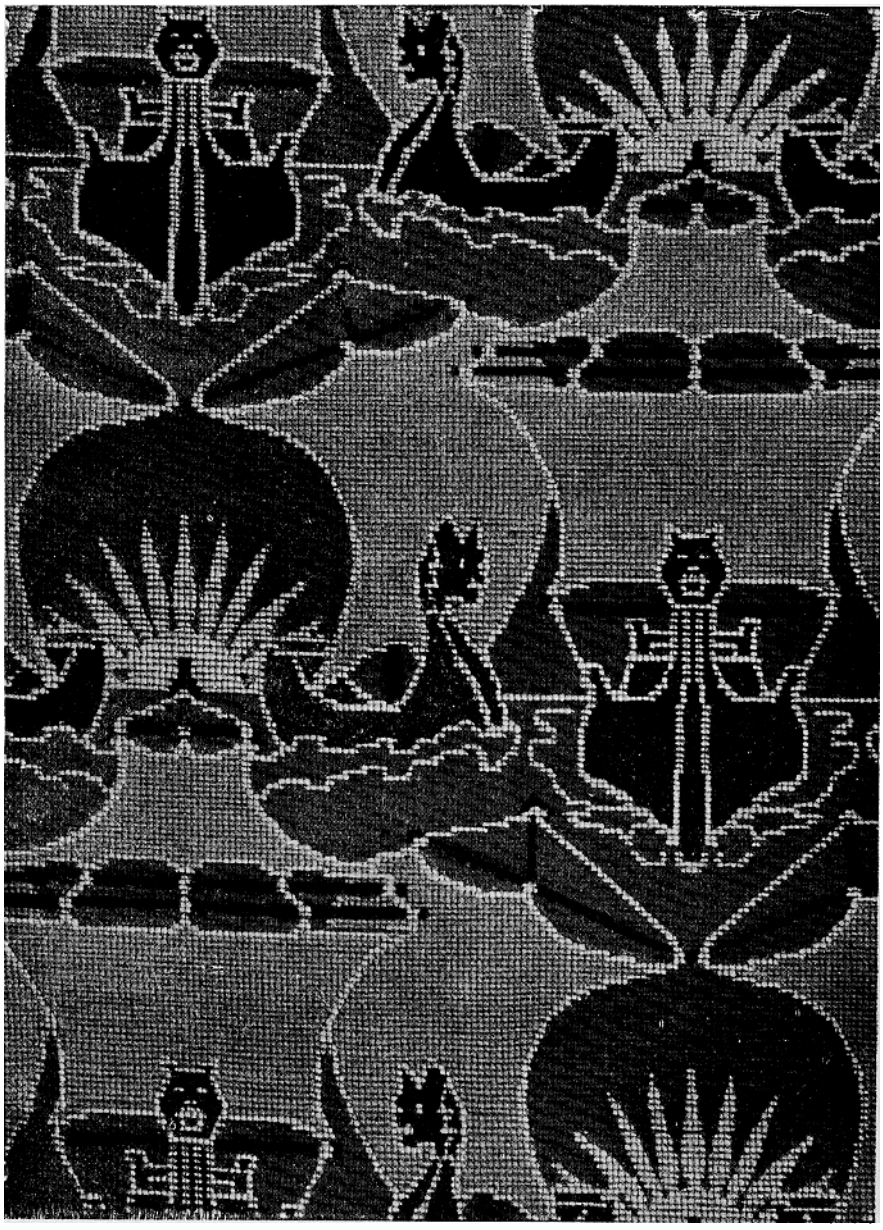

Fig. 211.

Each group of picks corresponds to one pick on the surface, and each colour of weft passes over the figuring ends where it is required to form figure, one weft

replacing another in succeeding horizontal sections of the design. The wefts are stitched on both sides of the cloth by the binding ends, the odd binding ends being raised on one group of picks, and the even binding ends on the next group. That is, the binding ends are raised and depressed alternately in an order that corresponds with the number of picks in each group—in 3-and-3 order if three wefts are employed, and in 4-and-4 order in the case of four wefts, etc. Each weft is stitched in longitudinal lines on the surface, which thus has the appearance of a weft rib.

In weaving the cloth the binding ends are drawn upon two healds, as represented at H in Fig. 213, and it is, therefore, only necessary to consider the figuring ends in constructing a design. The figure is painted solid in different colours, as represented in the upper portion of Fig. 212, while the paper indicates the ground colour ; and as many cards are cut from each horizontal space as there are wefts employed. In weaving the cloth right side up the cutting particulars for each card are :—Cut all but the weft colour that is required on the surface. The jacquard lift is made easier, however, by weaving the cloth wrong side up, in which case the card cutting particulars are :—Cut only the weft colour that is required on the surface. The plan in the lower portion of Fig. 212, in which the marks indicate weft, shows the complete weave produced by the picks 17 and 18 and the figuring ends 17 to 40 of the solid design ; the vertical marks indicating the 4-and-4 working of the healds, while the other marks represent the surface floats of the different wefts.

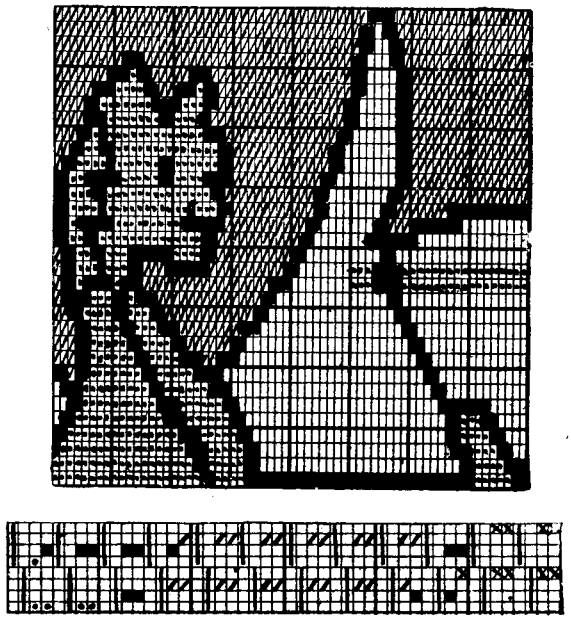

Fig. 212.

If only two wefts are employed in the structure represented in Fig. 211, the cloth is perfectly reversible, but with more than two wefts all except the one on the surface are interwoven alike on the underside, where the colours, therefore, show indiscriminately. In some weft tapestry cloths a plain weft-face is produced, as shown in the fabric represented in Fig. 222, the ends being drafted as indicated at D in Fig. 224. Also, the cloths may be made perfectly reversible, when more than two wefts are employed, by interweaving the surplus wefts in the centre in the manner illustrated by the plans above E, F, G, and H in Fig. 224.

Figuring with the Harness Threads.—In the texture represented in Fig. 211 the figuring ends really serve as stuffer ends, as they lie between the wefts on the face and back, and do not show on either side of the cloth. In the same structure, however, the cloth is sometimes cheapened by floating the figuring ends on the

surface in place of a weft, one pick of weft in each group thus being saved. Long warp floats require to be stopped by one or other of the wefts ; and the formation of large masses of figure by the figuring ends is not suitable, but they are conveniently used in outlining a design and in forming veins and stems.

A better quality of cloth than the example illustrated in Fig. 211 is produced by employing worsted yarns for the figuring ends in place of cotton, the following being suitable weaving particulars :—

Warp—2 figuring ends of two-ply 2/40's worsted, 2 binding ends of 2/80's cotton; 56 ends per inch.

Weft—10's worsted, 20 picks of each colour per inch.

The worsted ends are dyed the same colour as one of the wefts, and these two yarns interweave in plain order in the ground of the design, while the figure is produced by bringing the other wefts to the surface in the manner illustrated in Figs. 211 and 212. The only difference from the preceding system of cutting the cards is that the cards for the picks which are in the same colour as the figuring

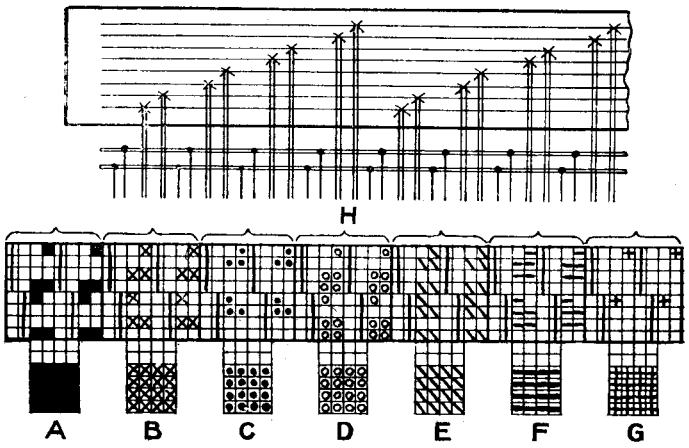

Fig. 213.

warp are cut plain. The counts of the design paper is in the proportion of the figuring ends per inch to the picks of each colour per inch.

Diversity produced by Mixing the Wefts.—In each of the foregoing methods of ornamentation variety of colour effect can be produced by bringing two of the wefts to the surface in some parts of the design and only one in other parts. For example, assuming that four colours of weft are employed, of which the fourth is the same in colour as the figuring ends, as described in the preceding paragraph, seven different effects can be produced, as represented at A to G in Fig. 213. The lower portion of the plans illustrates how the different effects may be painted upon design paper, if the heald-and-harness draft indicated at H is employed. The upper portion, in which the marks indicate weft, shows the corresponding complete weaves, including the binding ends which work in 4-and-4 order. The card-cutting particulars of each horizontal space of the solidly painted design, to weave the cloth right side up, are :—First card—cut B, C, F, and G ; second card—cut A, C, E, and G ; third card—cut A, B, D, and G ; fourth card—cut plain. The colours

are brought to the surface as follows :—A first weft, B second weft, C third weft, D first and second wefts together, E first and third wefts together, F second and third wefts together, and G the fourth weft along with the warp colour. There is also the difference in the effects that where two wefts are brought to the surface the figure is more solid than where there is only one.

Specially Stitched Weft Tapestry Cloth.—Fig. 214 represents a class of figured weft rib tapestry which is similar in appearance to that represented in Fig. 211, but the rib lines are finer, and the cloth is firmer and more suitable for upholstery purposes. In this case a binding weft is employed, so that the picks are not so liable to slip. Also there are two stitching warps, one of which binds the weft floats firmly on the surface, while the other stitches the wefts which are not required on the surface loosely to the underside. The particulars of the cloth are as follows : — Warp — 1 face stitching end, 2/80's black cotton ; 1 figuring end, two-ply 2/24's black cotton ; 1 back stitching end, 2/80's brown cotton ; 1 face stitching end, 2/80's black cotton ; 1 figuring end, two ply 2/24's black cotton. 24 two-ply figuring, 24 face stitching, and 12 back stitching ends per inch. About 103 yards of figuring, 127 yards of face stitching, and 108 yards of back stitching warp are required for 100 yards of cloth. Weft—3 figuring picks of 9's or two-ply 18's worsted in different colours, 1 binding pick of 2/80's cotton, 30 figuring picks of each colour, and 30 binding picks per inch.

Fig. 214.

In designing the figure the different effects are simply painted solid in different colours, as shown in Fig. 215, which corresponds with a portion of Fig. 214. Each vertical space of Fig. 215 represents a two-ply figuring end, and each horizontal space a pick of each weft, and the counts of the design paper with the foregoing particulars is, therefore, in the proportion of 24 ends to 30 picks, or 8 × 10. The figuring ends are used in forming the outline and the veins of the ornament and in shading the figure, as shown by the solid marks in Fig. 215 ; while two of the

wefts produce the figure, and the third the ground, as represented by the dots, diagonal marks, and blanks respectively.

Special Weft Tapestry Mounting.—Although the cloth represented in Fig. 215 is very complex, both the painting out of a design and the card cutting are simple,

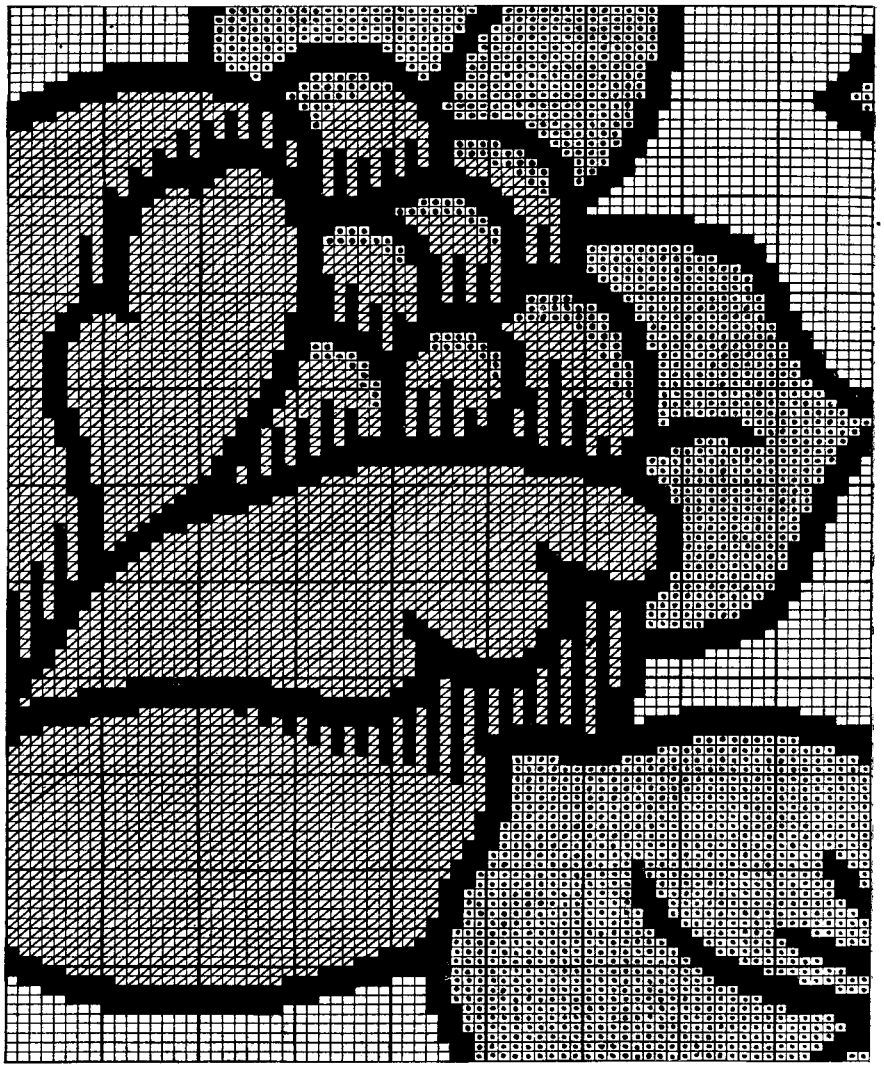

Fig. 215.

which is due to the employment of a very ingenious and interesting system of jacquard harness, lifting rod, and heald mounting. The arrangement is illustrated at A in Fig. 216, while B shows the order in which the ends are drafted. The face binding ends pass regularly over the figuring picks and under the binding picks on

the right side of the cloth, and are, therefore, conveniently drawn upon a heald C. The harness is in two longitudinal sections, the figuring ends being drawn upon the front portion D, and the back stitching ends upon the rear portion E.

As shown in the diagram A, the cords of the back stitching harness E are connected with alternate cords of the figuring harness, and are also provided with loops, through which lifting rods F are passed longitudinally, in the manner illustrated in Fig. 188 (p. 165). In this case, however, the rods are used simply to enable the back-stitching harness to be operated independently of the figuring harness. The hooks and needles are arranged the same as in an ordinary machine, and it will be seen that there are twenty ends in the cloth to each row of eight hooks and needles.

The cloth is woven wrong side up; the heald is left down on the figuring picks and raised on the binding picks, as shown at G in Fig. 216, while the rods are raised by means of special hooks in the jacquard, in the order indicated at H. Four cards are cut from each horizontal space of the design given in Fig. 215 as follows :—

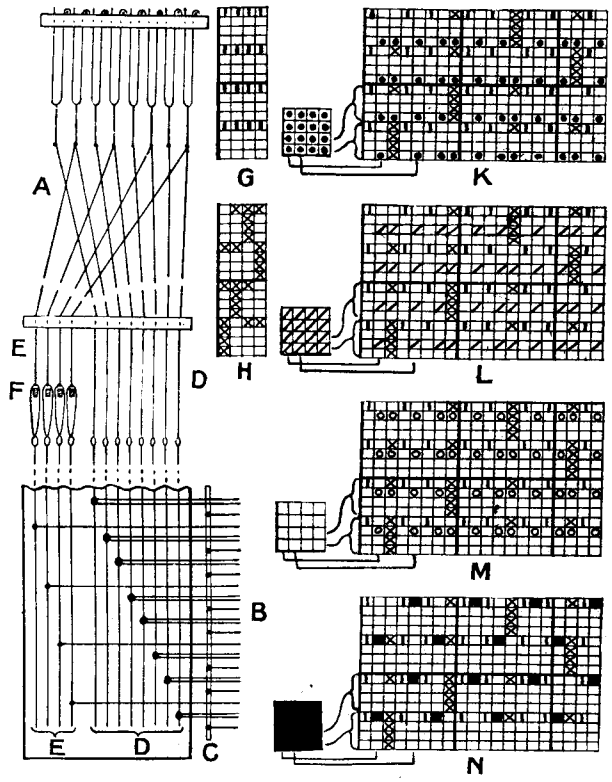

Fig. 216.

First figuring pick—cut the dots.
Second figuring pick—cut the diagonal marks.
Third figuring pick—cut the blanks.
Binding pick—cut the solid marks plain.

The four effects that are formed in the cloth are indicated in full at K, L, M, and N in Fig. 216, each of which is connected by lines with a plan that is indicated the same as the corresponding effect in Fig. 215. K brings the first weft to the surface on the right side of the cloth, L the second weft, M the third weft, while N produces the warp figure. The marks indicate ends raised in weaving the cloth wrong side up ; the crosses show the lifts produced by the rods, the vertical marks the heald lifts, while the other marks represent the lifts produced by the

figuring harness. The rods are lifted one at a time on the figuring picks, and stitch the wefts that are not forming figure in 4-sateen order on the reverse side of the cloth. Three of the rods are always left down on the figuring picks, and it is to automatically prevent the ends controlled by them from interweaving with the weft that forms the pattern on the under surface (the right side), that the back stitching harness cords are connected to the figuring harness cords. Where a weft forms the pattern on the right side of the cloth the figuring ends are raised, and with them the

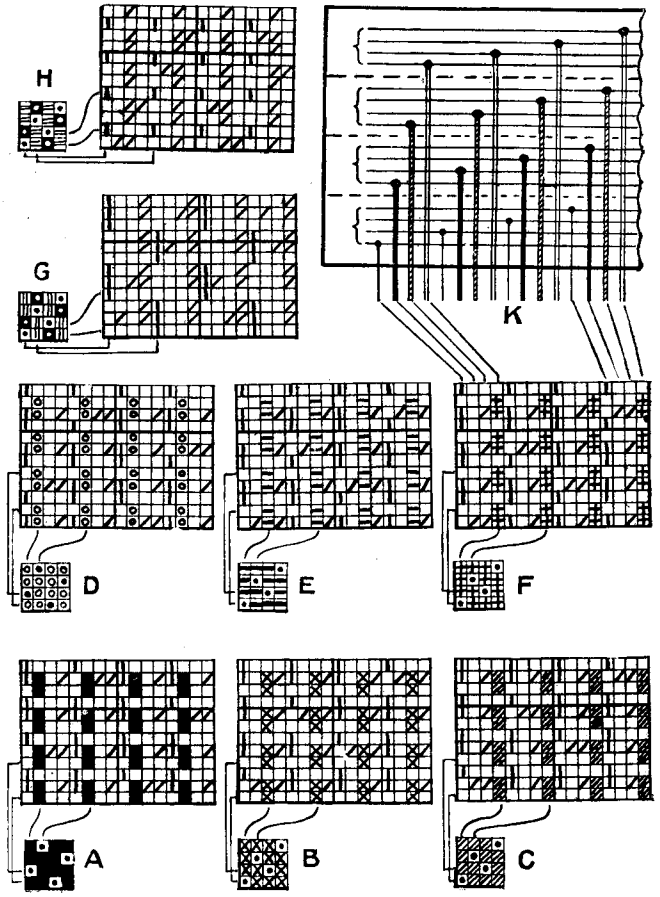

Fig. 217.

corresponding back stitching ends, so that the latter do not interweave with the weft on the face side of the cloth. The back stitching ends really form a loosely woven cloth with the weft on the reverse side, which, however, is stitched to the face texture by the interweaving of the back stitching ends with the binding picks. This is effected by leaving one rod down on each binding pick, as shown by the blanks on the picks, 4, 8, 12, and 16 in the plan H, Fig. 216.

Warp-Face Tapestry Cloth.—A class of tapestry cloth, in which the design

is due to colour, as in Fig. 214, is also largely made which has a warp-rib surface, the pattern in this case being chiefly due to employing two, three, or more differently coloured series of figuring ends. Two strongly contrasting figuring wefts—one very dark and the other very light—are, however, introduced, both of which form an effect on the surface in conjunction with each warp colour, and also produce small parts of the ornament independently. With three warp colours, which is a common arrangement, eight effects can be produced in any part of the cloth—six by combining each warp colour with each weft colour, and two by the wefts separately. Further, planting the warp colours is largely resorted to, and very great diversity of colour ornamentation is thereby obtained in the width of a fabric. In addition to the figuring warps and wefts, a fine binding warp and weft are employed, as shown in the following particulars of a cloth :—

Warp—1 binding end, 2/100's black cotton ; 3 figuring ends, 2/30's cotton in different colours ; 27 ends of each kind per inch.

Weft—2 figuring picks, 5's cotton in different colours ; 1 binding pick, 2/100's black cotton ; 23 picks of each kind per inch.

A design is painted in different colours to indicate the effects required on the surface, and in Fig. 217 eight effects are represented by the plans A to H, which are shown connected by lines with the corresponding complete weaves in which the marks indicate warp. The first, second, and third figuring warps are respectively interwoven with the first figuring weft at A, B, and C, and with the second figuring weft at D, E, and F, while G brings the first weft to the surface, and H the second weft. The vertical marks in the complete weaves indicate the lifts of the binding ends, and distinctive marks, which correspond with those shown in the plans A to F, represent the lifts of the figuring ends in forming the pattern on the surface, while the diagonal marks show the other lifts of the figuring ends. In each weave A to F the figuring ends required on the surface float over both figuring picks, and the binding ends are raised on the binding picks. On the figuring picks that are required to form the pattern on the surface along with the figuring ends, only the latter are raised, as shown on the first of each group of three picks in A, B, and C, and on the second of each group in D, E, and F. On the figuring picks that are not required to show on the surface, one of the remaining figuring warps is raised continuously, and the other in 1-and-3 sateen order, while the binding ends are lifted in 3-and-1 sateen order. The sateen order is indicated by the dots in the small plans A to F.

The weaves G and H in Fig. 217 illustrate two different methods of bringing the figuring picks to the surface, but in both cases the wefts are stitched by the binding ends. Two figuring warps are raised in 1-and-3 sateen order on the picks that are not required on the surface, and the remaining figuring warp on all these picks as well as on the binding picks. The dots in the small plans G and H show the sateen order of lifting one figuring warp, and the hollow circles the order of lifting the other figuring warp.

All the warps require to be controlled by the harness, and assuming that an ordinary jacquard and harness is arranged in four equal sections, and drafted as shown at K in Fig. 217, the ends will be lifted as indicated in the following, each horizontal space in the solid design representing three cards.

	Binding Warp.	First Figuring Warp.	Second Figuring Warp.	Third Figuring Warp.
Dark figuring pick.	Cut all but the dots in D, E, and F, and cut G plain.	Cut A and D solid, and cut the dots in E, F, and H.	Cut B, E, F, and H solid, and cut the dots in D.	Cut C, D, E, and F solid, and cut the hollow circles in H.
Light figuring pick.	Cut all but the dots in A, B, and C, cut G plain, and cut H solid.	Cut A and D solid, and cut the dots in B, C, and G.	Cut B, C, and E solid, and cut the dots in A and the hollow circles in G.	Cut A, B, C, F, and G solid.
Binding pick.	Cut A, B, C, D, E, and F solid, and cut G plain.	—	Cut H solid.	Cut G solid.

SCOTCH, KIDDERMINISTER, OR INGRAIN CARPETS

This is a class of texture in which the ornamentation is due to the use of differently coloured threads. In the simpler cloths the structure consists of two differently coloured plain fabrics, which are interchanged with each other in forming the design, as illustrated at N in Figs. 70 and 71 (p. 74). A number of different colour effects can be produced by combining two colours of warp with two different colours of weft, as described in reference to Fig 176 (p. 152) and Fig. 185 (p. 159). Also two or three warps are combined with two or three wefts, as illustrated in Figs. 206, 207, and 208 (pp. 187-189) in order to produce greater variety of pattern and a thicker structure. Designs in which only two double-plain effects are combined can be very conveniently woven by means of a special jacquard and harness mount; and although the class of Scotch carpet, for which the machine is particularly suitable, has been largely superceded by other makes, the arrangement embodies such a valuable principle of weaving that it is described and illustrated in the following :—

Double-Plain Cloth Jacquard.—This machine is specially arranged for weaving cloths in every part of which there are two differently coloured equal plain fabrics, one above the other, which interchange in forming the design. The jacquard is a compound or " twin " machine which is operated in conjunction with four working comber-boards. The ends, which are arranged as to colour in 1-and-1 order, are drawn in special order upon the harness. The principle of the machine and draft is illustrated in Fig. 218. To correspond with the two colours of warp there are two sets of hooks A and B, the hooks A having their bent upper ends turned towards the card cylinder, while those of B are turned towards the spring box. Only one series of needles C is employed, but each needle controls a hook of each set. There are two griffes carrying two sets of lifting blades E and F, and each blade is inclined towards the hooks that it governs, but whereas the hooks A, when in their normal position, are over the blades E, the hooks B are clear of the blades F. The harness cords have knots G tied upon them which rest (when the cords are not raised by the jacquard) upon the working comber-boards K, L, M, and N. Two comber-boards are allotted to each set of hooks and harness cords in order that each colour of warp may be lifted in plain order by the comber-boards independently of the jacquard.

The ends are drawn upon the harness as indicated at H in Fig. 218, in which

the solid lines represent, say, dark ends, and the shaded lines light ends. The dark ends are drawn upon the harness cords that pass through the front two boards N and M, and the light ends upon the cords that pass through the rear boards L and K. It will be seen that by raising the board N the odd dark ends will be lifted, by raising L the odd light ends, by raising M the even dark ends, and by raising K the even light ends.

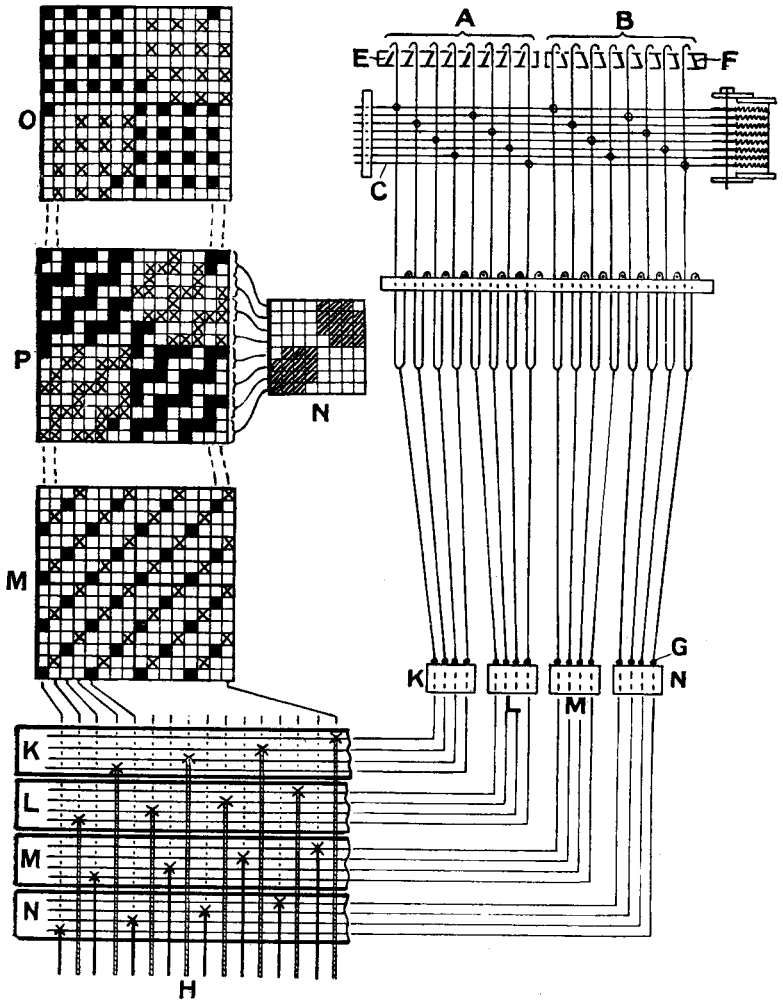

Fig. 218.

The needles are connected to the hooks in such a manner that the harness cords pass to the comber-boards without being crossed. Thus, the hooks in each set, in the order of 1, 2, 3, 4, 5, 6, 7, 8, are connected to the needles in the order of 1, 3, 5, 7, 2, 4, 6, 8, because the odd ends of each colour are drawn upon the harness of one board, and the even ends upon the harness of the next board.

The weft is in two colours, and is inserted in the order of a pick of each alternately. On one dark pick the odd dark ends are lifted by one board, and on the next dark pick the even dark ends by the next board; the plain weave of the dark fabric thus being formed. In the same manner on one light pick the odd light ends are raised by one board, and on the next light pick the even light ends by the other board, so that the plain weave of the light fabric is formed. The purpose of the jacquard is to lift the light ends on dark picks where a light surface is required, and to lift the dark ends on light picks in forming a dark surface.

Operation of the Jacquard and Comber-Boards.—The operation of the machine is as follows:—Each card acts for two picks—a pick of each colour—during which the two griffes are operated alternately. A blank in a card presses a hook A away from the path of a lifting blade E, whereas a hook B is pressed over a blade F. On the other hand, a hole in a card allows a hook A to remain over a blade E, and a hook B to remain clear of a blade F. Thus, one hook of a pair controlled by the same needle is certain to be raised on one pick, and the other left down on the other pick. Taking the order of wefting to be 1 dark, 1 light, the complete order of shedding is as follows:—

Odd spaces of design	First pick (dark)—	hooks	A (light)	and board	N (dark)	are raised.
	Second ,, (light)—	,,	B (dark)	,,	L (light)	,,
Even spaces of design	Third pick (dark)—	,,	A (light)	,,	M (dark)	,,
	Fourth ,, (light)—	,,	B (dark)	,,	K (light)	,,

The full weaves that are produced will be understood from an examination of the plans given at M, N, O, and P in Fig. 218. M shows the weave that is formed by the lifting of the boards, the solid marks representing the dark ends, and the crosses the light ends. Assuming that the marks of the plan N are cut upon the cards, the lifts indicated at O will be produced by the jacquard, the crosses representing light ends lifted on dark picks, and the full squares dark ends lifted on light picks. The complete weave formed by the boards and the jacquard in combination is, therefore, as shown at P, in which the full squares represent the dark surface and the crosses the light surface. In cutting the cards from a design, holes have to be cut to correspond with the positions where the colour of warp is required on the surface which is controlled by the hooks that normally are over the lifting knives. (P may be compared with N in Fig. 70, p. 74.)

Method of Designing.—In painting out a design the figure is indicated solid, and no weave marks are inserted upon either the figure or the ground. The sectional design given in Fig. 220 may be taken as an example, in which it will be seen that variety of effect can be obtained to some extent in painting in the figure. Each vertical space of the design paper corresponds to two ends, and each horizontal space to two picks, and there is, therefore, a saving in cards of three-fourths.

Limitation of the Mounting.—The limitation of the machine is that only two effects are possible in the cloth since each colour of warp can only be interwoven with the colour of weft that is allotted to it. Each effect does not necessarily require to be in a solid colour, as the weft colours may be different from the warp colours, but the interweaving of each colour of warp with both colours of weft is impossible. In many cases this is a disadvantage as compared with the effects that can be woven in a machine in which every end is controlled by a separate needle. Also,

as the two fabrics are separate except where they interchange, the wear of the cloth is not so good as that of a solid structure of the same weight and thickness. The original type of Kidderminster carpet has, therefore, been modified in various ways, and as will be seen by comparing the following examples with Figs. 211 to 216, the textures, in the modified forms, are very similar in principle of construction to weft-face tapestry cloths. Thicker and stronger yarns are, of course, employed in the carpets.

Weft-Face Ingrain Carpets.—Fig. 219 represents a fabric in which the design is due to the interchange of two differently coloured wefts, while the corresponding

Fig. 219.

sectional plan, given in Fig. 220, illustrates the method of painting out a design. The warp is arranged—1 binding end, 1 two-ply figuring end, as shown in the heald-and-harness draft given at A in Fig. 221. In some cases the figuring ends are single, but if they are two-ply they should be drawn separately through double-eyed mails in order that they will spread out, and give a fuller appearance to the cloth. If an ordinary form of jacquard is used two cards are cut from each horizontal space of Fig. 220, as follows :—First card, cut the blanks ; second card, cut the marks. The healds are operated in 2-and-2 order, and the complete weaves, given at B and C in Fig. 221, are produced in the figure and ground respectively. The cloth is perfectly reversible, a dark figure on a light ground being formed on one side, and a light figure on a dark ground on the other side. Sometimes, however,

one of the wefts is chintzed in order to develop a portion of the figure in a third

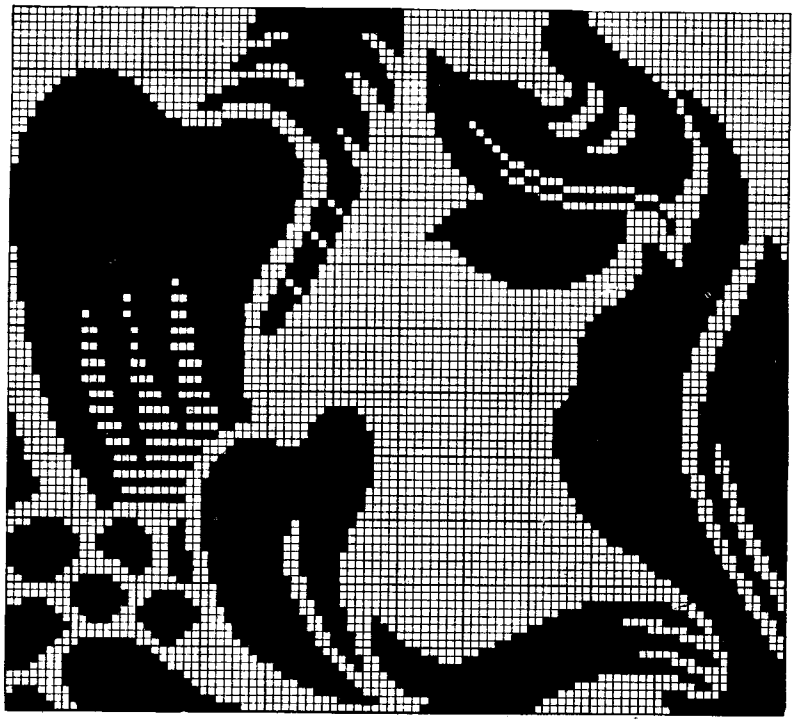

Fig. 220.

colour, in which case the cloth is generally not reversible, because the chintzed weft produces horizontal lines in the ground on the underside.

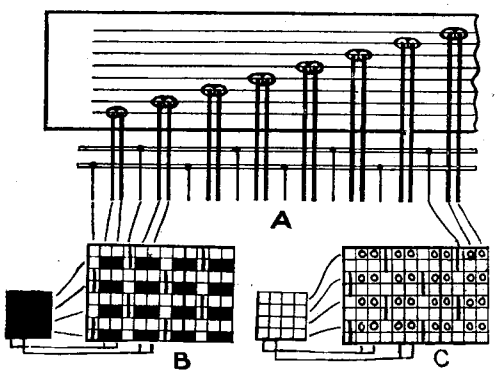

Fig. 221.

From an examination of the weaves given at B and C in Fig. 221 it will be seen that the harness ends left down on the first pick of each pair are raised on the second pick. The double-plain machine, illustrated in Fig. 218, can be adapted to weave the cloth by connecting each harness cord to two hooks that are controlled by the same needle. The arrangement then enables one card to act for two picks, as the ends left down by the hooks A on the first pick are automatically raised on the second pick by the hooks B.

Reversible Four-Ply Weft Structure.—The class of structure, represented in

Fig. 219, is also made with more than two series of differently coloured wefts, and in order to enable changes to be readily made from one cloth to another, an ordinary form of heald-and-harness mount is chiefly employed, and the two figuring ends, which alternate with each binding end, are drawn on separate harness cords. Fig. 222 represents a fabric in which the design is formed in four differently coloured wefts, the following being suitable weaving particulars :—

Warp—1 cotton binding end, 3/24's ; 2 jute figure or stuffer ends, 9 lbs. per spyndle ; 7 binding ends and 14 jute ends per inch.

Weft—60 yards per oz. worsted or woollen ; 14 picks of each colour per inch. The binding ends in this class of cloth require to be from 60 to 120 per cent. longer

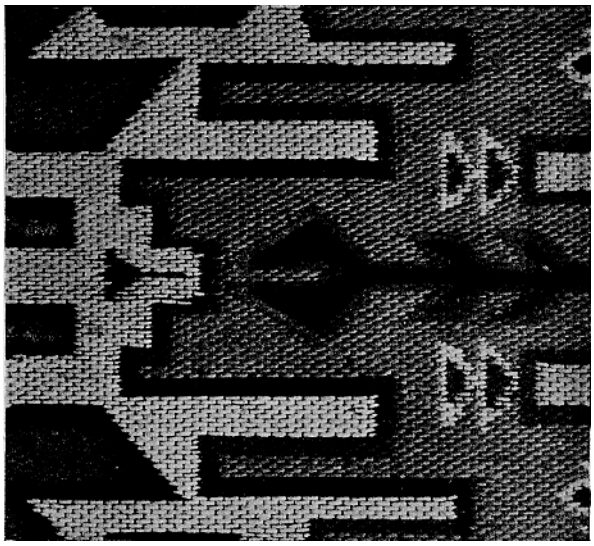

Fig. 222.

than the jute ends, according to the thickness of the weft and the number of picks per inch.

Fig, 223 shows a portion of the design given in Fig. 222, the different marks representing different colours of weft on the surface, while D in Fig. 224 represents a form of heald-and-harness mount that is used in weaving the cloth. The plans E, F, G, and H in Fig. 224 respectively correspond with the four effects represented in Fig. 223, and each plan is connected by lines with the corresponding complete weave in which the marks indicate weft. The healds are operated in 4-and-4 order, as indicated by the vertical marks ; and if the draft D in Fig. 223 is employed four cards are cut from each horizontal space of the design as follows :—

First card—cut	G	solid,	and	odd	ends	of	F	and H.
Second ,,	,, H	,,	,,	,,	E	,,	G.	
Third ,,	,, E	,,	,,	,,	F	,,	H.	
Fourth ,,	,, F	,,	,,	,,	E	,,	G.	

In the complete weaves, the marks which correspond with those in the solid

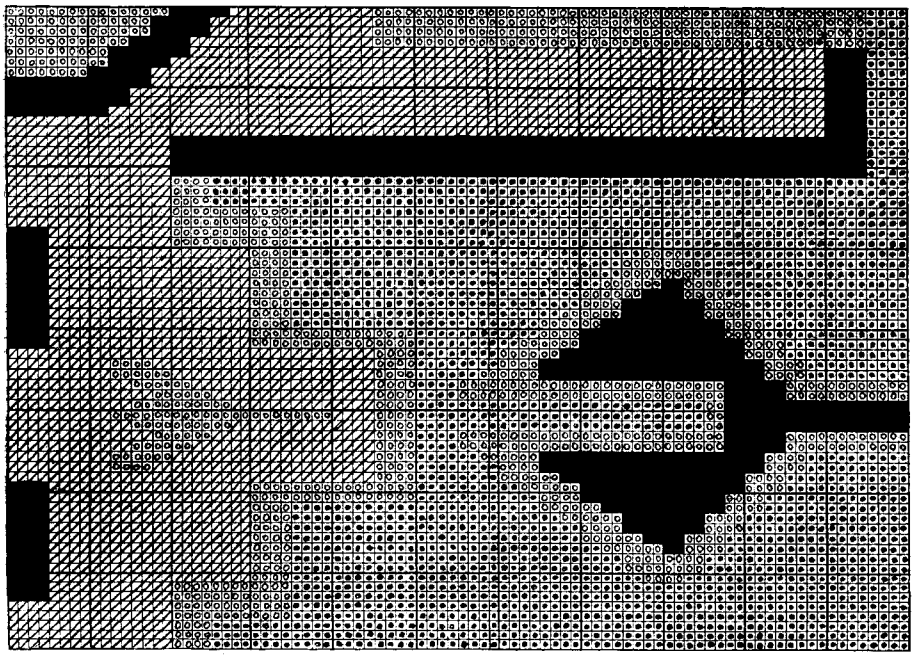

Fig. 223.

plans indicate the weft that is on the surface, and it will be seen in each example that one pick in every group of four picks floats over two pairs of figuring ends

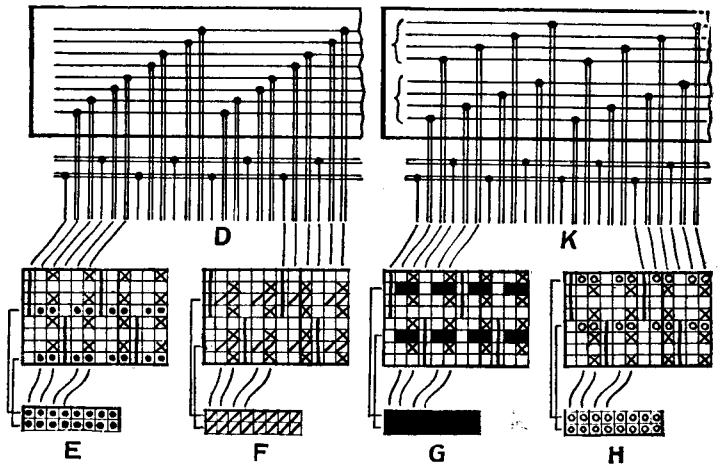

Fig. 224.

and one binding end Similar floats are also formed by one of the wefts on the

underside of the cloth, as indicated by the picks in the full weaves upon which there are five blanks to one mark. On the remaining two picks of each group of four, the odd figuring ends are raised and the even ones left down, as indicated by the crosses. Therefore, in every part of the cloth two picks lie in the centre, while one forms figure on the surface and the other a similar figure on the back, the cloth being reversible. Three wefts are much more commonly used than four wefts, but the structure is the same except that there is only one weft in the centre.

In place of the draft given at D in Fig. 224, the sectional harness arrangement, indicated at K, may be employed, in which the odd figuring ends are drawn upon the front, and the even figuring ends upon the rear harness cords. In the latter system the design only needs to be painted out upon half as many vertical spaces as there are figuring ends in the repeat, the cards being cut as follows :—

	Front Section.	Rear Section.
First card.	Cut F, G, and H.	Cut G.
Second card.	Cut E, G, and H.	Cut H.
Third card.	Cut E, F, and H.	Cut E.
Fourth card.	Cut E, F, and G.	Cut F.

With either the draft D or K in Fig. 224 the weft floats are stitched alternately by the binding ends, and a plain weft surface is produced. The cloths, however, are also woven with two binding ends alternating with the figuring ends, as indicated in the draft H, Fig. 213 (p. 194), in which case the weft floats are stitched in a straight line, and a weft-rib surface is formed. Further, in some of the carpet fabrics none of the wefts are in the centre, all except the one forming the figure being interwoven alike on the underside, in the manner illustrated by the tapestry example given in Figs. 211 and 212.

Methods of producing Variety.—Many variations of the carpet styles, illustrated in Figs. 219 to 224, are made chiefly with the idea of obtaining diversity of colour in the design in an economical manner. Worsted, or even jute, figuring ends may be used in the dyed state in forming small parts of a design in conjunction with the figuring wefts. The wefts may be mixed in pairs on the surface and produce effects in addition to those formed in solid colours, in a method similar to that illustrated in Fig. 213 (p. 194).

A cloth may be woven in four colours of weft which is only equivalent in weight to a two-wefted cloth, the first and third colours representing one weft and the second and fourth colours the other weft. Two wefts are brought to the surface together, or one weft in conjunction with the figuring warp, a large variety of intermingled colour effects resulting. For instance, each weft colour can be mixed with the figuring warp colour, and the first and second wefts with either the third or the fourth weft. A combination of eight effects can thus be formed in a design without interfering with the 2-and-2 working of the healds. In painting out a design the different effects may be indicated as represented in the lower portion of the plans A to H in Fig. 225. A, B, C, and D respectively show the first, second, third, and fourth colours intermingled with the figuring ends, alternate spaces being left blank to show where the warp is brought to the surface. E shows the first and third wefts combined ; F, the first and fourth ; G, the second and third ; and H, the second and fourth ; the horizontal spaces

being painted alternately in different colours to represent the wefts required on the surface. Two cards are cut from each horizontal space of a design, in each case all but the marks of the weft required on the surface being cut. The complete weaves, in which the marks indicate weft, are shown in the upper portion of the plans A to H in Fig. 225, and in this example two binding ends alternate with two figuring ends.

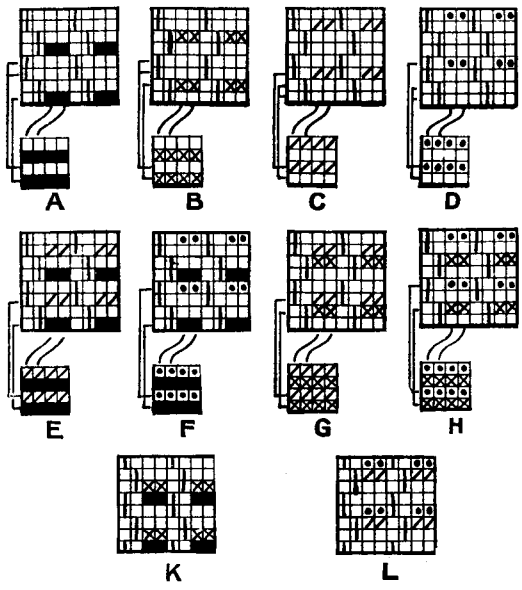

Fig. 225.

It is possible to combine the first and second wefts together, and the third and fourth together, as shown at K and L in Fig. 225, but if these effects are used in a design in addition to the others, the binding ends require to be controlled individually by the jacquard and harness. This is in order that the lifts of the binding ends may be arranged to fit with the order in which the wefts are brought to the surface, as shown in K and L, in which it will be seen that the vertical marks are in different positions from those in the other plans.

CHAPTER XI

FANCY TOILET AND QUILT FABRICS

Fancy Toilet Cloths—Classification of the Fabrics—Loose-Back Toilets. *Fast-Back Toilets and Marseilles Quilts*—Method of Designing—System of Loom Mounting—Four-Pick Structure—Five-Pick Structure—Special Five-Pick Cloth. *Mitcheline or Patent-Satin Quilts*—Method of Loom Mounting—Method of Designing and Structure of the Cloth—Other Varieties of Quilts.

FANCY TOILET CLOTHS

In fancy toilet cloths (which are similar in structure to welts and piques of which they are a development *) tight stitching ends, brought separately from a heavily tensioned beam, are woven into a slack plain face cloth in such a manner as to produce a less or more elaborate design according to whether a dobby or a jacquard shedding motion is employed. A simple style is represented in Fig. 226 for which the condensed plan is given at A in Fig. 227. Each mark of A indicates the lift of

* Welts and piques are described and illustrated in the accompanying book, "Textile Design and Colour"—"Elementary Weaves and Figured Fabrics."

a tight stitching end over two face picks, by which the slack face cloth is drawn down and indentations formed in the surface; the blank diamond spaces between the marks correspond with the raised or embossed portions of the cloth. In weaving the design A in a dobby loom four healds would be employed for the plain face ends, and nine healds for the stitching ends, as shown in the draft given at B in Fig. 227. In jacquard weaving the plain face ends are drawn upon two healds (or four according to the sett of the warp) placed in front of the harness, only the tight stitching ends being drawn upon the harness, as shown at C in Fig. 227. The draft enables a design to be woven that repeats upon three times as many ends as there are jacquard needles employed. A shows the card-cutting plan for a jacquard machine, the marks being cut.

Classification of the Fabrics.—The cloths are classed as 2-pick, 3-pick, 4-pick, and 5-pick stitch according to the number of picks that each horizontal space of a design represents—that is, the number of picks per stitch; and they are also described as "loose-back" and "fast-back" according to whether the stitching ends are floated loosely or are interwoven on the underside. The bulk of loose-

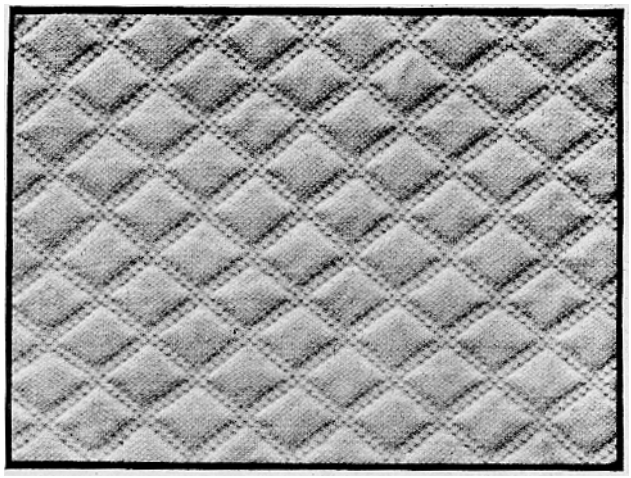

Fig. 226.

back toilets are made on the 3-pick basis, and a heald-and-harness draft, as represented at C in Fig. 227, is employed for jacquard styles; whereas fast-back cloths are made 4 or 5 picks per stitch, and are woven in a jacquard with working comberboards.

Loose-Back Toilets.—Full weaves, to correspond with the plan A, are given at D, E, and F in Fig. 227, which are constructed on the loose-back principle, and are arranged 2, 3, and 4 picks per stitch respectively. In D no wadding picks are inserted, and in jacquard shedding each card acts for two picks, forming the lifts shown in solid marks, while the healds are raised in alternate order by means of tappets so as to produce the plain weave, as represented by the dots.

Generally, thick wadding weft is employed in the cloths which lies between the tight backing ends and the unstitched portions of the face fabric, and gives

greater prominence to the latter while making the cloth more substantial. In the 3-pick cloths the picks are usually arranged in the order of 4 face to 2 wadding, as shown at E in Fig. 227, in order that a loom with changing boxes at one end only may be used. In this case, in jacquard shedding, each card acts for three picks, while the healds are raised alternately on the face picks, and both together on the wadding picks ; the latter lifts are indicated by the crosses in E. In a 4-pick structure the picks are arranged 2 face and 2 wadding, as shown at F in Fig. 227,

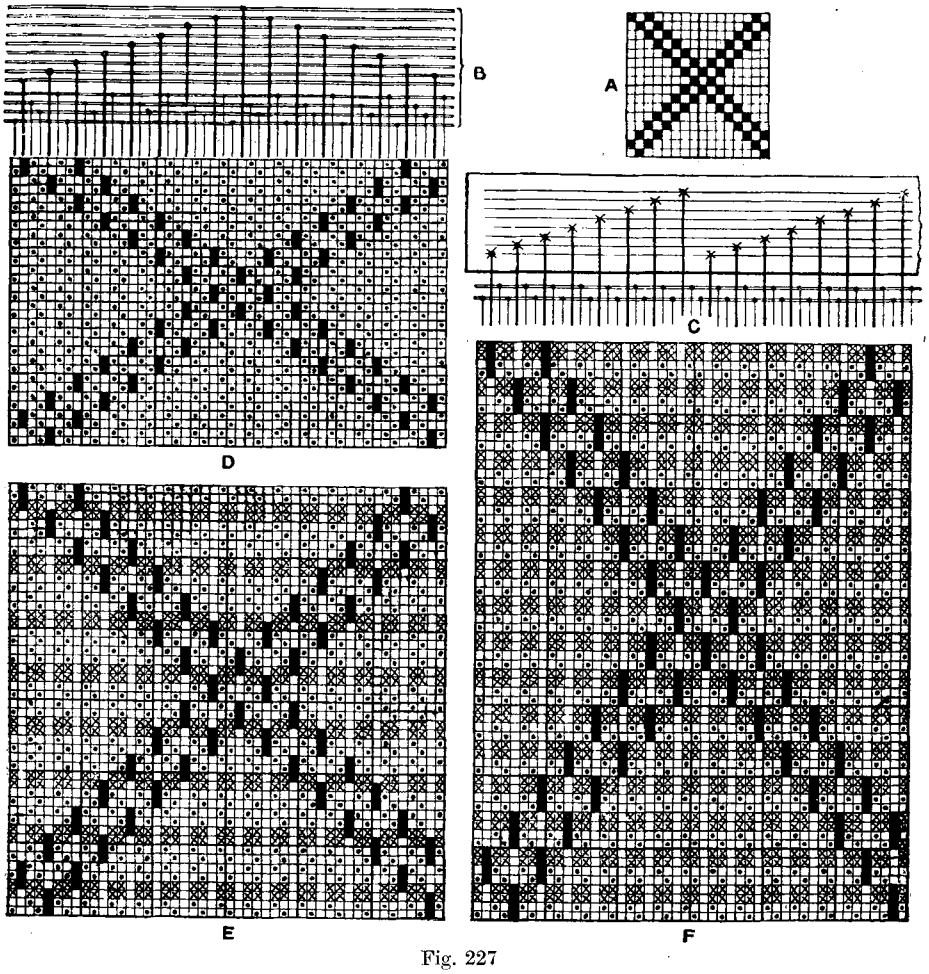

Fig. 227

and each card in jacquard shedding acts for four picks. The system of designing for elaborately figured loose-back toilets, which is exactly the same as for fast-back cloths, is illustrated in Fig. 229. Sometimes the 4-and-2 structure, represented at E in Fig. 227, is made what is termed "half-fast" back by raising the stitching ends at rather infrequent intervals on the wadding picks under the embossed figure.

FAST-BACK TOILETS AND MARSEILLES QUILTS

Fast-back toilet fabrics are exactly the same in principle of construction as Marseilles quilts, which are usually made with either 4 or 5 picks to each stitch or each horizontal space of a design. A representation of a portion of a Marseilles quilt fabric is given in Fig. 228, and a sectional design to correspond in Fig. 229. In this structure the tight stitching ends are interwoven on the underside in plain order with a portion of the picks, so that two plain fabrics are formed—one above the other—in every part of the cloth. In the embossed figure the two fabrics are quite separate from each other, and wadding picks lie between them, but in the

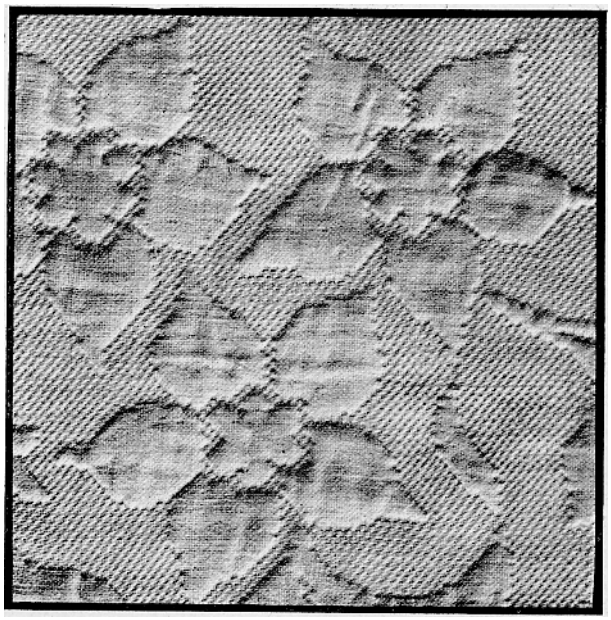

Fig. 228.

ground they are very firmly united by the interweaving of the stitching ends with the face picks.

Method of Designing.—In preparing a design for the card-cutting the embossed figure may be indicated by a wash of colour, in the manner represented by the shaded squares in Fig. 229, and plain weave is inserted round the figure in order to separate it from the ground. The order in which the stitching ends are required to be interwoven with the face picks is then indicated in the ground of the design, and various small weaves, such as those shown at G, H, and I in Fig. 229, may be employed. In the example shown in Fig. 228 the ground texture is as firm as it is possible to make it, as the stitching ends are raised in alternate order. The ground weave is therefore plain, which, however, only needs to be indicated at the left of the design, as shown in Fig. 229. The card-cutting particulars of the example are :—Cut the ground plain, and miss the figure ; but when a fancy

ground is employed, the marks of the ground weave are cut. The stitching ends are left down in the embossed sections of the cloth, lifts only being indicated in the bound portions; and in every part of a design the order of marking requires to be arranged to fit with plain weave.

System of Loom Mounting.—In weaving the cloth a jacquard machine is combined with two working comber-boards and two (or four) healds, and the ends are drafted in the method illustrated at J in Fig. 230. The arrangement very

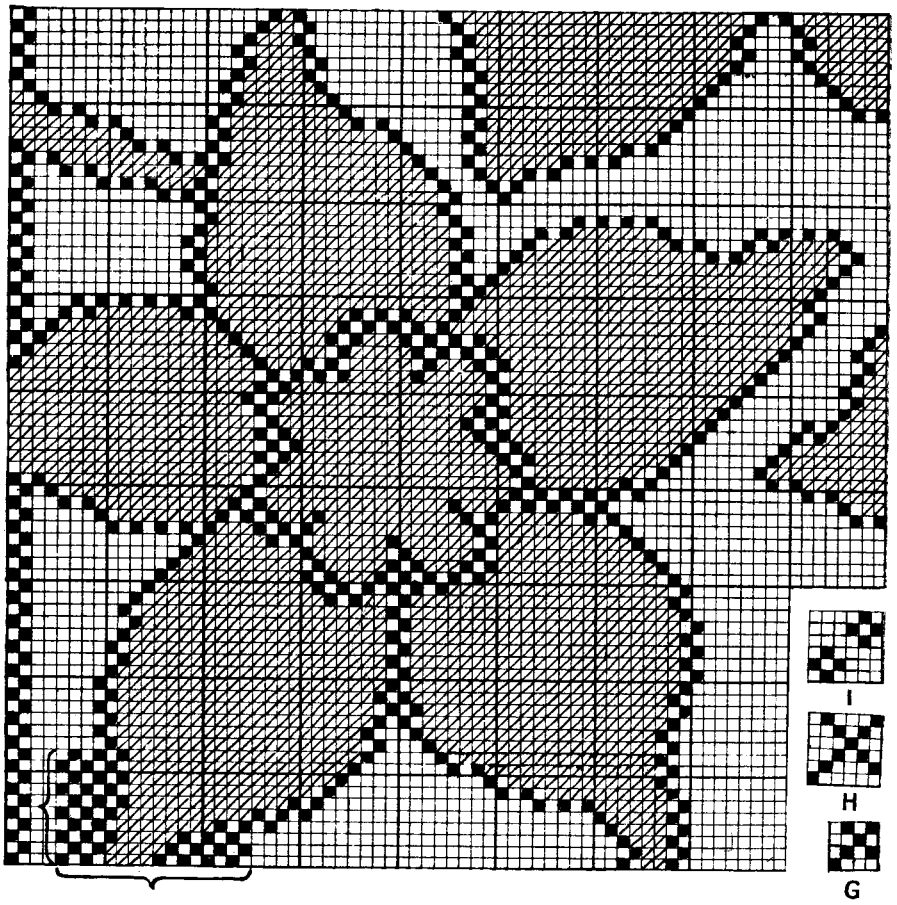

Fig. 229.

largely extends the size of repeat of a jacquard, and a great saving is effected of time, labour, and material in the designing and card-cutting. The ends which form the plain-face cloth are drawn upon healds placed in front of the harness, while the odd and even stitching ends are separately controlled by the harness cords, whose knots rest upon the front and back comber-boards respectively. In order to avoid crossing the harness cords in their passage from the hooks to the comber-board, the needles and hooks are connected in the manner illustrated in

the upper portion of Fig. 424, the odd needles controlling the harness cords that pass through one board, and the even needles those that pass through the other board.

Four-Pick Structure.—The plans K and L in Fig. 230, each of which repeats upon six ends and eight picks, respectively show the weaves of the embossed and bound portions of a cloth which is woven with four picks per stitch. The warp is arranged the same as in the pique and toileting structures, and the weft is inserted in the order of two fine picks and two thick picks. The embossed weave K is formed by the operation of the healds and the comber-boards, as follows :—The healds are raised in alternate order on the two fine face picks, so as to form the plain face cloth (represented by the dots), and both together on the thick picks (shown by the crosses), the face ends thus being raised on the wadding and backing picks. The comber-boards are raised in alternate order on the fourth and eighth picks (indicated by the diagonal strokes), the plain back weave thus being formed by the second of each pair of thick picks, while the first of each pair forms the wadding. In the bound weave L, Fig. 230, the order of lifting is the same as in K, but, in addition, the jacquard hooks are raised so as to lift the stitching ends in alternate order over a group of four picks at a place, as shown by the solid marks. The stitching ends are thus raised over the fine face picks, while on the underside they interlace the same with the two thick picks. The tappets which control the healds and comber-boards are made eight picks to the round, and the jacquard is operated once in every four picks.

The complete weave, in the 4-pick structure, is given at M in Fig. 230 of the ends 5 to 20, and the picks 1 to 10 which are enclosed by brackets in Fig. 229. Each card acts for four picks, and, as shown by the diagonal strokes, the alternate lifting of the stitching ends by the comber-boards, where the embossed structure is formed, joins properly with the alternate lifts formed by the jacquard in the bound portions. From a comparison of M in Fig. 230 with F in Fig. 227 it will be seen that the fast and loose-back structures are alike, except that in the embossed portions of the fast-back cloths the tight stitching ends, by means of the working comber-boards, are interwoven in plain order with the even thick picks.

The interweaving of the picks 1, 2, 3, and 4 with the ends 1 to 24 of the design M, is represented at N in Fig. 230, the bound structure being shown on the left, and the embossed effect on the right. O shows the interweaving of the last three ends of M with the picks 9 to 16, the embossed and bound structures being represented in the upper and lower portions respectively. The plain face threads are shown in solid black, and the threads are connected by lines in order that the drawings may be readily compared with the plan M.

The following are the weaving particulars of a cloth with four picks per stitch :—

Face warp, 2/80's cotton ; stitching warp, 2/48's cotton ; face weft, 30's cotton ; wadding and backing weft, 10's cotton ; 108 ends and 144 picks per inch. The stitching ends contract from 5 to 8 per cent., and the face ends from 15 to 20 per cent., while the shrinkage in width is about 12 per cent. Since each vertical space of the design paper is equivalent to three ends, and each horizontal space to four picks, the counts of the design paper (not allowing for contraction) is in the ratio of $(108 \div 3)$ to $(144 \div 4)$—or 8×8 for an 8-row machine, and 12×12 for a 12-row machine. Large machines with 12 hooks per row are mostly used in weaving quilts.

The 4-pick structure is sometimes made as shown at P in Fig. 230, which corresponds with the picks 1 to 8, and the ends 1 to 32 of M. In this case the fourth and seventh of each series of eight picks form the backing picks, and the third

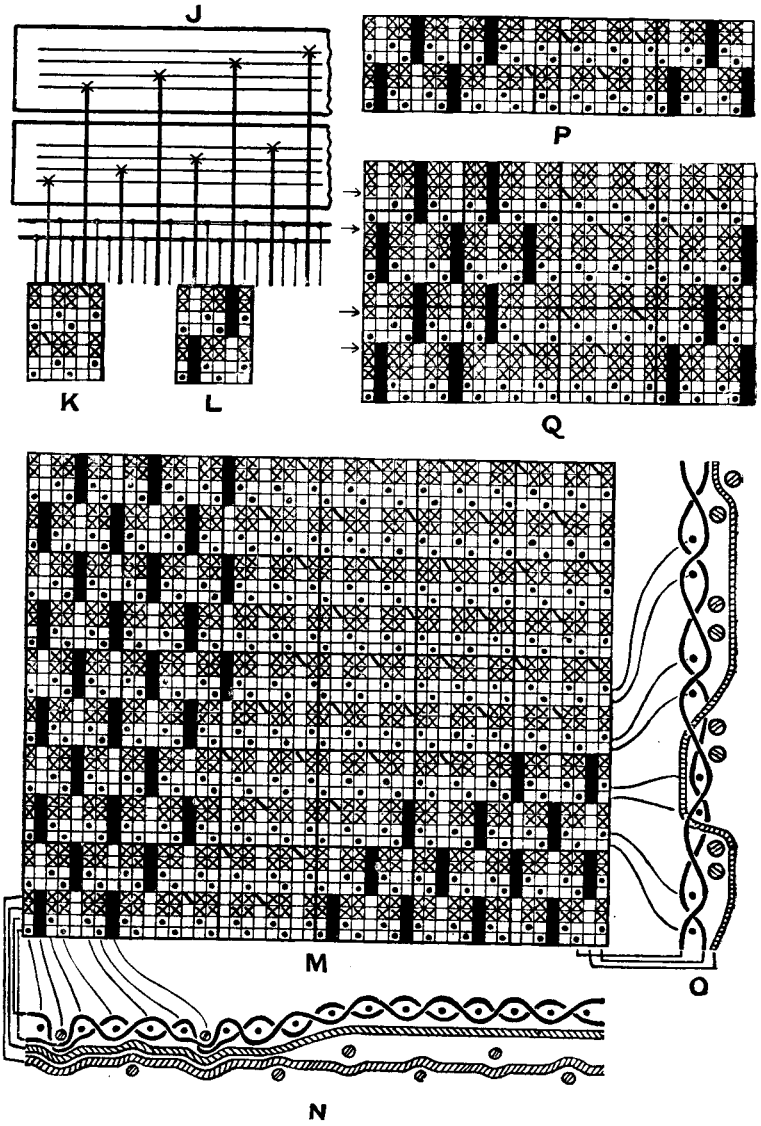

Fig. 230.

and eighth the wadding picks; and the arrangement is used when the backing picks are formed of the same weft as the face fabric. The complete order of wefting is then—2 picks fine, 1 pick thick wadding, 4 picks fine, 1 pick thick wadding, which necessitates the use of a loom that is provided with changing boxes at both ends.

Five-Pick Structure.—The structure of a 5-pick cloth is illustrated at Q in Fig. 230, which corresponds with the picks 1 to 16 and the ends 1 to 32 of M. In this structure in each series of ten picks the fifth and eighth (indicated by the arrows at the side of Q) form the backing picks, and these consist of the same kind of weft as the face picks, so that the complete order of wefting is 2 picks fine, 2 picks thick wadding, 4 picks fine, and 2 picks thick wadding. Each card acts for five picks; the healds are operated in alternate order on two picks, and then are raised together on three picks; and the comber-boards are raised alternately on the pick that follows and that which precedes the wadding picks. To correspond with the foregoing particulars of a cloth the structure represented at Q would be woven with 180 picks per inch, of which 72 fine picks would form the face, 36 fine picks the back, and 72 thick picks the wadding. The system of designing, illustrated in Fig. 229, is correct for both the structures P and Q.

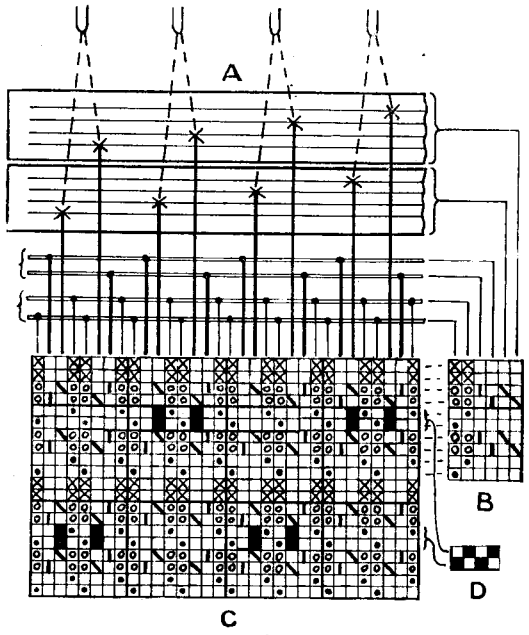

Fig. 231.

Special Five-Pick Cloth.—In a further development of the Marseilles quilt structure the face and back ends and picks are in equal proportions, and there are two wadding picks to four face and four back picks. A different arrangement of jacquard harness-and-heald mount is employed, which is illustrated at A in Fig. 231. The hooks and needles are connected the same as in an ordinary machine, but two harness cords are attached to each hook, one of which passes through the front comber-board, and the other through the rear board, as represented in the upper portion of the diagram A. The system of tie-up is also illustrated at A in Fig. 234. Two sets of healds are employed, the face ends being drawn upon the front set and one-half of the back ends upon the back set. The other half of the back ends are drawn in alternate order upon the two working comber-boards.

The order in which the healds and comber-boards lift, and produce the unbound or embossed portion of the cloth, is indicated at B in Fig. 231. The dots in B represent the plain face weave, the circles the face ends raised on back picks, the crosses the face ends raised on wadding picks, while the vertical and diagonal marks respectively show the lifts of the back healds and the knotted comber-boards, by which the plain weave of the back fabric is produced.

Two repeats of the complete weave of the bound portions of the cloth are given at C in Fig. 231, in which the solid marks show the order in which the harness back ends are lifted over the face picks by the jacquard. Each card acts for ten

picks, and the machine lifts on two picks in each group ; and as two consecutive harness cords are connected to each hook the harness back ends are raised in pairs.

D in Fig. 231 shows the actual card-cutting plan which, in conjunction with the lifts formed automatically by the healds and the comber-boards, will produce the plan C. The method of designing is illustrated by Fig. 229, but it will be seen in this case that each small space of the paper corresponds to eight ends and ten picks in the cloth. As regards the threads on the face of the cloth each needle is equivalent to four ends, and each card to four picks ; and compared with the arrangement illustrated at J in Fig. 230 a saving of three-fourths of the cards is effected, because the figuring capacity of the jacquard is doubled and only half as many cards are required.

In Fig. 231 the picks are arranged 2 face, 2 back, 2 face, 2 back, and 2 wadding, but the principle of the shedding is not limited to this order of wefting. The looms used in weaving the different classes of Marseilles quilts and fast-back toilets are provided with tappets at the side, as illustrated in Fig. 190 (p. 168), for operating the jacquard, comber-boards, and healds, and the tappets are arranged 8 or 10 picks to the round, according to the class of cloth.

MITCHELINE OR PATENT SATIN QUILTS

The Mitcheline quilt structure is a double cloth in which two plain fabrics are so firmly bound together as to be inseparable. The design is due to the interchange of the two fabrics, and the cloth is equally compact and solid in every part. A representation of a cloth is given in Fig. 232, while Fig. 233 shows a portion of the design to correspond, as it is indicated upon design paper. The following are the weaving particulars of a medium quality of cloth :—

Fig. 232.

Warp—2 ends of 18's cotton to 1 end of 32's cotton.

Weft—2 picks of 40's cotton to 2 picks of 8's soft spun cotton.

64 ends and 96 picks per inch. The 18's warp contracts about 2 per cent., and the 32's warp (which is placed on a separate beam) from 20 to 25 per cent., while the shrinkage in width varies from 10 to 15 per cent.

The 18's warp and the 40's weft form the plain ground fabric, and the 32's warp and the 8's weft the plain figuring fabric, on the right side of the cloth, and *vice versa* on the reverse side. The 32's warp of the plain figuring fabric is really a binding warp which interweaves regularly with the 40's weft of the plain ground fabric, and thus binds the two fabrics solidly together. The cloths are mostly woven grey and then bleached, but sometimes the ends which form the ground (the 18's) are all coloured or are arranged in stripes of white and colour; a white figure then being formed upon a coloured or a striped foundation.

Method of Loom Mounting.—As in weaving Marseilles quilts a combination

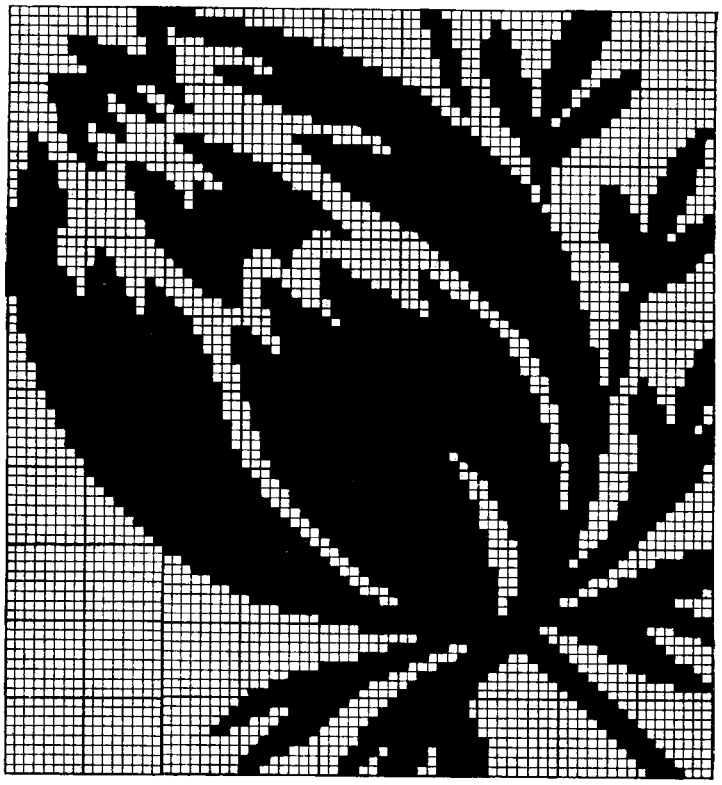

Fig. 233.

of two working comber-boards and two healds is employed. The diagram given in Fig. 190 (p. 168) shows the arrangement, and A in Fig. 234 illustrates the principle of the harness tie, while B shows the system of drafting. Two-thirds of the warp threads (the 18's) are drawn upon the harness, and one-third (the 32's) upon the healds, as shown at B. Two harness cords, however, are connected to each hook (as shown also at A in Fig. 231), one cord passing through the front comber-board, and the other through the back board, as shown at A, so that including a heald thread, each hook is equivalent to a group of three threads. By raising a hook, two harness threads—one on each side of a heald thread—are lifted together,

but by raising the comber-boards separately, the two harness threads, by means of the harness knots resting upon the boards, are operated independently of each other.

Method of Designing and Structure of the Cloth.—Taking the order of wefting as 2 picks fine (40's) and 2 picks coarse (8's) the order of shedding is as follows :— The comber-boards lift in alternate order on the two fine picks, and form the plain weave represented by the dots in the plans C and D in Fig. 234. The healds lift in 2-and-2 order alternately and produce the weave shown by the crosses in C and D. The jacquard is raised on the first coarse pick and remains up on the second coarse pick and lifts the harness threads in pairs (one on each side of a heald thread), according to the form of design that is required, so that the weave C is formed in one portion and D in another portion of the cloth. The figure is formed

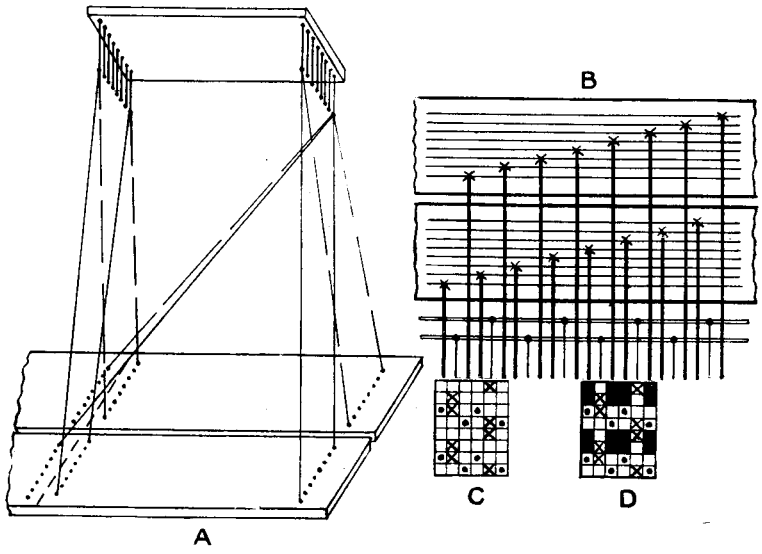

Fig. 234.

chiefly by the floats of the thick weft, and in weaving the cloth right side up the marks in the design given in Fig. 233 indicate harness ends down, or weft. Taking the marks in C and D in Fig. 234 also to indicate weft, the former shows the ground weave and the latter the figure weave on the right side of the cloth ; but in weaving the cloth wrong side up the marks represent warp, and C forms the figure weave and D the ground weave. The blanks, or the marks of the design Fig. 233, are cut according to whether the cloth is woven right or wrong side up. It will be seen in C and D that the healds are raised alternately on the thick picks (the third and fourth in each group), in order to form the plain weave of the figuring fabric. The regular binding of the two cloths together is effected by the alternate lifting of the healds on the fine picks (instead of both being raised, or both left down, which would be necessary in order to form two separate fabrics). On the third and fourth picks the jacquard is raised while the same card presses; then the jacquard is lowered between the fourth pick and the first pick of the

next group of four, and the card cylinder is turned in readiness for the following pair of thick picks.

Variations cannot be produced in a design by altering the structure of the cloth, but a subsidiary effect can be woven by painting upon alternate horizontal spaces only, as shown on the left of the small plan given at E in Fig. 235, or the marks of the design may be arranged so as to form a special effect, as indicated on the right of E. The complete weave, to correspond with the picks 1 to 10 of E, is given at F in Fig. 235. Taking the marks to indicate weft, the drawing G shows how the picks 1 and 4 of F interlace with the ends 1 to 24, while H represents the interlacing of the last three ends of F with the picks 1 to 16. In G and H the thick

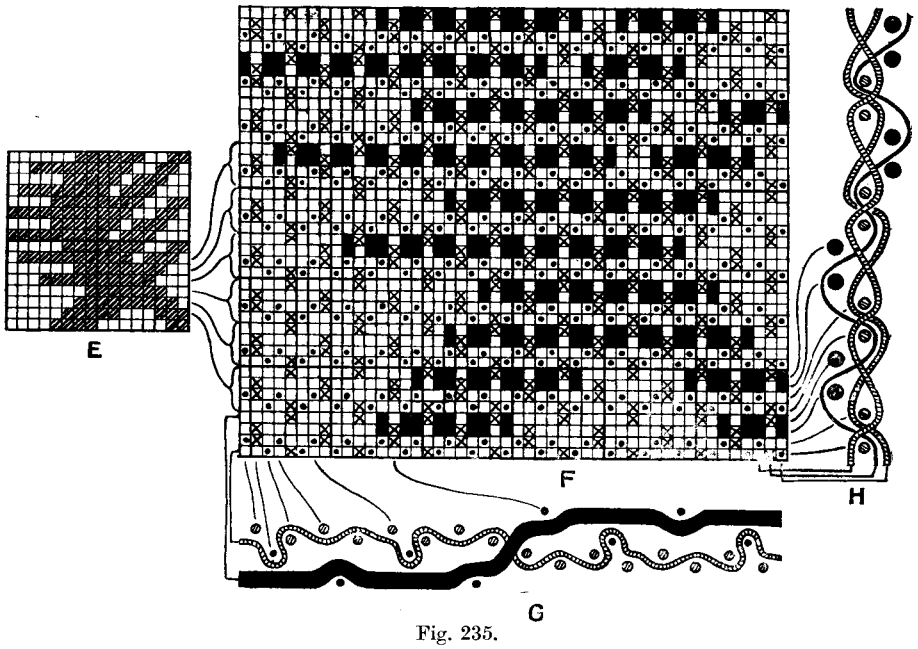

Fig. 235.

picks and fine ends, which form the figuring cloth, are shown in solid black, in order that they may be distinguished, and connecting lines are indicated to enable the threads to be compared.

The counts of design paper for a cloth counting 72 ends and 96 picks per inch is in the proportion of $(72 \div 3)$ to $(96 \div 4) = 8 \times 8$, or 12×12. On account of each horizontal space representing two thick picks, the figure in coarse cloths has a steppy outline, and in order to avoid this, sometimes a separate card is employed for each thick pick, the operation of the jacquard and the card cylinder being modified to correspond.

Other Varieties of Quilts.—Other forms of quilts are in regular use, such as honeycomb, Alhambra, and rib or rep quilts. Honeycomb quilts are single cloths composed of very thick yarns in which ordinary and Brighton honeycomb and similar weaves are employed, and very frequently these weaves are used in conjunction with warp and weft figure effects. The Alhambra quilt structure is an extra warp figured cloth, and a representation of a fabric is given in Fig. 148

(p. 134), while Fig. 147 illustrates a heald and harness mount that is employed. In a rib or rep quilt the threads are arranged the same as in an Alhambra quilt, and one form of the structure is woven in an Alhambra quilt loom. In this type all the figuring ends are raised on one pick, and all the ground ends (by lifting the healds together) on the next pick. Also, on the picks on which the ground ends are lifted, the harness ends are raised where the figure is formed, the lifting of both series of ends causing long weft floats to be produced under the figure. In another form of rib quilt a warp figure is produced on both sides of the cloth on a plain rib ground. The inverted hook type of jacquard, illustrated in Fig. 186 (p. 161) is used, and the cloth is similar in structure to the example given in Fig. 187 (p. 162), but on account of the thick weft and small number of picks per inch that are employed in the structure, it is customary to use a separate card for each pick. In addition, a cloth is largely used for bed mats that consists of a plain foundation which is figured with coloured extra weft, the surface being almost entirely covered by the figuring floats.

CHAPTER XII

GAUZE AND LENO FABRICS

Structure of the Cloths. *Gauze Mounting*—The Doup—Bottom and Top Douping—Gauze and Leno Drafting—Relative Position of Healds—The Easer or Slackener—Sheds formed in Doup Weaving—Construction of Lifting Plans—The Shaker Motion—Gauze and Leno Compared—Modifications of Pure Gauze and Leno. *Combinations of Gauze and other Weaves*—Stripe Patterns—Cellular Tennis Shirtings—Russian Cords—Simple Cross-over and Check Gauze Effects. *Simple "Net" Lenos*—Comparison of Top and Bottom Doup Pegging Plans—Denting Net Lenos—Designing Net Lenos and Features to Note—Production of Pattern by Varying the Lifts of the Standard Ends—Bead Mounting for Net Lenos. *Combinations of Gauze and Leno with Extra Warp and Extra Weft Effects. Two or More Doup Patterns. Patterns produced by one Doup and two or more Back Crossing Healds*—Comparison with Two-Doup Style—Construction of Heald-Knitting Plans for Gauze Stripes—Fancy One-Doup Net Leno—Distorted Weft Styles—Gauze and Figure Weave Combinations.

Structure of the Cloths.—In gauze and leno weaving certain ends—termed crossing ends—are passed from side to side of what are termed standard ends, and are bound in by the weft in these positions. The crossing and standard ends may be arranged with each other in various proportions, as 1-and-1, 1-and-2, 1-and-3, 2-and-2, 2-and-3, etc., but an essential condition is that each group of crossing and standard ends must be placed in one split of the reed. A crossed system of interlacing can be obtained when all the warp is brought from one beam, and in some cases this is essential in order to produce the desired effect. Very frequently, however, there is such a difference in the take up that it is necessary for the two series of ends to be brought from separate beams. The warp may consist entirely of crossing and standard ends, or stripes of these may be combined with stripes in which the ends interlace in the ordinary manner so as to form plain, twill, figure, etc. It is also possible for the crossing and standard ends to form the crossed interlacing alternately with straight interlacing in any required order. There is, therefore,

almost unlimited scope for the production of variety of effect in striped, checked, and figured fabrics by combining gauze or leno with practically any other system of interweaving. Where the crossed interlacing occurs, an open, perforated structure may be formed, or the crossing ends may be interwoven in zig-zag form on the surface of a more or less compact ground texture. Nearly all kinds of yarns and yarn combinations can be used, but in open perforated structures particularly the threads should be as smooth, as uniform in thickness, and with as little loose fibre on the surface as possible. Silk threads, being the smoothest, are the best, but cotton is very suitable, especially when mercerised, and also linen, as these yarns possess little loose fibre ; while worsted yarns, when made from a good quality of wool and hard twisted and gassed, yield clear effects. Colour may be introduced to form stripes and checks, and various fancy yarns, such as printed, knopped, spiral, gimp, slub, etc., may be inserted at intervals either as crossing, standard, or ground ends, or in the weft, in order to give a special effect. The crossing ends require to be of good quality; and very light gauze fabrics are sometimes given the requisite firmness by using stiff linen or polished cotton yarn as weft.

GAUZE MOUNTING

The necessary additions to an ordinary shedding arrangement consist of a half-heald—termed a doup or slip—which is connected with an ordinary heald or harness, and an easing or slackening motion, while in some cases a shaker motion is required.

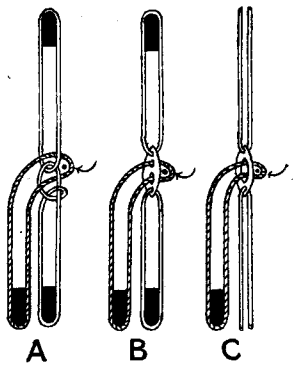

Fig. 236.

The Doup.—In Fig. 236 the different types of doups which are in most general use are represented, A and B showing two methods of connecting the half-heald to an ordinary heald, while C shows how it is connected to a jacquard harness. The crossing ends pass through the loops of the half-heald where indicated by the dots, and in the direction shown by the arrows ; and it will be noted that while in A and B the half-heald is permanently connected to the ordinary heald, in C the loop is held in position by the warp thread. The first method is more convenient in drawing in the warp and in repairing broken ends. The advantage of the latter method is that the doup, which wears out much more rapidly than the harness, can be readily replaced ; but, on the other hand, if the crossing ends are absent, the loops will slip out of the mail eyes. During weaving, however, this is not very detrimental, as when the loose slip is used it is customary to have two crossing ends passing through each loop, both of which must be broken before the loop can detach itself from the harness. In Fig. 236 the half-heald is shown with a lath only at the bottom, but frequently a lath is also provided at the top, which is connected near each end to the bottom lath by means of cords, the arrangement, however, being simply in order to facilitate connections being made to the shedding apparatus.

Bottom and Top Douping.—The half-heald may be placed with the lath below the warp, as shown in Fig. 236, and in the diagrams in Fig. 237, or above, the

position in the latter case being represented by Fig. 236 when turned the other way up, and by the diagrams in Fig. 237A. Bottom douping is more commonly employed, as it is simpler to follow, is more conveniently applied in the loom, and the lift is not so heavy. This method, however, makes it necessary for certain styles to be woven wrong side up. In top douping the parts are better under the observation of the operative, and the repairs to the half-heald are more readily effected; but if a loop breaks, as it hangs down, it is liable to become entangled with the warp and cause breakage, while the tension on the crossing ends, when a spring-reversing motion is used, makes it difficult in some cases to get a level bottom shed line. In practice the use of the top doup is generally limited to styles which require to be woven right side up, and can only be thus produced with the top doup. For some patterns which require two doups it is found advantageous to use both methods together.

In bottom douping the half-heald is invariably placed in front of the ordinary heald to which it is connected, as shown in Fig. 237; but in top douping it is sometimes placed in front and sometimes behind, the latter position being shown in the diagrams in Fig. 237A. The choice of the position in top douping is largely a matter of opinion, the advantage claimed for placing the half-heald behind being that the relative position of the parts is then the same as in bottom douping with the half-heald in front.

Gauze and Leno Drafting.—For the simplest style of doup weaving the following healds are necessary:—A half-heald or doup, lettered D in Figs. 237 and 237A; a front-crossing heald F, to which the doup is attached; a back-crossing heald B, through which the crossing ends are drawn; and a standard heald S, which carries the standard ends. (In practice the terms very largely used for the healds are respectively—Doup, front standard heald, back standard heald, and standard heald, or sometimes ordinary heald. It is considered that the former designation is less liable to lead to confusion, the term standard being used only for the healds which carry the standard ends, crossing for the front and back healds which operate the crossing ends, while ordinary will be applied to healds which are not used for the douped effect, but to produce some other weave.) G in Fig. 237 shows a bottom doup draft in which one end crosses one end. In drawing in the warp the ends are drawn through the back crossing heald B and the standard heald S in the ordinary manner. Then the front crossing heald F and doup D are placed in front, the standard ends are drawn between the leashes of F, while each crossing end is passed under the standard end and drawn through a loop of the doup D. In top-douping the crossing ends are passed over the standard ends, as shown at K in Fig. 237A. The crossing ends may cross the standard ends either from the left or from the right. No ends are drawn through the mails of the front crossing shaft, the purpose of this heald being simply to support the half-heald.

Relative Position of the Healds.—In mounting the healds in the loom, in order to reduce the acuteness of the angle formed by the crossing warp when the crossed shed is made (shown at H and L in Fig. 237 and 237A) it is customary to allow a greater amount of space between the front and back crossing healds than between the other healds. In the drafts G and K in Figs. 237 and 237A the back crossing heald is shown next behind the front crossing heald. The position is a matter of opinion, and by some it is preferred to have the back crossing heald behind all or a portion of the other healds, as the further back it is placed the less acute is the angle formed

by the crossing ends when the crossed shed is made, and there is, therefore, less strain on the crossing warp. However, so long as sufficient space can be obtained between the back and front crossing healds, the former may with advantage be placed next behind the latter, as then there is no liability of friction and entanglement of the crossing ends with the leashes of the other healds. When the design necessitates the use of all the shedding levers of a dobby, and the space between the healds is thus limited, it is better for the back crossing heald to be placed behind a few of the ordinary healds, or otherwise the angle formed by the crossing ends will be too acute (see further reference, p. 243).

The Easer or Slackener.—This consists of a bell crank lever A fulcrumed at C, one extremity of which supports a cylindrical bar E, Figs. 237 and 237A, which extends across the width of the warp, while the other end is connected to the shedding apparatus. After the healds have been mounted in the loom the easing bar is placed with the crossing ends passing in contact with its surface (over or under according to the position of the crossing warp beam), and usually in a position further back than the back rest. The crossing ends thus have a longer stretch than the other ends, and when the lever A is operated the bar E moves inward and gives in a sufficient length of the crossing ends to compensate for the greater length required when they form the shed in the crossed position. The lever is returned to its normal position by means of a spiral spring, and as in many cases the tension on the crossing warp makes it necessary for a very strong spring to be used, it is advisable for the easer to be arranged to give off the required length of warp with as little movement as possible. As many easers are required as there are doups employed, and several warp beams may be necessary, a proportion of which may be placed lower and the remainder higher than the back rest; but the crossing ends, after leaving the easing bars, should be passed in contact with rods which will guide them all to the lease rods in line with the other warp threads.

Sheds Formed in Doup Weaving.—These are illustrated for bottom douping at H, I, and J in Fig. 237, and for top douping at L, M, and N in Fig. 237A. The formation of the *crossed* shed, which is the chief feature in doup weaving, is shown at H and L in the two figures. When this shed is formed the crossing ends are moved out of their normal position to the opposite side of the standard ends. In bottom douping the doup D and the front crossing heald F are raised, and the back crossing heald B and the standard S are left down, as shown at H; while in top douping the position of the healds is exactly the reverse, as shown at L. The crossing ends, being held by the back crossing heald in one line of the shed, and by the doup and front crossing heald in the other line, pass almost at right angles from one to the other; hence a greater length of crossing warp is required from the fell of the cloth to, say, the lease rods than when these ends are in the normal position. The easer A is, therefore, operated at the same time as the front crossing heald, and the easing bar E is moved in from the position represented by the dotted circle; the additional length of crossing warp required thus being given in.

The formation of the *open* shed, in which the crossing ends are operated in their normal position, is illustrated at I and M in Figs. 237 and 237A. In bottom douping the doup D and the back crossing heald B are raised, and the front crossing heald F and the standard S are left down; the loops of the doup being drawn under the standard ends and lifted with the crossing ends when the latter rise on the normal side of the standard ends, as shown at I. In top douping

exactly the opposite conditions prevail, as shown at M. When this shed is formed the lever A is depressed and the easing bar E is moved outward, the stretch of the crossing warp thus being increased to the normal.

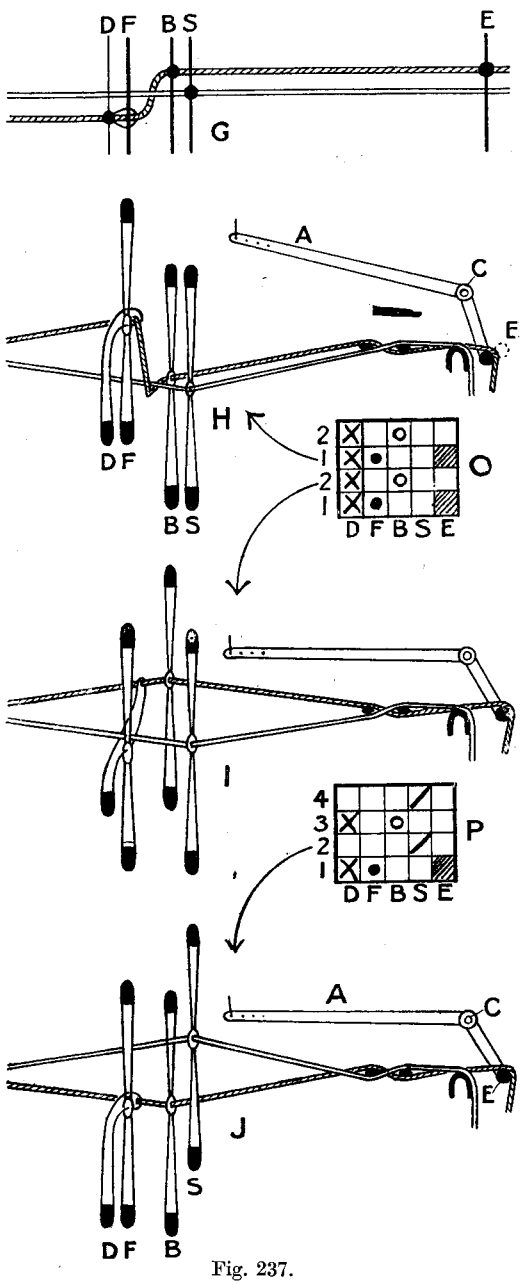

Fig. 237.

J and N in Figs. 237 and 237A show the formation of an ordinary shed in which the standard heald only is raised in bottom douping, while only that heald is depressed in top douping. The easing bar E is again in its outward position.

The correct setting of the doup is of the greatest importance as regards the prevention of broken ends and undue wear of the loops. Its height should be carefully regulated, and it should move exactly in accordance with the movements of the front and back crossing healds. Thus, in bottom douping, if it is not raised sufficiently the loops will drag on the crossing ends, or on the leashes of the front crossing heald. On the other hand, if it is raised too high the loops will slide through the eyes of the front crossing heald when the cross shed is formed, while they will hang slack and be liable to become entangled on the open shed. Also, in order to facilitate the crossing movement, the standard heald should be set slightly higher in bottom douping and rather lower in top douping than the healds which operate the crossing ends.

Construction of Lifting Plans.—O and Q in Figs. 237 and 237A show the lifting plans for bottom and top douping respectively when the crossed and open sheds are formed alternately, the picks numbered 1 in the respective plans corresponding with the drawings shown at H and L, and those numbered 2 with I and M. The plans P and R similarly show the order of lifting

when an ordinary shed is formed between the crossed and open sheds, the picks numbered 1 respectively corresponding with H and L, 3 with I and M, and 2 and 4 with J and N. The crosses represent the lifts of the doup, the dots of the front crossing heald, the circles of the back crossing heald, and the diagonal strokes of the standard, while the shaded squares show when the easer is operated. It will be noted that four spaces, D, F, B, and E, are provided for showing the operation of the crossing ends. The easer is always moved when the front crossing heald is brought into action, while the doup is operated with both the front and the back crossing healds. In practice, therefore, the lifts of the easer and the doup are frequently omitted from the lifting plan, as the other marks of the plan readily indicate when these should be operated. Also, in order that there will be absolute certainty of the movements being in unison, in bottom douping especially, the easer is sometimes connected to the shedding lever that controls the front crossing heald; while the lath of the half-heald is connected to the back crossing heald lever, and also by cords to the lath of the front crossing heald on the opposite side of the shed.

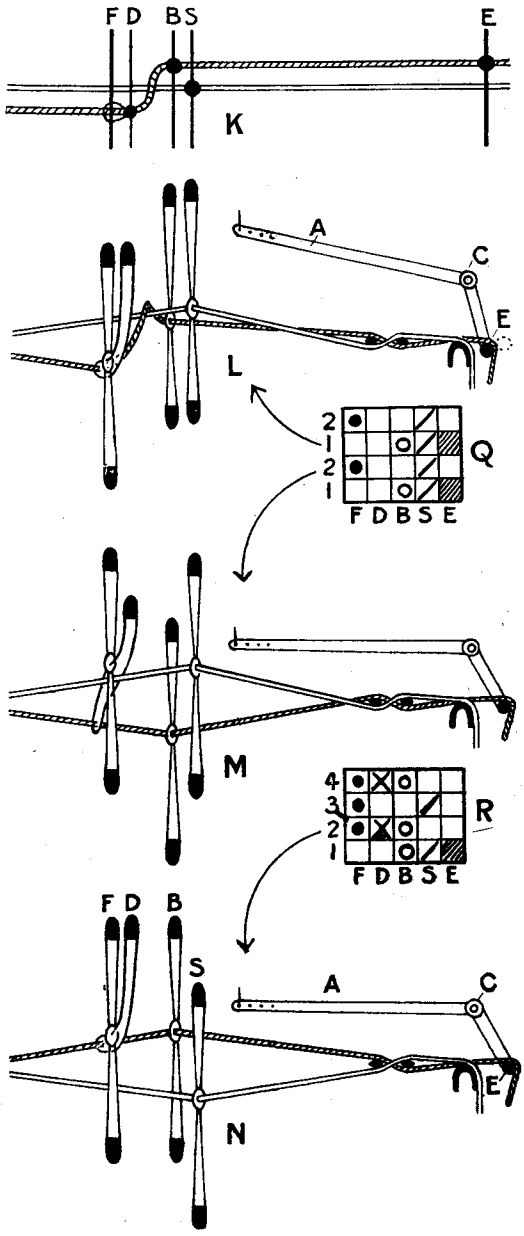

Fig. 237A.

The Shaker Motion. — This mechanism is required under certain conditions in both bottom and top douping. From an examination of the crossed and open sheds, shown respectively at H and I in Fig. 237, it will be seen that the front and back crossing healds change positions in forming the sheds, but the standaid is at the bottom and the

doup at the top in both cases. In an open or a semi-open shedding motion, in changing from one shed to the other, the front and back crossing healds move simultaneously, and the mail eyes thus pass each other in the centre. At this time the crossing ends, and with them the loops of the doup, have to slip under the standard ends from one side to the other. In the first place, therefore, it is clear that the doup should be lowered to the centre along with the heald that is being depressed, and then be taken back to the top along with the heald that is being raised. This movement of the doup can be readily arranged for, even when it is operated separately in a double-lift open-shed dobby, by connecting it to two jacks, and arranging the pegging to allow one to fall and the other to lift. The next point to consider is the position of the standard ends which, so far as regards the interlacing of the threads, do not require to be raised at all. Assuming that the standard heald is stationary at the bottom—at about the centre of the movement in an open or a semi-open shed, the parts will occupy the position represented at T in Fig. 238, where the front and back crossing healds are shown nearly level. It is evident that the crossing ends, and with them the loops of the doup, in changing from one side to the other of the standard ends, will drag against the latter, and excessive strain will be put upon the warp. In addition, if the easer is operated from the ordinary shedding arrangement, the easing bar will be about midway between its two extreme positions, as shown in the diagram T; and when the crossing takes place the length of the crossing warp will be insufficient to reach under the standard ends. The formation of a shed, under the conditions shown at T, is clearly impossible. If, however, the standard heald is raised half-way, or a little higher, at the time that the front and back crossing healds are passing each other in the centre, there will be no obstacle to the crossing ends and the loops passing from one side to the other of the standard ends, as is represented at U in Fig. 238.

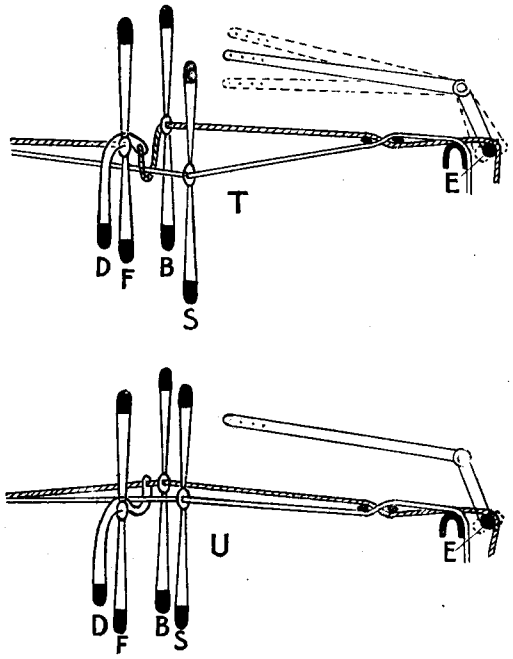

Fig. 238.

It is for the purpose of raising the standard ends to the centre of the shed and of returning them to the bottom when the crossing has been effected that a shaker motion is employed. The additional mechanism is only required when, in an open or a semi-open shedding motion, the crossed and open sheds, or *vice versa*, are formed on successive picks, on both of which the standard ends are down. This, of course, is in reference to bottom douping, but the same applies in open shedding to

top douping, except that the standard ends require to be moved from the top to the centre and back again by the shaker. The shaker motion may be dispensed with (1) when one or more picks separate the crossed and open sheds, because then the doup and the front and back crossing healds are level before the crossing commences; (2) when the crossed and open sheds succeed each other so long as the healds, which govern the crossing and standard ends, are all level between the picks. The latter condition may be due either to the type of shedding motion employed or to the order in which the standard ends interlace. Thus no shaker is necessary—(*a*) in closed shedding, as all the healds are level between the picks; (*b*) in top douping in double-lift semi-open shedding, as the shafts required up on successive picks are lowered to the centre between the picks; (*c*) in double-lift open and semi-open shedding, when in each group there are two or more standard ends which work plain, as in this case the two standard healds are in the centre at the same time as the front and back crossing healds. Sometimes, however, and particularly when the standard ends are somewhat crowded, shaking, in a modified form, is employed when not absolutely necessary; but the idea here is not so much to move the standard ends half the height of the shed as to shake them sufficiently to enable the crossing from one side to the other to be more readily effected.

The half-lift of the standard ends is obtained in various ways, but usually a motion is more readily applied to bottom than to top douping. It is necessary to keep in mind that the standard ends, in addition to being moved by the shaker, may require to be operated by the ordinary shedding mechanism. As a general rule, in order to simplify the mechanism, the shaking is effected on every pick, whether required or not, and the standard ends may thus receive an undue amount of vibration. In tappet weaving the half-lift is obtained from a specially shaped double-winged tappet, and in dobby weaving the loom is sometimes fitted with a shaker tappet and the necessary connections. In another method the shaking movement is obtained by means of suitable connections from the crank arm of the loom; whilst most makers now provide special attachments to double-lift dobbies for the purpose. In top douping in a double-lift open shed dobby, a simple arrangement consists of connecting the standard heald to two contiguous jacks, both of which are pegged to lift when the standard is required to remain at the top, while when the half-movement is necessary, one is pegged to fall and the other to rise, the shaking thus being done only when required.

Gauze and Leno Compared.—The terms gauze and leno are frequently used synonymously to designate any fabric in which the doup principle of weaving is employed. Sometimes, however, the term gauze is applied to fabrics in which the crossed interweaving produces a light perforated fabric, while leno is used to distinguish heavier styles in which the crossing ends form a distinct zig-zag effect on the surface of the cloth. Again, the term gauze is sometimes applied to those fabrics in which the crossing ends pass from one side to the other of the standard ends on succeeding picks, in contradistinction to which the term leno is used for styles in which one or more picks are inserted between the successive movements of the crossing ends. The last system of classification is useful, since it very largely serves to distinguish doup fabrics which, when produced on the double lift shedding principle, require a shaker motion, from those for which such a mechanism is unnecessary.

A typical open or perforated gauze structure, in which one crossing end passes from side to side of one standard end on succeeding picks, is illustrated in Fig. 239. A corresponding flat view is given at H in Fig. 240, and the interweaving of the threads is represented in section at K; while G shows the draft for a bottom doup, and O the lifting plan. The crossing ends, represented in solid black, are raised over the weft on every pick—on the right of the standard ends on the odd picks by the lifting of the front crossing heald and doup, and on the left on the even picks by the lifting of the back crossing heald and doup. The standard ends are under the weft on every pick, but they lie above the crossing ends between the picks. In top douping, the positon of the threads is exactly the reverse, and the crossing ends would then be represented by the shaded lines, and the standard ends by the solid lines in H.

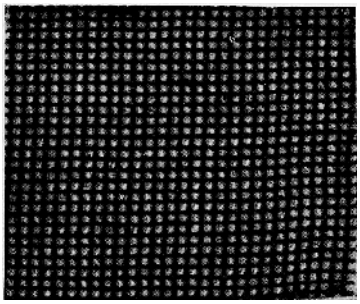

Fig. 239.

If both the crossing and standard ends are brought from one beam, the ends will bend equally, as shown at H in Fig. 240; but if the two series of ends are brought from separate beams, the standard ends may be arranged to lie straight in the cloth while the crossing ends do all the bending, as shown at I in Fig. 240. Although H and I are exactly alike as regards the interlacing of the threads, the woven structures appear quite different, and, in addition, more picks per inch can be inserted in the latter method than in the former.

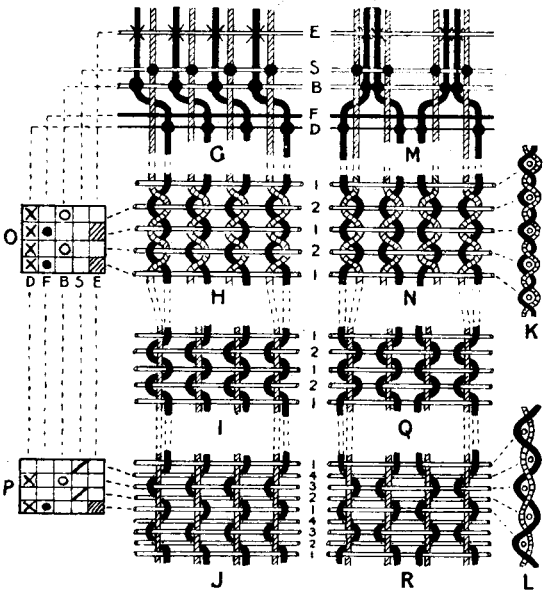

Fig. 240.

The flat view given at J and the section at L in Fig. 240 illustrate a typical leno style for which G is the draft and P the lifting plan. The crossing ends are lifted on the odd picks only — first on the right and then on the left of the standard ends—while the latter work plain, and are under the odd and over the even picks. This structure is much more readily wefted than is the case in either H or I.

By comparing the diagrams on the left of Fig. 240 with those shown in Fig. 237, it will be seen that the draft G and the lifting plans O and P in the two figures respectively coincide. The structure shown at H in Fig. 240 is produced by the alternate formation of the crossed and open sheds represented at H and I in Fig.

237, and in an open-shed machine the standard ends require to be lifted by a shaker between the picks. In producing the structure shown at J in Fig. 240, an ordinary shed, such as is indicated at J in Fig. 237, is formed between the crossed and open sheds, and a shaker motion is unnecessary in this case.

Modifications of Pure Gauze and Leno.—A simple modification of the pure gauze and leno structures is obtained by pointed drafting, in which the crossing ends are drawn under (or over) the standard ends alternately to left and to right, as shown at M in Fig. 240. With the lifting plan O the structure represented at N may be formed by bringing all the warp from one beam. The crossed and open sheds are formed alternately, and the ends interlace as shown at K, but each pair of ends is turned the opposite way to the adjacent pairs. The pattern may be made more effective by using a special yarn for the crossing warp and bringing it from a separate beam, thus forming the structure represented at Q. With the draft M and the lifting plan P in Fig. 240 the structure illustrated at R results, the pairs of ends interweaving as shown at L, but turned in opposite directions. The fabric represented in Fig. 241 corresponds with the structure shown at R.

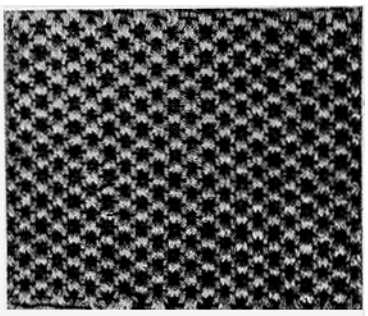

Fig. 241.

Variety of effect is chiefly obtained in the pure gauze and leno weaves by combining threads in both warp and weft, which are different in thickness, colour, or material, and, by varying the denting of the warp threads; very interesting stripe, cross-over, and check patterns being produced.

COMBINATIONS OF GAUZE AND OTHER WEAVES

Stripe Patterns.—The next system of ornamentation consists of combining gauze or leno—one crossing one—with plain or other weave in stripe form. In these styles the gauze portion is frequently made two or more picks in a shed in order that sufficient picks may be inserted to obtain a good structure in the ordinary weave. Also, in order to secure the necessary openness in the doup section and density in the ordinary weave, the latter may be made two or more times finer in the reed than the former. A stripe consisting of gauze (in which one end crosses one end with two picks in a shed) and plain cloth is shown in Fig. 242. A flat view of a portion of the structure is given at A in Fig. 243, while B shows the system of drafting, four healds being allowed for the plain stripe. In the lifting plan given at C the lifts of the easer are not indicated, but the doup is shown raised,

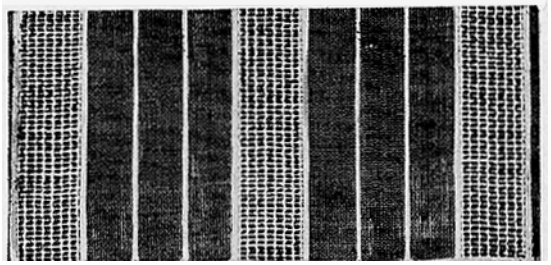

Fig. 242.

and the standard heald depressed on every pick, while the front and back crossing healds are lifted on two consecutive picks alternately. The order of denting is indicated below B, the ends being placed two per split, but in the gauze stripe a split is missed between the pairs of ends. In order to obtain a clear edge to the plain stripe, however, no split is missed between the gauze and the plain.

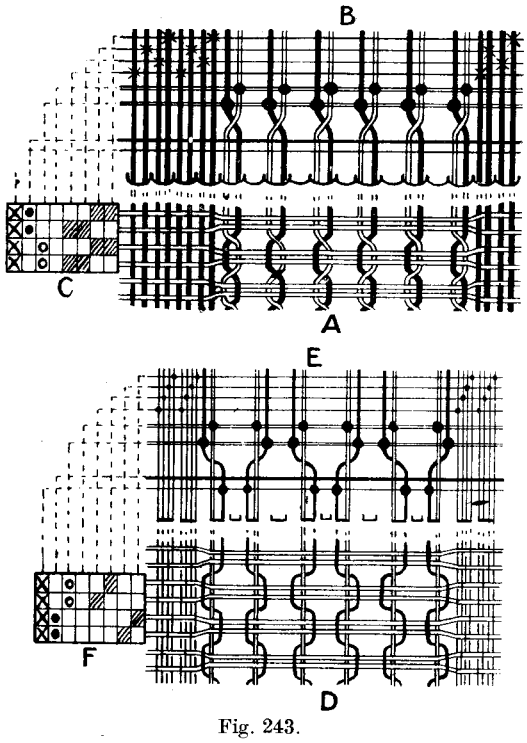

Fig. 243.

Cellular Tennis Shirting.—This class of fabric is largely ornamented on the foregoing principle, and an illustration is given in Fig. 244 in which the typical cellular structure is combined with a 3-and-1 warp twill stripe. A sectional drawing, corresponding with the pattern, is given at D in Fig. 243, which shows how the threads interweave as viewed from the wrong side of the cloth. To weave the cloth right side up, a top doup is necessary; but as this causes the lift to be very heavy, it is convenient to use a bottom doup and weave the cloth wrong side up. The draft for the bottom doup is shown at E in Fig. 243 with the order of denting indicated below—the twill stripe being dented 4 ends per split, and the gauze stripe 2 ends per split, with a split missed between the pairs of ends—while F shows the lifting plan. The following are suitable particulars for the cellular structure :—2/20's cotton warp, 30 ends per inch; 18's cotton weft, 40 picks per inch. As the standard ends lie almost straight in the cloth only about 104 yards of standard warp, compared with about 150 yards of crossing warp, are required for 100 yards of cloth. The shrinkage in width is about 10 per cent.

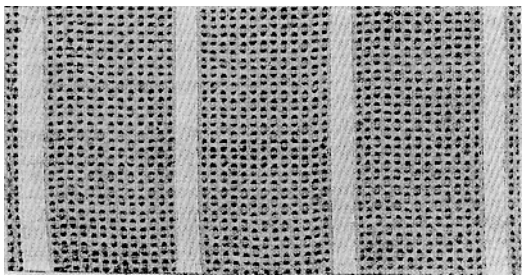
Fig. 244.

Russian Cords. — Fig. 245 shows a gauze and plain stripe—termed a Russian cord—in which the idea is not to produce an open structure by means of the doup, but to form solid vertical lines which are in strong colour contrast with the ground. A crossing

end is passed on succeeding picks from side to side of a thick standard end, which is similar in colour to the crossing end; or there may be several of such standard ends working together as one, as represented on the right of Fig. 245, which shows the standard ends with the crossing end removed. The flat view given at G in Fig. 246, which corresponds with the pattern, illustrates the principle of construction, the effect being represented, for convenience, as viewed from the right side of the cloth. To weave the fabric right side up a top doup is required, and the draft with the doup in front of the front crossing heald is then as shown at H in Fig. 246, and the lifting plan as at I; and it will be noted that the order of lifting for the gauze effect is the same as is illustrated at Q in Fig. 237A in reference to the formation of pure gauze in top douping. A comparatively large number of picks per inch are inserted, and as the standard ends are bulky, bold horizontal traverses of the crossing ends are made at frequent intervals. Heavy cord lines are thus produced which, on account of the contrast in colour with the ground warp and weft, appear to be formed in extra weft. The crossing warp requires to be very much longer than the standard warp, and in the example is about four times as long, but the proportionate lengths vary according to the reed and picks of the cloth, and the bulkiness of the standard ends. Variety of effect is sometimes given to these styles by having the standard ends different in colour from the crossing ends, and ceasing to form either the crossed or the open sheds for a number of times in succession. The thick standard ends are thus left uncovered by the crossing ends for a space, the latter lying straight in the cloth and being practically concealed by the former, hence the continuity of the coloured line is broken by spots of another colour.

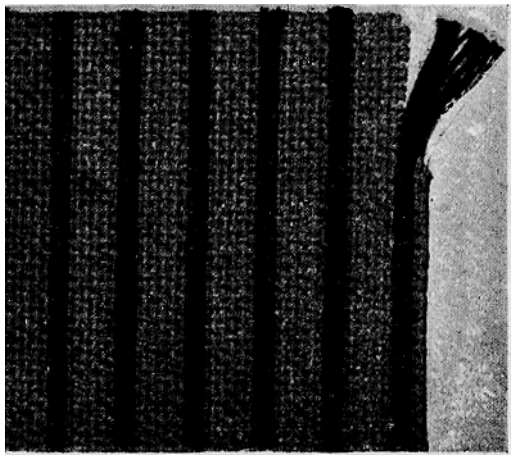

Fig. 245.

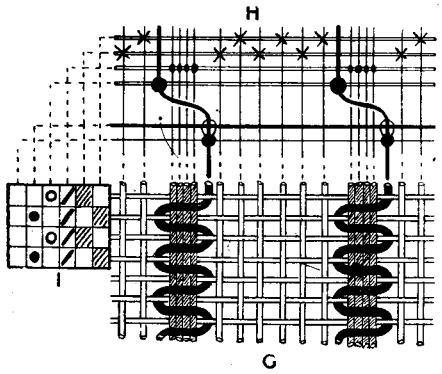

Fig. 246.

Simple Cross-over and Check Gauze Effects.—The next development, on the draft-one crossing one, is the combination of gauze and plain weave to form cross-over effects, as shown in the pattern in the upper portion of Fig. 247; or, by suitably arranging the denting, to form check effects, such as is illustrated by the pattern in the lower portion of the figure. A flat view, to correspond with the upper pattern,

is given at A in Fig. 248, in which the picks are shown in groups of five, the weft threads being readily inserted towards each other where the weave is plain, but clearly separated where the crossing is made. The draft is given at B, and the lifting plan at C in Fig. 248, and it will be seen that the plain weave is formed by the standard heald lifting alternately with the doup and back crossing heald on the picks 1—5, and with the doup and front crossing heald on the picks 6—10. Plain weave may thus be formed in two ways on the draft B, and it will be shown that the second method is the foundation upon which many elaborate figured gauze styles are produced with one doup.

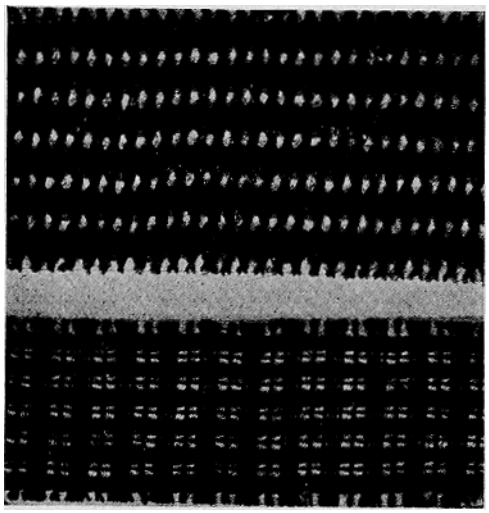

Fig. 247.

In the pattern shown in the upper portion of Fig. 247 two ends are placed regularly in each split of the reed, but in the lower pattern the order of denting is arranged 8 ends in 4 splits, 2 splits missed, 2 ends in 1 split, and 2 splits missed. The ends are thus separated as shown in the corresponding flat view given at D in Fig. 248, for which E is the draft, and F the lifting plan. Plain weave is formed for five picks by the doup and back crossing heald lifting alternately with the standard heald, then the doup and front crossing heald are lifted, forming a crossed shed for one pick which is clearly separated from the five plain picks. An open effect is thus formed horizontally which corresponds with that formed vertically by the missed dents, and a check pattern results. The number of ends and picks in each group may be varied as desired, but if the crossing is required to be clear and precise, each group of plain picks should consist of an odd number, and the standard ends should be down on the picks which precede and succeed the crossing. The styles shown in Fig. 247 may be effectively ornamented by using different colours or thicknesses of warp and weft yarn, and they may also be readily combined in stripe form with other weaves.

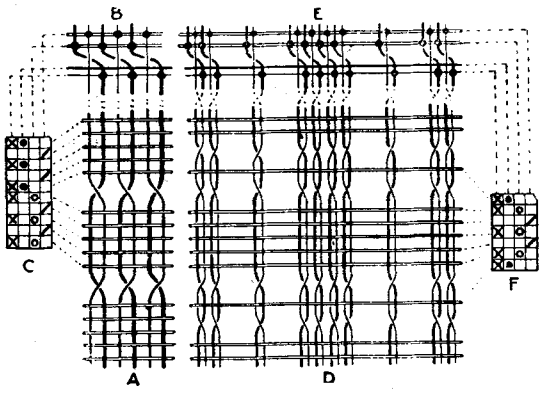

Fig. 248.

A flat view of a gauze and plain weave combination is given at G in Fig. 249,

which may either be used by itself or be arranged in stripe form with another weave. In this case there are two crossing ends and three standard ends in each group, the former being drawn alternately on two back crossing healds, and drafted alternately to left and to right of the standard ends, which are also drawn on two healds, as shown at H. The lifting plan is given at I, and it will be seen that the standard ends work in perfectly plain order throughout, but the crossing ends only work plain when they are operated on the open shed side of the standard ends. When the crossed shed is formed the two crossing ends in each group work alike, since there is only one doup. As there is always either the front or one of the back crossing healds raised the doup requires to be lifted on every pick; but on account of the standard healds working plain a shaker motion is unnecessary for them in open shedding. The style may be modified in various ways; and excellent results are obtained, as the alternate grouping and spreading of the threads enables a comparatively compact texture to be combined with considerable openness. The example is illustrative of the necessity of care being taken in deciding upon which lifts to select as the crossed sheds. Thus, if the two picks which go together had been taken as the open sheds, the plain interweaving of the crossing ends would have been formed on the crossed sheds; hence two front crossing healds and doups and one back crossing heald would have been necessary, with the ends drafted in the opposite direction.

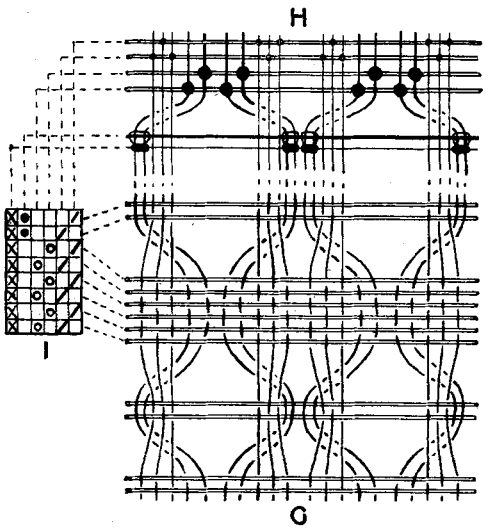

Fig. 249.

SIMPLE "NET" LENOS

The term "net" or "spider" leno is commonly applied to doup styles in which the crossing ends are mostly floated on the surface of the cloth, and are interlaced so as to form waved lines. The effect formed by the crossing ends is usually a chief feature of the pattern, and these ends, therefore, require to be of special material, colour, or thickness, so that they will show in clear contrast with the ground. Each group of standard ends generally forms a somewhat compact ground structure across which the doup ends are traversed, the latter ends being really introduced on the extra warp principle. An agreeable open appearance is, however, frequently given to a fabric by suitably missing splits between the groups of ends (see Fig. 273).

Fig. 250 illustrates a style in which the crossing ends are all drafted in the same direction across four standard ends. A portion of the structure, showing how the threads interlace, is represented at A in Fig. 251, while the draft is given at B, and the lifting plan at C. The standard ends, as is very frequently the case in these styles, work two ends together in plain order throughout, in order that

they will spread out as much as possible ; and they are also kept as straight as possible in the cloth, so that the maximum amount of traverse will be given to the crossing ends. Fig. 251 illustrates the production of the effect wrong side up with a bottom doup, the crossing ends being lifted on one pick in every five. The order of lifting fits with the plain interweaving of the standard ends ; thus, where a crossing end is raised, the double standard end next to it is left down, and the former is held by the weft against the latter. Fig. 250 illustrates a good method of colouring the ground of a net leno style. Thus, light crossing ends are introduced on a dark ground and dark crossing ends on a light ground, while to correspond with the vertical lines formed by the crossing ends narrow horizontal lines are formed by light picks on a dark ground, and by dark picks on a light ground.

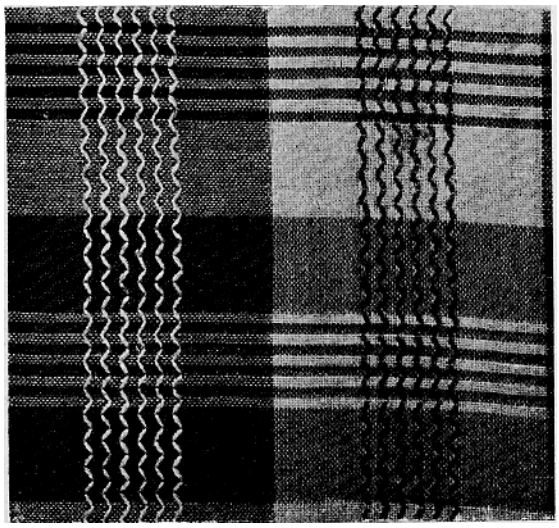

Fig. 250.

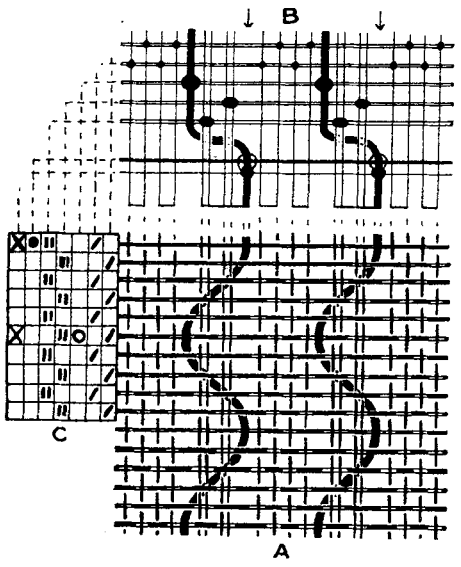

Fig. 251.

The fabric represented in Fig. 252 shows a modification of the last style produced by pointed drafting, a method which can be used very effectively for giving prominence and variety to the zig-zag interlacing. A flat view, showing the interweaving of the threads in the broad leno stripe, is given at D in Fig. 253, the draft at E, and the lifting plan at F, in this case the production of the effect being represented right side up with a top doup. Each doup end is drawn to right or to left over three double standard ends. The crossing ends are lifted for 4 picks, on which they lie across the standard ends, and depressed for 2 picks, on which they are held by the weft either on one side or the other of the standard ends. The marks in F represent where the healds are lifted and the easer operated, and it will be noted that the latter takes place when the front crossing heald is depressed.

Comparison of Top and Bottom Doup Pegging Plans.—The construction of the lifting plan for a top doup draft is more difficult than in the case of a bottom doup, as the healds are mostly at the top and are depressed to produce the crossed interweaving. It is a good plan to first indicate lightly—say, in circles—where the doup and the front and the back crossing healds are to be depressed; then to fill in the spaces for these healds with marks except where the circles are indicated, the latter marks being afterwards rubbed out. A comparison of G in Fig. 253 with the three spaces in F, with which G is linked, will serve to make the method clear. The lifting plan of the healds for a top doup is just opposite to that for a bottom doup if the doup is in front of the front crossing heald in both cases, but the easer is operated at the same time in both.

Fig. 252.

Denting Net Lenos.—As each group of crossing and standard ends must be placed together in one split of the reed, the denting of these styles is a very important feature. For example, in the fabric represented in Fig. 252, there are 22 ends in each plain stripe which are reeded 2 per split, while in the narrow doup stripe there are 2 groups of ends which must be placed in two splits, and in the broad doup stripe 5 groups, which must be placed in 5 splits. The narrow doup stripe, however, occupies the width of 12 ends, or 6 splits of the plain stripe, and the broad doup stripe the width of 26 ends or 13 splits. Sometimes the required spacing of the ends is obtained by plucking out the wires of the reed at the proper places, but this has the disadvantage that the reed can then only be used for a similar form of stripe. As a general rule, the effect can be produced by suitably missing splits between the groups of ends, the double standard ends, in working plain, readily spreading out and filling up the spaces.

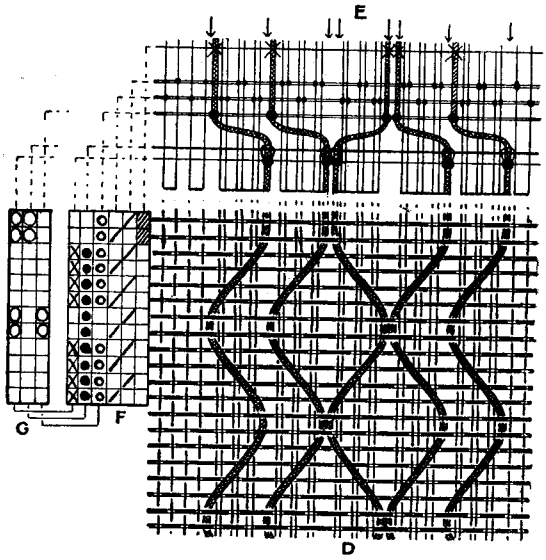

Fig. 253.

If the reed is fine and there is a considerable number of ends to a split, there may be too much friction upon the warp, but this can be reduced by tying the wires of the empty splits together with twine near the balks, and thus widening the spaces between the wires where the ends are passed. The denting of the stripe given in Fig. 252 is indicated by the horizontal lines below the draft E in Fig. 253, while the arrows shown above represent where the eight splits require to be missed to make up the width of 13 splits in the leno stripe.

Designing Net Lenos and Features to Note.—Even with only one front and one back crossing heald, great variety of effect can be produced by suitably varying the arrangement of the ends, the draft, and the lifting plan. In designing a number of styles, point-paper may be very conveniently used, and two effects are thus indicated at H and K in Fig. 254. The standard ends are first marked in (as shown by the double vertical strokes, which may be taken to represent two ends per mail), a blank vertical space being left on both sides of each group; then the interlacing of the crossing ends is schemed, and marks are inserted on the blank spaces to show where the front and back crossing healds are operated. In H and K, Fig. 254, the full squares and crosses respectively show where the front crossing and the back crossing healds are operated, and thus indicate warp in bottom douping and weft in top douping, the other marks representing warp or weft up as the case may be. The draft and lifting plan may readily be constructed from such plans for either method of douping. (In H the full squares and crosses represent weft, and the plain marks warp.)

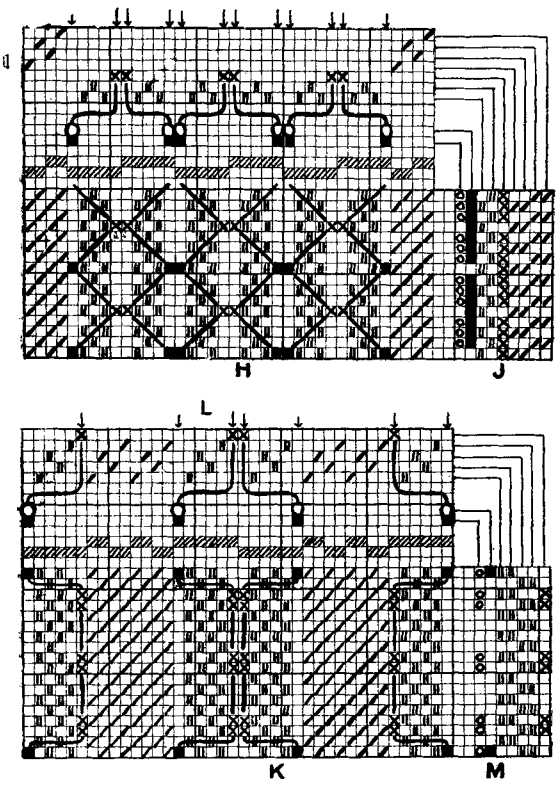

Fig. 254.

H in Fig. 254 corresponds with the net leno stripe shown in the extra warp stripe fabric that is represented in Fig. 155 (p. 138). The crossing ends traverse three double standard ends which work plain, the draft being given at I, and the lifting plan at J for top douping. The binding in of the crossing ends is effected on one pick only at a place, which necessitates, in order to get a clear cross at each traverse, (1) that the interweaving of the crossing ends must cut with the plain interweaving of the standard ends; (2) that the standard ends must be point-drafted

in the same manner as the doup ends. In reference to the first feature, comparison with A in Fig. 251 will show that when the standard ends work plain and the crossing ends are bound in by one pick only, the binding picks must be separated by an even number of picks when there is an even number of standard ends, and by an odd number of picks when there is an odd number of standard ends. In reference to the second point, in a pointed doup draft, and with the binding effected on one pick only at a place, the outer ends of contiguous groups of standard ends must work alike. This, however, is not necessary when the crossing ends are bound in each time on two consecutive picks, in the manner shown at D, in Fig. 253, and K, in Fig. 254. A comparison of these examples with A, in Fig. 251, and H, in Fig. 254, will show that binding the doup ends on two successive picks has the advantages that a more perfect plain foundation can be formed by the standard ends, and that either an odd or an even number of picks may separate the binding picks; while in addition, when fine, tender weft is used, there is less liability of the crossing ends breaking the yarn and being irregularly stitched in.

K, L, and M, in Fig. 254, correspond with the fabric represented in Fig. 255, in which each doup end crosses four double standard ends. The plans show the production of the effect wrong side up with a bottom doup, therefore the full squares and crosses in K and M indicate where the doup ends are raised for binding. The crossing ends are mostly on one side of the standard ends, being on one side for 14 picks, compared with 2 picks on the other side; and the example illustrates an important point to note when this is the case, viz., to draft in such a manner that as few crossed sheds as possible will be formed. By drawing the crossing ends in the direction shown at L, the crossed shed is formed only on 2 picks in the repeat, while the open shed is formed on 6 picks; whereas if the doup ends had been drafted in the opposite direction, three times as many crossed as open sheds would have been made. In Fig. 254, the grouping of the ends in the reed is indicated by the shaded squares below the drafts, while the arrows above show where splits are missed.

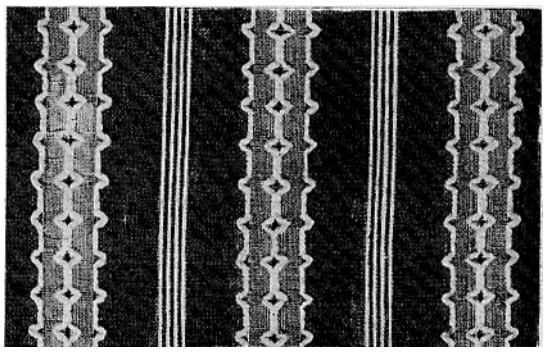

Fig. 255.

Production of Pattern by Varying the Lifts of the Standard Ends.—Fig. 256 illustrates a method of producing variety of pattern in net leno styles by varying the lifts of the standard ends. N shows a somewhat exaggerated view of an effect combined with a 4-thread warp sateen stripe; O is the draft in which each doup end is drawn across four standard ends, and P the lifting plan. The arrangement is for a bottom doup, hence the full squares and crosses in N and P indicate the lifts of the front and back crossing healds respectively. The other marks also represent warp up, but the waved lines will be formed by the doup ends on the underside of the cloth during weaving. The crossing ends are sometimes traversed

across the four standard ends under which they are drafted, but at other times only across two ends; and in the plan N a space is left in the centre of each group of standard ends in order that the intermediate position may be more conveniently shown. When in the latter position, two of the standard ends are lifted, and two are left down, but as shown in P, the front crossing heald, or the back crossing heald—as the case may be—is lifted as usual. The lifting of the crossing ends will cause them to actually move across the four standard ends, but as at the same time the two standard ends nearest the position where the crossing ends are lifted, are also raised, the latter slide along the weft picks until they are held by the weft

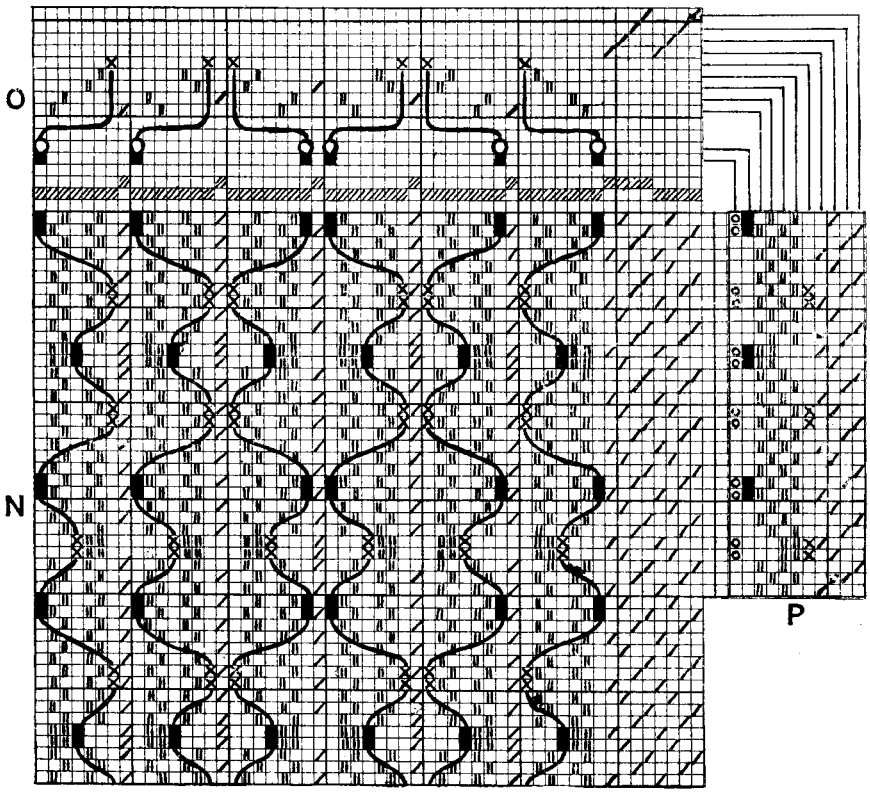

Fig. 256.

against the two standard ends which are down. Further diversity of effect can be produced by modifying the order of lifting and the draft, still using four standard healds; while by employing a larger number of standard healds, much greater scope is given for pattern development with one front and one back crossing heald.

Bead Mounting for Net Lenos.—In this system, which may be readily employed for net leno styles such as have been illustrated, the doup is dispensed with, a number of beads being substituted, one for each loop of the slip; two ordinary healds are used for the front and back crossing healds, and two easers are required. The arrangement is represented in Fig. 257, which, in order that comparisons may be made, shows how the pattern given in Fig. 252 would be produced on the

bead principle; while the illustrations D, E, and F, in Fig. 257, correspond with those similarly lettered in Fig. 253. A limitation of the bead system is that it is necessary for each waved line to be formed by two threads, which are interlaced in the cloth as one; but as it is usual in net lenos for a somewhat thick crossing thread to be used, in most cases this is not detrimental, a similar result being obtained by using two finer threads. In E, Fig. 257, the ends which form the plain stripe, and the double standard ends, which are in groups of three, are shown drawn on two healds, S 1 and S 2. A crossing end is drafted on each side of each group of standard ends, one being drawn through the heald B 1, and the other through B 2; then they are passed together through the eye of a bead, represented by a circle. The ends, carried by the heald B 1, are passed in contact with an easing bar E 1, and those carried by B 2 in contact with an easing bar E 2. The order of denting, indicated above the draft, is the same as in doup weaving, and the beads, which, of course, are behind the reed, slide to and fro on the crossing ends with the movement of the sley. D, in Fig. 257, shows a flat view of the effect on point-paper, the double waved line representing the traversing of the pairs of crossing ends; while the crosses indicate the positions where they are stitched in by the weft on one side of the standard ends, and the full squares the positions on the other side. In producing the structure right side up (to correspond with a top doup), the crossing ends are passed through the beads above the standard ends, but if woven wrong side up (to correspond with bottom douping) they are passed through the beads below the standard ends.

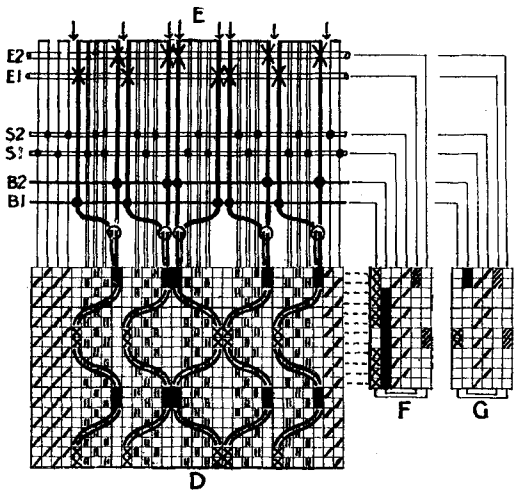

Fig. 257.

The plan F in Fig. 257 shows the order of lifting in producing the cloth right side up, the two standard healds, S 1 and S 2, working plain throughout. When both the healds B 1 and B 2 are raised the two easers are out of action, and the crossing ends lie on the surface of the cloth. When the heald B 1 is depressed, the easer E 2 is operated, and slackens the ends carried by the heald B 2, and the two ends of each pair are drawn down and stitched in on that side of the standard ends where the crosses are indicated in D. Similarly, at the same time that the heald B 2 is depressed, the easer S 1 is operated, and slackens the ends carried by B 1, thus allowing both ends of a pair to be stitched in on that side of the standard ends where the full squares are indicated in D. G, in Fig. 257, shows the order of lifting for producing the cloth wrong side up, the healds B 1 and B 2, in this case, being alternately raised to bind in the crossing ends, while as before the easing slackens the ends that are carried by the heald which is stationary. The chief advantage of the arrangement is its cheapness, the cost of the beads, which practi-

cally never wear out, being merely nominal in comparison with the expensive doup. At the same time the shedding of the healds is simpler than in doup weaving, and the parts easier of arrangement; but when more than one order of crossed interweaving is required the mounting becomes complicated on account of two easers being required for each series of beads.

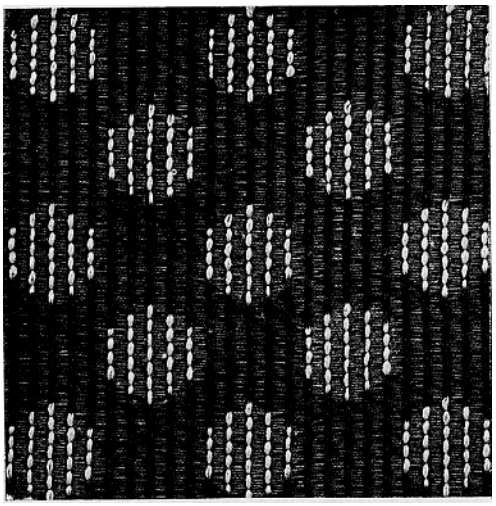

Fig. 258.

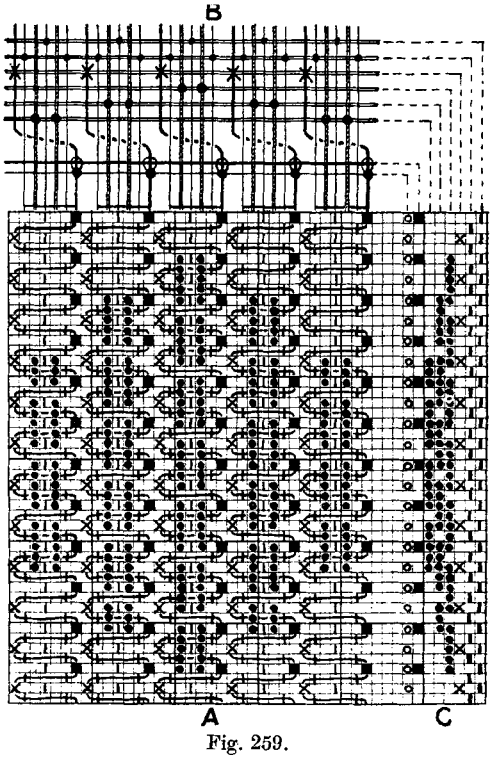

Fig. 259.

COMBINATIONS OF GAUZE AND LENO WITH EXTRA WARP AND EXTRA WEFT EFFECTS

Fig. 258 illustrates a simple but useful principle of ornamenting an open leno and plain structure by means of extra warp. There are six ends in each group, which are arranged as follows: — One standard, one extra, one standard, one extra, and one standard, under which a crossing end is drawn from left to right, as shown in the draft given at B in Fig. 259. A representation of the working of the threads which form one spot is given on point-paper at A in Fig. 259, in which, for convenience in showing the crossed interlacing, a space is allotted for each crossing end at each side of the standard and extra ends, 7 vertical spaces being thus allowed for 6 ends. C shows the lifting plan of the portion of the design given with the draft B, but it will be understood that in producing the full design three additional healds are required to form the second extra warp spot. The standard ends work in plain order throughout, as shown by the vertical strokes in A and C; the crossing ends are raised on the second of each group of four picks by the back crossing heald, as shown by the crosses, and on the fourth of each group by the front crossing heald, as shown by the full squares, while the extra

ends are raised only where the figure is required to be formed, as indicated by the dots. The half-heald is lifted on all the even picks, as shown by the circles in C. There are 8 groups of ends per inch, and the style would be conveniently produced in a reed with 24 splits per inch, reeded 6 ends per split, and 2 splits missed alternately. For 100 yards of cloth, 105 yards of extra warp, 110 yards of standard warp, and about 190 yards of crossing warp are required, three beams thus being necessary. Large figures, which show in clear contrast with the ground, may be woven on this principle by means of a small number of healds, while another feature of the style is that the traversing of the crossing ends binds in the extra ends on the back. There is, therefore, no difficulty in disposing of the extra ends where they are not required to form figure, and at the same time, as they are below the standard ends they are quite invisible from the face side of the cloth.

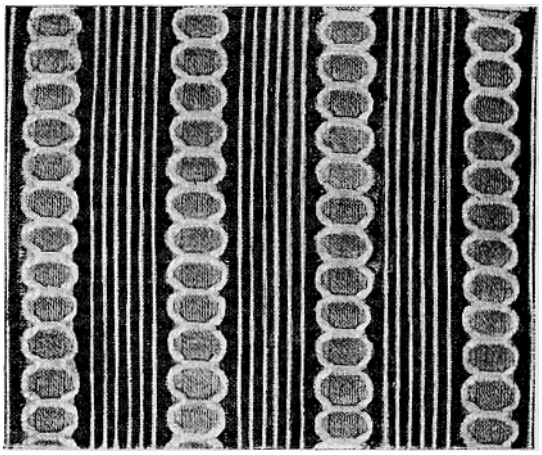

Fig. 260.

Fig. 260 shows a combination of net leno with an extra warp spotted stripe, the plan for which is given at D in Fig. 261, while the draft and lifting plan for top douping are respectively indicated at E and F. The crossed shed is formed on four successive picks, on which all the standard ends are raised, therefore separate healds, from the plain ground healds, are required for the standard ends. Only one heald is required for the extra warp spot, which on paper appears rectangular, but on the crossed sheds the picks, which bind the crossing ends, float right across from one to the other. The spot thus has a rounded appearance in the cloth, with a white outline formed by the doup ends and the weft. As shown in the denting plan, below the draft, the ground ends are sleyed two per split, and there are, therefore, four ends per split where the extra warp spot is formed, while a split is missed on each side of each group of standard ends, as indicated by the arrows above the draft.

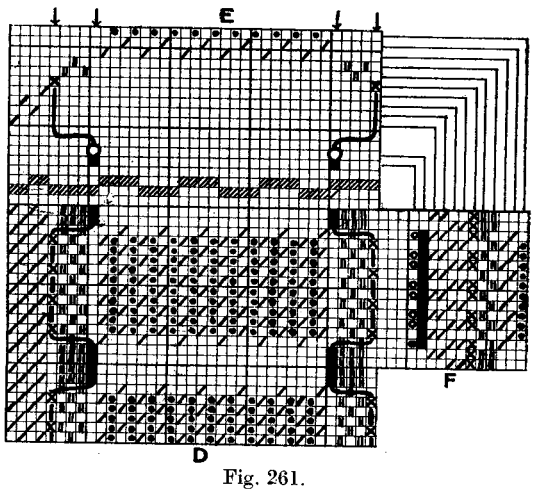

Fig. 261.

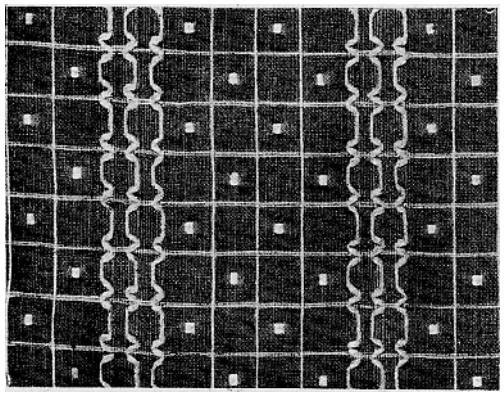

Fig. 262.

Fig. 262 shows the combination of net leno with an extra weft spot formed in the centre of an over-check. A plan of a portion of the effect is given at A in Fig. 263, and the corresponding draft and lifting plan for a bottom doup at B and C respectively; the weave marks representing warp up, while the waved lines show how the crossing ends interlace. The shaded marks in A represent the positions of the white check lines in the cloth, while the brackets at the bottom of the plan denote the ends that

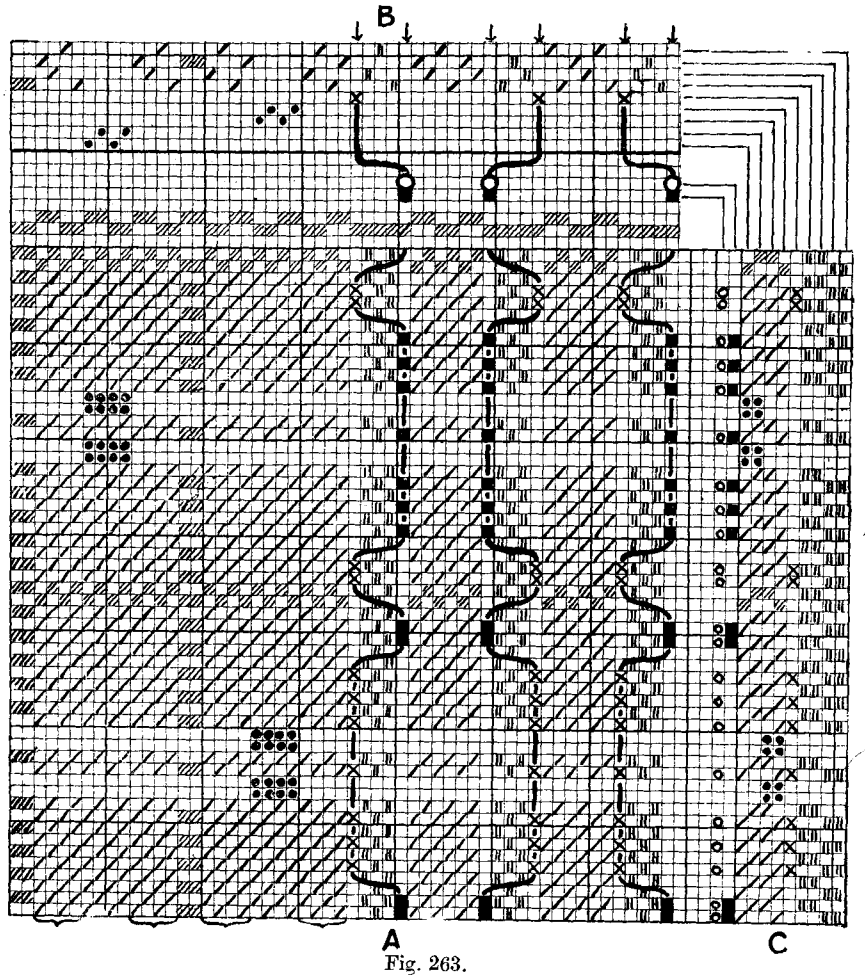

Fig. 263.

are repeated in forming the complete check. The dots indicate the ends that are raised in producing the extra weft spot on the underside, the extra picks being introduced in even numbers with the ground picks. The interweaving of the doup ends is the same on one side as on the other side of the standard ends —exactly the same number of crossed as open sheds being made—therefore in this case the ends may be drawn with equal advantage in either direction across the standard ends. The crossed interweaving fits with the repeat of the overcheck and the extra weft spot, hence it is necessary for the boxing and take-up motions to be kept perfectly in unison with the shedding. The example may, therefore, be most advantageously produced by using the shedding motion to govern the box mechanism, and for throwing the take-up catch out of action when the extra picks are inserted.

The different positions of the back crossing heald in relation to the standard healds may be noted by comparing the drafts given in Fig. 254 (p. 236) with that shown in Fig. 263. In Fig. 254, the back crossing heald is placed behind the standard healds, an arrangement which is frequently adopted in order to reduce the acuteness of the angle that is formed when the crossed shed is made. Any advantage that is thus gained in reduced strain, however, is liable to be neutralised by the friction caused by the crossing ends rubbing against the leashes of the standard shafts ; this being particularly the case when the standard healds are finely set. In Fig. 263, the back crossing heald is in a better position, as in this case it is placed in front of the standard healds, while the strain on the crossing ends is reduced by placing it behind four ordinary healds.

TWO OR MORE DOUP PATTERNS

Two or more doups and front crossing healds, with a corresponding number of easers, are sometimes required for net leno effects, for certain styles of open structures, and for patterns in which net leno and open effects are combined. Fig. 264 shows a 2-doup net leno arranged in stripe form with an extra warp effect, the corresponding sectional plan, draft, and lifting plan for which are given at A, B, and C, respectively, in Fig. 265. The arrangement is for top douping, hence the full squares and crosses in A represent doup ends down, while all the other marks represent warp on the surface. The doup ends cross from side to side of three double standard ends, half the crossing ends working exactly like the other half except that they are turned in opposite directions by means of pointed drafting ; and each gauze stripe in Fig. 264 contains two repeats of the crossed interlacing shown in A. The interlacing of the outer crossing ends repeats on 8 picks, and of the inner crossing ends on 16 picks, but the complete design occupies 48 picks (of which only 24 are shown) on account of the extra warp weave (represented by dots) repeating on 6 picks. The fact that two crossing ends are traversed in a different manner from each other does not necessarily mean that two doups are essential, but in this case it will be apparent from an examination of the marks in A, which show the binding in of the first two crossing ends, that two doups must be used. Thus, neither the crosses nor the full squares of the first crossing end correspond in arrangement with either the crosses or the full squares of the second crossing end, and it is, therefore, clear that two back crossing healds, as well as two front crossing healds and doups, are required. If, however, the crossing end

lifts, either on one side or the other of the first group of standard ends, had been the same as those on either side of the second group, it would have been possible to produce the effect with one front crossing heald and doup, although two back crossing healds would have been necessary (see Fig. 272). The denting of the pattern is shown below the draft in Fig. 265, while the arrows indicate where splits are missed.

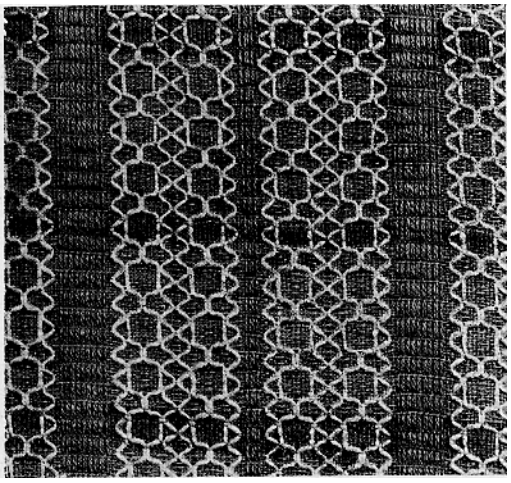

Fig. 264.

Fig. 266 shows an open structure in which, by means of two doups, the picks are distorted by being grouped together and then separated in alternate sections, the cloth being given a spider's web appearance. A flat view of the structure is given at D in Fig. 267, and the draft and lifting plan for bottom douping at E and F. The crossing ends, represented by solid lines in D, are always raised, therefore the half-healds are lifted on every pick, as shown by the circles in F; while the standard ends are always down, only one standard heald being required. Each back crossing heald lifts its crossing ends on nine successive picks, which, being in the same shed, are readily inserted towards each other; then a crossed, an open, and a crossed shed are successively formed, causing three picks to be clearly separated from each other and from the group of nine picks. The grouping and separating of the picks by the two sets of healds, however, occur at different periods, with the result that the three upper and three lower picks pass from one group of nine to another.

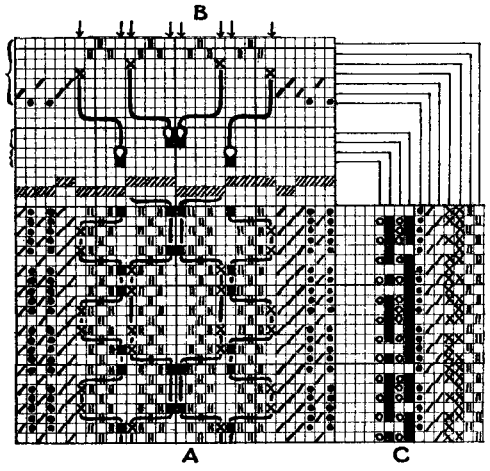

Fig. 265.

Fig. 268 shows a 3-doup style in which a net leno stripe, requiring one doup, is combined with an open structure, the latter consisting of alternate sections of gauze and plain for which two doups are required. A flat view of a portion of the effect, and the corresponding draft and lifting plan are given at G, H, and I, respectively, in Fig. 269. The order in which the ends are grouped in the reed is indicated above the draft, and two splits are left empty in the centre of the net leno stripe. The arrangement shows the combination of top and bottom douping, the whip crossing

ends being drawn in pairs *over* three double standard ends which work plain throughout; while in the gauze and plain section two crossing ends are drawn *under* two standard ends. In the open gauze structure the ends and picks are grouped in fours, the crossing ends being over, and the standard ends under the picks. This order of shedding is also employed on the picks which precede

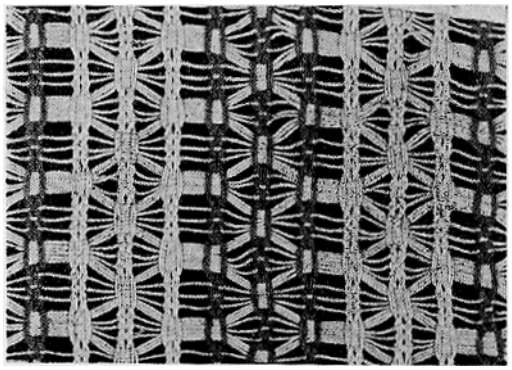

Fig. 266.

and succeed the open interlacing, the change from the plain weave to the crossed shedding and *vice versa* being thus made gradually. The net leno stripe requires one back crossing heald and two standards, but on account of formation of the plain weave two back crossing healds and two standards are required to correspond with each of the other doups. With the exception of the whip ends, all the ends

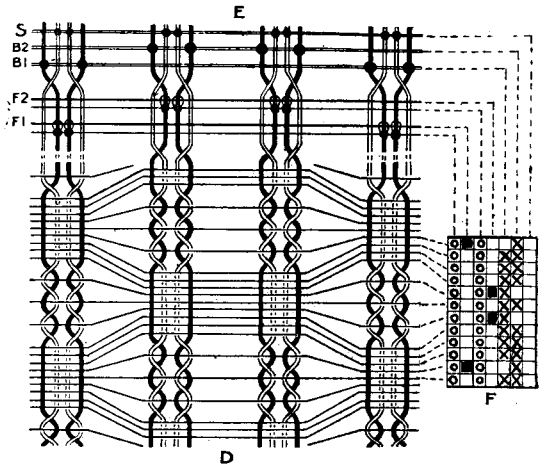

Fig. 267.

take up equally, hence the effect may be produced by the use of two warp beams, but three easers are required to correspond with the three doups.

Fig. 270 shows a 3-doup check effect in which there are two special features—viz., the crossing of thick ends carried by one doup, across fine ends controlled by another doup; and the deflection of thick picks horizontally to correspond

with the vertical waved lines formed by the thick ends. A flat view of the structure is given at J in Fig. 271, and the corresponding draft and lifting plan at K and

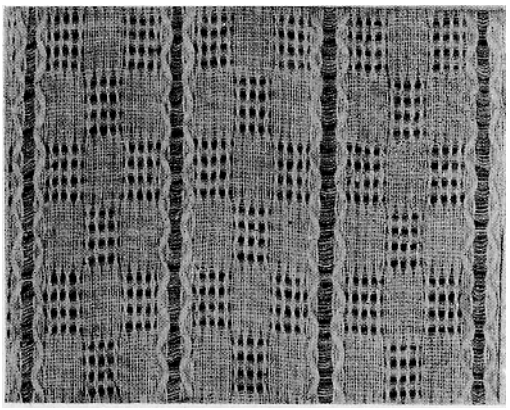

Fig. 268.

L respectively. The three groups of threads are correspondingly numbered in the illustrations, and exactly one repeat of the lifting plan is indicated by the bracket

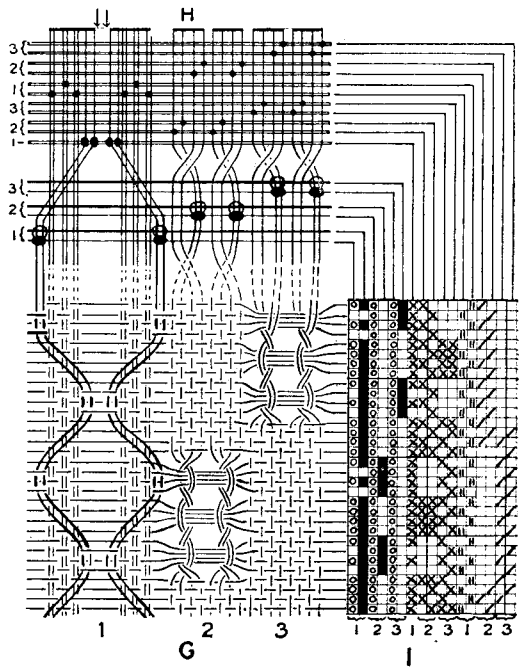

Fig. 269.

at the side of L. In reference to the first feature the pairs of fine ends numbered 2 act as standards to the thick doup ends numbered 1, and it is, therefore, necessary

for the latter, in passing from the back crossing heald 1 to the front crossing heald

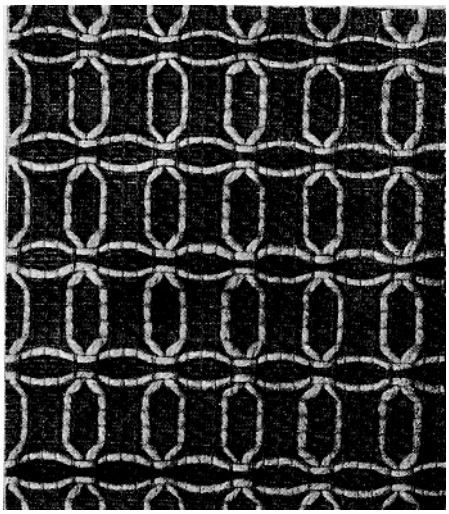

Fig. 270.

1, to cross under the former in front of the doup 2. In regard to the second point,

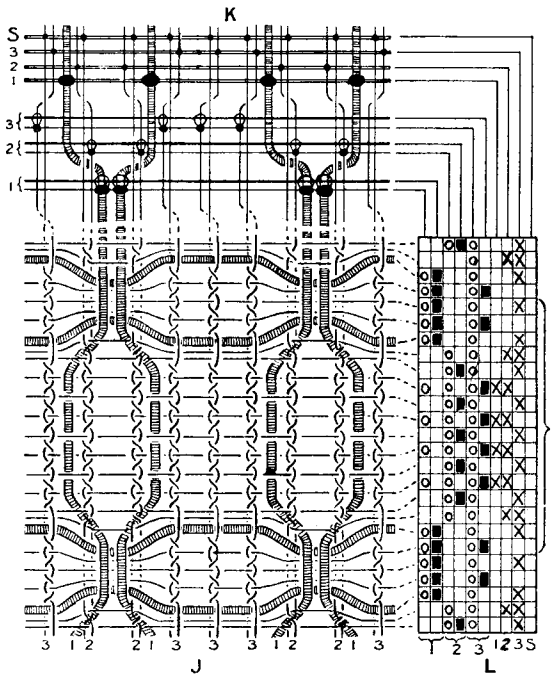

Fig. 271.

the fine ends 2 form the crossed interlacing on all the eleven fine picks between the thick picks, then a crossed shed is formed by the doup 1 on the two thick picks and the three fine picks between them, during which the fine ends 2 float at the back. The five picks, being in the same shed, are readily compressed by the crossed interlacing of the ends 2, and the thick picks thus approach each other where they intersect the ends 2. The fine ends 3 form the crossed interlacing on the three picks between the thick picks, and as the latter are in the same shed as the two ground picks on the opposite sides, they are readily forced apart where they intersect the fine ends 3. The cloth is woven right side up by means of bottom douping.

PATTERNS PRODUCED BY ONE DOUP AND TWO OR MORE BACK CROSSING HEALDS

In this principle the idea is to produce effects in which some of the crossing ends interlace quite differently from other crossing ends with a simple mounting, only one doup and front crossing heald, and one easer being employed. It is, of course, always advisable to use as few doups as practicable, and frequently it is possible to weave effects in a 1-doup mounting which have the appearance of requiring a large number of doups. As many back crossing healds are required, however, as there are different orders of interlacing employed for the crossing ends. The feature of the system is that since only one front crossing heald is employed, whenever this is operated, all the doup ends cross simultaneously to the crossed side of the standard ends ; and so long as a back crossing heald is left out of action the crossing ends carried by it weave continuously on the crossed side of the standard ends. When, however, a back crossing heald is operated, the ends that it carries pass to the open shed side of the standard ends ; therefore, by employing a number of back crossing healds, and operating them differently, varied orders of interlacing are formed. In the more elaborate styles the normal positon of the crossing ends in the cloth is on the crossed side of the standard ends, the traversing of the ends being really effected by the formation of open sheds when the back crossing healds are operated. The half-heald has to be operated, not only on the crossed sheds, but also whenever any one of the back crossing healds is brought into action. In drafting a given pattern, great care is necessary in deciding which is the crossed and which the open shed side of the standard ends, as according to the direction in which the crossing ends are drawn across the standard ends, an effect may require, for example, four doups and four easers, with one back crossing heald, or one doup and one easer with four back crossing healds.

Comparison with Two-doup Style.—A, in Fig. 272, shows a net leno structure in which there are two orders of interlacing the crossing ends, which, as shown in the draft B and the lifting plan C, can be produced by means of one doup and front crossing heald, and two back crossing healds. In order that comparisons may be made, the crossed interlacing in Fig. 272 is arranged similar to that represented in the 2-doup effect shown in Figs 264 and 265 ; and the example illustrates how a slight modification of the 2-doup effect would enable it to be produced by one doup. The extra warp, the ground ends, and the outer crossing ends work exactly the same in the two examples, but the centre crossing ends are drafted in the opposite direction in Fig. 272, and a slight change is made in the order of lifting. The repeat of the crossed interlacing is on 16 picks in both cases, but in

A, Fig. 272, it will be noted that the full squares, which indicate where the front crossing heald is operated, are always on the same picks, viz., 2, 8, 10, and 16. The crossing ends are, therefore, always on the crossed side of the standard ends on these picks, and they are traversed to the opposite side only when the back crossing healds are operated alternately with the front crossing heald. It will be seen that while the first back crossing heald is operated and traverses its threads on the picks 4 and 6, and 12 and 14, the second is only brought into action to traverse its threads on the picks 4 and 6, so that the latter threads lie straight on the surface of the cloth between the picks 10 and 16.

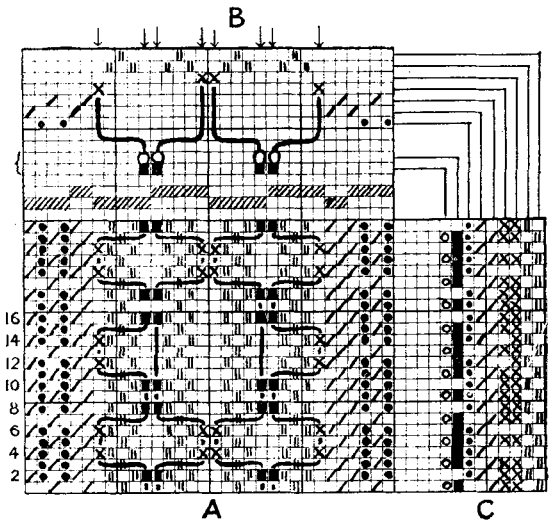

Fig. 272.

Fig. 273 shows an extra warp figure in two colours combined with a 1-doup net leno effect in which there are two different orders of interlacing. A point-paper plan of the pattern is given at D in Fig. 274, the draft at E, and the lifting plan for top-douping at F. The crossing end at each side of the extra warp stripe traverses two double standard ends, but in the centre of the doup stripe the traverse of each crossing end is only across one double standard end. The front crossing heald is operated on every fourth pick, and the back crossing heald for the centre crossing ends is operated alternately with it, but that for the crossing ends at the sides is only brought into action once in every eight picks. The crossing ends in the centre thus make twice as many traverses as those at the side, but as the latter move a greater distance the take up of the crossing ends is the same; therefore they can all be brought from one beam. The net leno stripe is given a very open appearance by splits being missed between the groups of ends; and arrows are indicated above the draft E to indicate the missed dents. In the extra warp stripe the figure is produced on a plain ground, the dots representing the figure formed by one extra warp, and the shaded squares that formed by the second extra. The reed has 44 splits per inch, and the

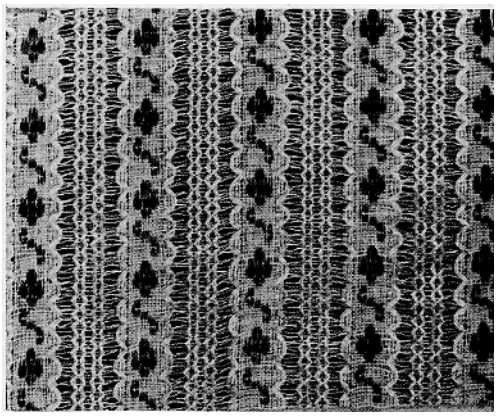
Fig. 273.

grouping of the ends is indicated by the horizontal lines above the draft, two ground ends being placed in each split in the extra warp stripe; thus there are four ends per split where there is only one extra, and five per split where both extras are introduced.

Construction of Heald Knitting Plans for Gauze Stripes.—When knitted healds are used for a complicated draft, such as that shown at E in Fig. 274, it is very important that the leashes are spaced correctly, so that the ends will pass from

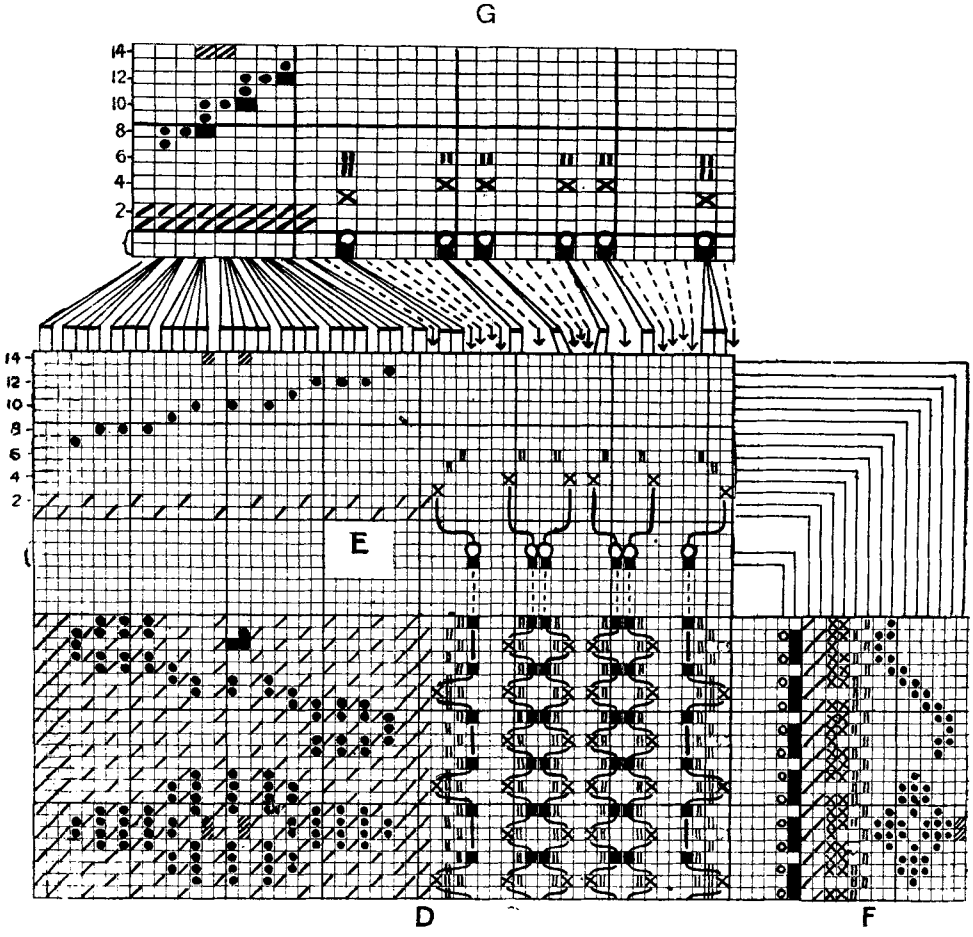

Fig. 274.

the heald eyes through the reed without unnecessary friction. G in Fig. 274 shows how a plan may be readily contructed from a given draft and order of denting which will enable the healds to be knitted with perfect accuracy. Ordinary design paper may be used, and the piece of paper should contain as many vertical spaces as there are splits in the repeat, and as many horizontal spaces as there are healds. Thus G is 30 spaces wide and 16 spaces deep as the pattern is on 30 splits, and there are 14 healds in addition to the doup and front crossing heald. The lines which

connect the draft and denting plan with G will enable the method to be followed. On each vertical space in G there are as many marks indicated as there are ends passed through the corresponding split, and on each horizontal space as many marks as there are ends drawn on the corresponding heald. The first split contains two ends which are drawn on the healds 1 and 2; therefore marks are placed in G where the first vertical space intersects the horizontal spaces 1 and 2. In the second split there are four ends which are drawn on the healds in the order of 1, 7, 2, 8, and marks are inserted in G where the second vertical space intersects the horizontal spaces 1, 7, 2, 8. This method is followed throughout except that where there are two ends on one heald in the same split, as on the heald 8 in the third split, one of the marks is placed on the square alongside its correct position, as shown where the solid squares are indicated in G. The dotted lines, which connect the arrows with the plan G, indicate where vertical spaces are left empty to correspond with the empty splits. The plan gives the exact position of the heald leashes in relation to the position of the ends in the reed, and if the rate of knitting is the same as the sett of the reed the order of knitting and missing will be obtained by reading along the spaces of G horizontally. It is, however, more economical for the healds to be knitted at a lower rate than the sett, and in the accompanying list the order of knitting and missing is shown in the centre column at the rate of the sett of the reed, and in the column on the right at half the rate :—

Position of Heald.	Rate of knitting = splits per inch of reed.	Rate of knitting = ½ splits per inch of reed.
Doup and front crossing heald, and heald 6	knit 1 1 1 1 1 1 miss 10 4 1 3 1 4 1	knit 1 2 2 1 miss 4 2 1 2
Healds 1 and 2	knit 9 miss 21	—
Healds 3 and 5	knit 1 1 miss 10 17 1	knit 1 1 miss 5 8
Heald 4	knit 1 1 1 1 miss 15 1 3 1 6	knit 2 2 miss 7 1 3
Healds 7, 9, 11, and 13	knit 1 miss 29	knit 1 miss 14
Healds 8, 10, and 12	knit 3 miss 27	knit 3 miss 12
Heald 14	knit 2 miss 28	knit 2 miss 13

It will be noted that in the second column the numbers knitted and missed total 30 to correspond with the 30 splits in the pattern, but in the third column the total is half that number, viz., 15, to correspond with the rate of knitting being reduced one-half. It is not advisable to knit the healds 1 and 2 at half the rate of the reed.

Fancy One-doup Net Leno.—Fig. 275 shows a typical example of a fancy net leno which has been produced in a one-doup mounting. The corresponding sketch plan is given at H in Fig. 276, in which, in order that the interlacing of the crossing ends will be more clearly seen, the plain weave of the standard ends is shown only on the first six picks. The draft is given at I and the lifting plan at J for bottom douping, five back crossing healds being employed. In H and J the full squares show the lifts of the front crossing heald, while the crosses show where the back crossing healds lift. Each doup end lies straight in the cloth—floating five and one—

on the crossed side of the standard ends except where the lift of a back crossing heald alternates with the lift of the front crossing heald; the figure being formed where the interlacing is straight, and the ground where the traverses are made. The doup is raised on every third pick, as shown by the circles in J. In designing styles of this character, the order of lifting the front crossing heald should first be decided upon, and corresponding marks be indicated upon the point-paper (as shown by the full squares in H) where the crossing ends will be bound in on the crossed sheds. Experimental sketches may then be made of different orders of traversing the crossing ends by forming open sheds, from which the drafts and lifting plans can be readily constructed. If possible, however, each crossing end should be given the same number of traverses, or the take up will vary and more than one crossing warp beam will be required. Thus, in Fig. 276, some of the doup ends make five, others six, and others seven, traverses in the repeat, and three whip beams were used in producing the effect.

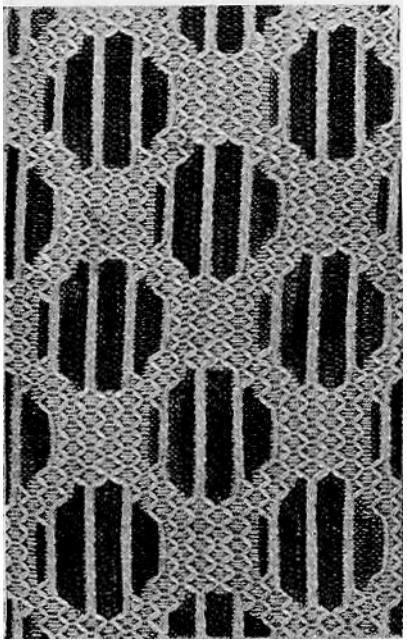

Fig. 275.

Distorted Weft Styles.—The pattern given in Fig. 277, and the corresponding illustrations A, B, and C in Fig. 278, show a method of distorting the picks in a 1-doup mounting, by which effects, similar to the 2-doup style given in Figs. 266 and 267, may be produced. One end crosses one end, and four back crossing healds—numbered 2, 4, 6, and 8, in the draft B—are employed. The front crossing heald always lifts on the even picks, and, as shown in the flat view A, each doup end lies on the crossed side of its standard end for seven picks which are grouped together, then a crossed interlacing is made which separates a pick from the group of seven picks. The lifts of the back crossing healds, which form the crossed interlacing, occur at different times, and some of the picks thus pass from one group to another. Where the seven picks are grouped together, the interlacing is arranged so as to permit the picks to approach each other as readily as possible, consistent with the lifting of the front crossing heald on alternate picks, on which the standard ends are down. On the other picks of each group the weft interlaces two-and-two, and the weave enables a considerable quantity of weft yarn to be put into the cloth, which renders it suitable for using as the ground of a figured gauze style in which the figured portion of the cloth is required to be compact. The structure may be varied in many ways, and D, in Fig. 278, shows a modification which can be produced by repeating the draft of the first eight ends shown in B, and using the lifting plan E. A more open distorted effect is produced than in A, which is suitable for a lighter wefted cloth, although this weave will allow many more picks to be inserted than can be obtained in a pure gauze, one crossing one.

Gauze and Figure Weave Combinations.—A further development in a single doup heald mounting is illustrated by the pattern in Fig. 279, a portion of which is represented at A in Fig. 280, while B shows the draft and C the lifting plan. There are two standard, one front crossing, and 12 back crossing healds, and one end crosses two ends. For convenience in showing the interlacing of the crossing ends a space is left in the plan A on each side of the standard ends. The standard

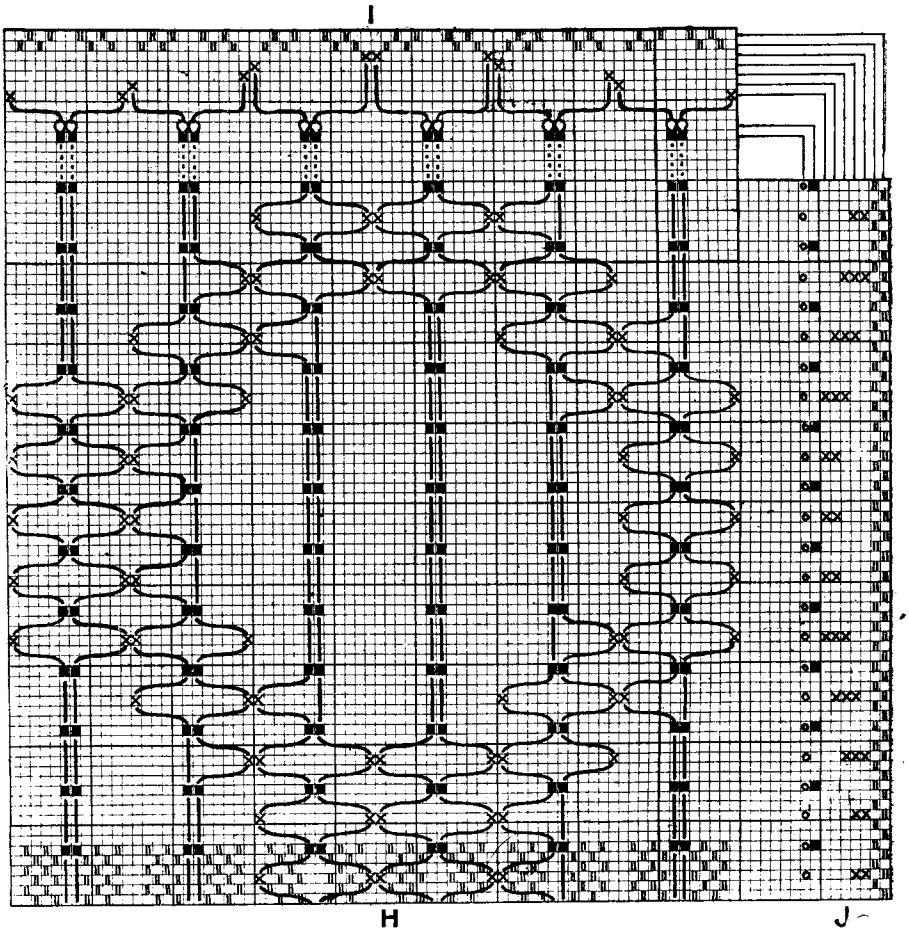

Fig. 276.

healds work plain throughout, while the front crossing heald is always raised on the even picks ; and it is the operation of these healds that produces the opaque figure portion of the cloth (represented by diagonal strokes in A), in which the crossing ends work continuously on the crossed side of the standard ends. The back crossing healds are only operated where the open-gauze structure is required, and in the plan A these places are represented where the crosses and full squares alternate on opposite sides of the standard ends, the former marks showing the

lifts of the back crossing healds. In the opaque figure the first and third ends of each group work alike, and if the warp and weft yarns are similar, a two-and-one weft rib effect is produced. The figure structure may, however, be developed as a warp rib by using thicker yarns for the crossing and the first standard ends than for the second standard end, and

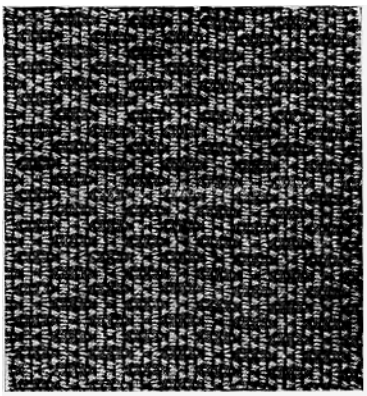

Fig. 277.

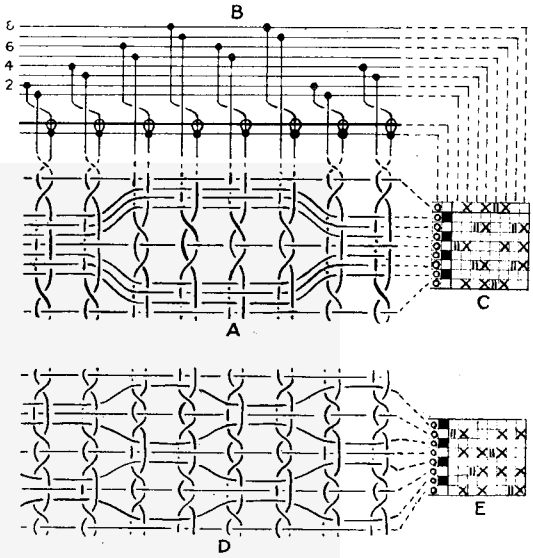

Fig. 278.

by wefting one pick fine, one pick coarse. As the standard ends work plain throughout a shaker is not required in a double-lift machine, and the style is, therefore, specially suitable for the production of elaborate effects in double-lift jacquards.

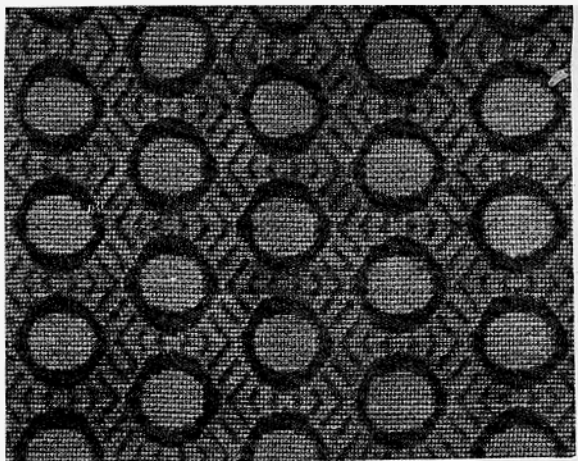

Fig. 279.

Fig. 281 shows a single-doup effect, which is a combination of gauze and plain weave, in which one crosses one. A simple example, to illustrate the production

of the style, is given in Fig. 282, and for convenience in grouping the illustrations, a method of producing warp (or weft) float, in addition to the gauze and plain, is shown in the same figure. Two plans A and B are given at opposite corners of Fig. 282, the first showing a combination of plain weave and gauze—the latter effect being represented by the blanks—and the second a combination of plain, figure, and gauze. Flat views, to correspond with A and B, are given respectively

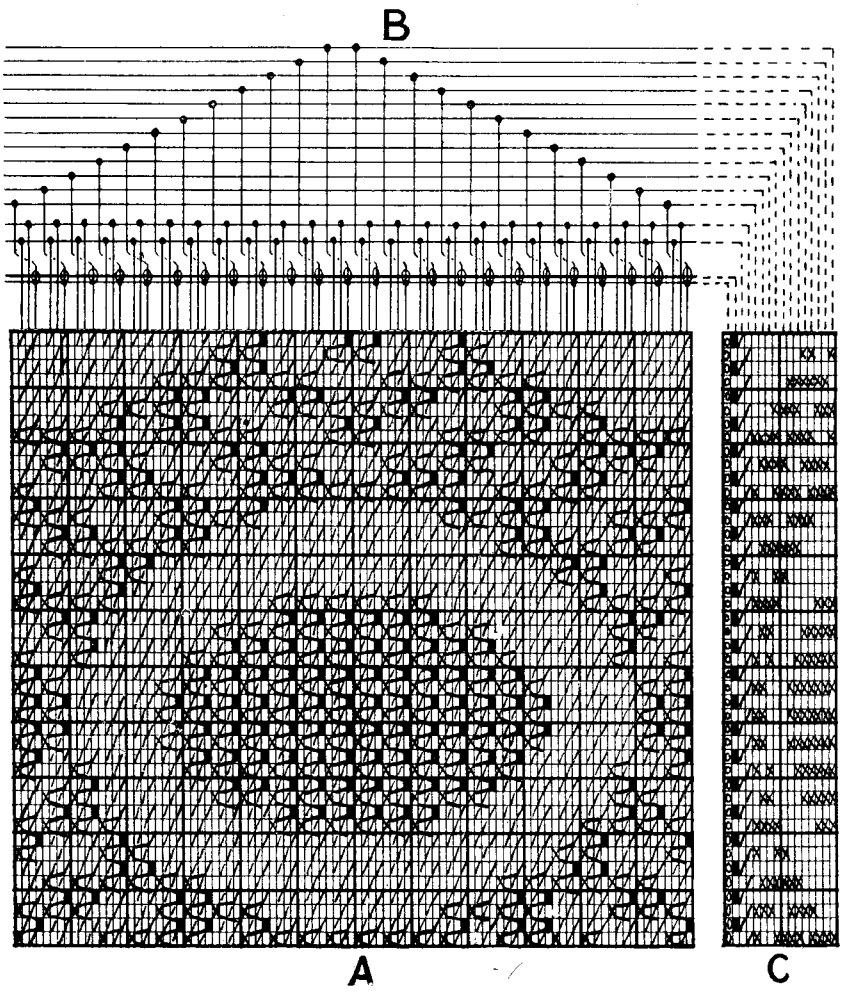

Fig. 280.

at C and D, and two heald drafts E and F are shown, either of which can be employed in producing the effects. A lifting plan is shown on each side of each flat view; G, corresponding with A and C, and H with B and D if the draft E is employed, while with the draft F, I corresponds with A and C, and J with B and D. In the plans G, H, I, and J, the full squares indicate the lifts of the front crossing heald, which is raised on alternate picks, and the circles the lifts of the doup which is

raised on every pick. The crosses show where the back crossing healds are raised in forming the gauze ground, and the dots the lifts of the same healds where warp figure is produced; while the vertical strokes indicate the lifts of the standard healds. In comparing the lifting plans with the designs A and B, it is necessary to keep in mind that all the crossing ends are raised by the front crossing heald and doup on the even picks, therefore on these picks no other healds are raised in G and I, and only certain standard healds (where figure is formed) in H and J. The ends should be studied in pairs, 1 and 2 together, 3 and 4 together, etc., and it will be seen that gauze is formed by lifting a back-crossing heald alternately with the front crossing heald, whereas a standard heald is lifted alternately with the latter in producing plain weave. By raising a standard heald on the cross sheds (the even picks), and both standard and back crossing healds on the open sheds (the odd picks), warp figure is formed on the upper side of the cloth, a weft figure being

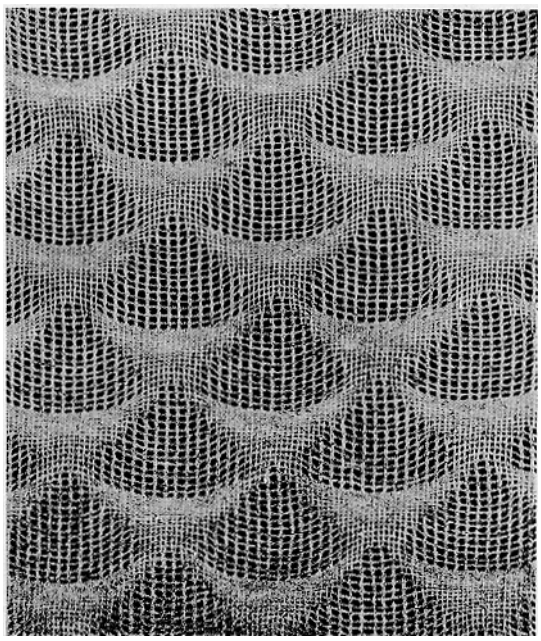

Fig. 281.

produced in this system by weaving the cloth wrong side up. The lifting of a back crossing heald in forming the figure causes a crossing end to pass temporarily to the open shed side of its standard end, but the latter is raised at the same time so that there is nothing to prevent the crossing end from slipping back when the following crossed shed is made. Therefore, in the figure and plain portion of the design all the crossing ends weave continuously on the crossed side of the standard ends.

The principles of gauze weaving, illustrated in Fig. 282, are employed for a class of figured gauzes produced in jacquard machines; and in weaving the effects shown at A and B in a jacquard mounting the plans for the card cutting would be

as shown at G and H, or as at I and J, according to the arrangement of the harness draft. One purpose of the illustrations given in Fig. 282 is to demonstrate that the construction of the design or lifting plan for a given effect is much simpler with the transposed draft F than when the straight draft E is employed. It will be noted in the flat views C and D that in the plain and figure portions the standard ends are the odd ends, and the crossing ends the even ends. In the draft E, however,

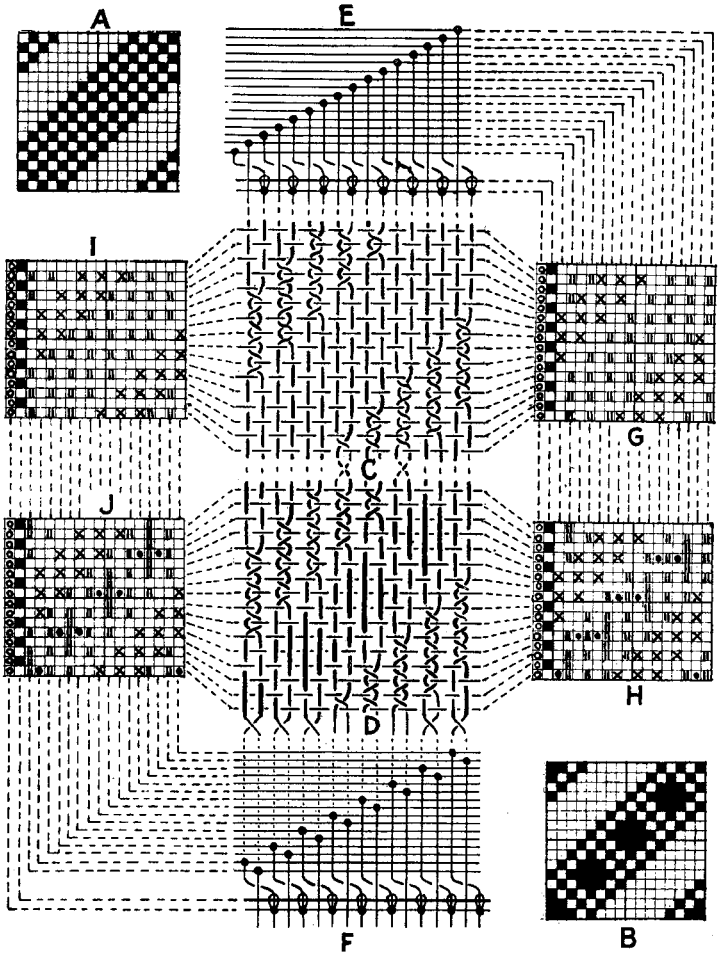

Fig. 282.

the odd (standard) ends are drawn on the even shafts, and the even (crossing) ends on the odd shafts. It is therefore necessary, in constructing the card-cutting or pegging plans, for the ends to be transposed in pairs, the lifts of the odd ends in the figure and plain being indicated on the even vertical spaces of G and H, and of the even ends on the odd vertical spaces. At the same time it has to be taken into account that the back crossing healds (the odd shafts) must not be raised on the cross sheds (the even picks). In the draft F, however, the ends are

transposed in pairs in the healds, the odd (standard) ends being drawn on the odd shafts and the even (crossing) ends on the even shafts. Therefore, in this case, the plans I and J exactly correspond with the designs A and B, except that the lifts, obtained by raising the front crossing heald, are omitted, and marks are inserted, as shown by the crosses, in the gauze ground.

CHAPTER XIII

JACQUARD GAUZE AND LENO FABRICS

Ordinary Jacquard and Doup-Heald Mountings—Styles of Cloth—Combinations of Gauze, Plain Weave, and Warp (or Weft) Figure—One-crossing-one Styles—Special Ground Weaves —One-crossing-two Styles—Use of Two Doups—Modification of Gauze Ground—Net-Leno Figured Styles—One-crossing-three Patterns—Combinations of Twill and Gauze. *The Special Gauze Jacquard and Harness*—Arrangement of Harness, Hooks, and Needles—System of Drafting—Method of Douping and Easing—Construction of Gauze Ground Weaves—Designing of Figures—System of Card-cutting—Top Douping in the Gauze Harness. MADRAS GAUZE FABRICS—Structure of the Cloth—*The Madras Loom*—System of Drafting—Method of Crossing the Ends—Method of Easing—Arrangement of Shuttle Boxes—Operation of the Gauze Reed—Operation of the Easing Bar—Operation of the Tug Reed—The Picking Motion—The Up-take Motion—*Madras Designing*—Modifications of the Structure—Single Cover Chintzed Design—Gauze Figure on Opaque Ground—Complex Three-colour Fabric—System of Card-cutting.

THERE are three chief systems of mounting for jacquard gauze effects, viz. :—(1) An ordinary jacquard and harness working in combination with one or more doup healds ; (2) a special jacquard and harness in which there are extra needles, hooks, and cords for effecting the douping and easing ; (3) a Madras jacquard and harness in which the crossing of the ends is effected by means of a special gauze reed.

ORDINARY JACQUARD AND DOUP-HEALD MOUNTINGS

The alterations and additions, required in changing from straight interlacing to gauze, are practically the same in an ordinary jacquard and harness as in heald work. The doup and doup heald are placed in front of the harness, which is moved a sufficient distance back from its usual position to allow the shafts to be operated in front of the comber-board. The healds may be operated by tappets, but it is usually more convenient to make use of special front hooks at each side of the jacquard, in order to give a straight lift to the healds. In the case of a heavy doup lift, several hooks at each side may be employed to lift the doup heald, duplicate holes being cut in the cards to correspond. In many cases the lifting of the healds may be simplified by connections being made from them to the jacquard griffes. Thus, in a single-lift machine, if the half heald is required to be raised on every pick, it may be connected to the griffe, whereas in a double-lift jacquard, if the doup heald is required up on alternate picks, it may be connected to one griffe, and the half-heald to both griffes. In the latter case, the half-heald is lowered to the centre of the shed for the crossing at each pick. Spiral springs are used to draw down the healds, while the easing is effected by means of a transverse bar, as in heald work, the extremity of the easing lever being connected to the same

hooks or griffe as the doup heald, or to separate hooks at the back of the machine. It is advisable to have the doup heald and easer operated from the same source, and if separate hooks are used, the same needle should control both. This makes it impossible for a cross shed to be formed without the easing being effected at the same time. If the repeat of the lift of the doup heald is on two or four picks, it is convenient to cut holes in every card opposite the needles which control the healds and easer, pegs being then inserted in the corresponding holes in the cylinder to act in place of blanks in the cards.

Single-lift jacquards are generally found most convenient in figured gauze weaving, particularly in producing fabrics for which, in double-lift shedding, a shaker motion would be required. In arranging to weave designs in double-lift jacquards, it is necessary to carefully consider the type of gauze structure to be formed. The styles that are most suitable are those which require no shaker motion, as, for instance, fabrics in which the standard ends work continuously in plain order, or in which one or more picks are inserted between the crossed and open sheds. Although seldom employed, shaker motions have been devised for double-lift jacquards, and in one method the bannister harness principle is adopted, wood staves being passed through loops formed in the standard harness. The loops are made long enough to allow the ordinary lifts of the harness to be made, while by means of a tappet the staves are raised a distance equal to half the height of the shed. The standard ends left down by the harness are thus raised to the centre. In another method the knotted comber-board principle is employed, large knots being made in the standard harness in such a position that they rest on a supplementary board placed above the ordinary one. The knots do not prevent the standard ends from being raised in the usual manner, while by giving a half shed lift to the upper board the ends are raised to the centre.

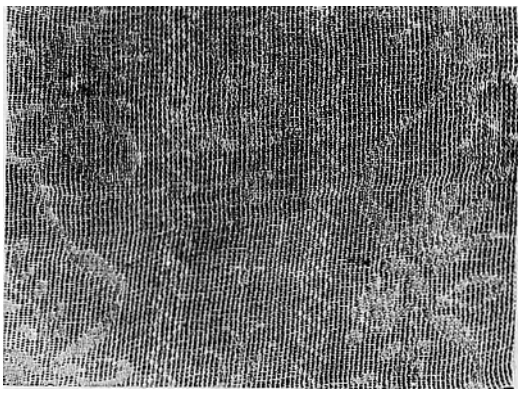

Fig. 283.

Styles of Cloth.—The principal styles of cloth produced in an ordinary jacquard with a doup in front consist of:—(1) Gauze or leno combined in stripe form with figured effects; (2) combinations of ordinary weave and gauze, one of which forms the figure and the other the ground; (3) combinations of ordinary weave, warp (or weft) figure, and gauze. The first style calls for no special attention, since the same ends are not required to form successively both figure and gauze. Examples of the second and third styles have been described in relation to dobby effects, and illustrated in Figs. 275 to 282; and the same principles apply to jacquard patterns, except that in one case a pegging plan is required and in the other case a card-cutting plan. The crossed interlacing that is produced may consist of a light, open formation, or of a rather heavy net-leno structure.

Combinations of Gauze, Plain Weave, and Warp (or Weft) Figure.—Examples of this type of structure are given in Figs. 283 and 284, the former illustration representing a combination of gauze and plain weave, while in the latter, weft figure on the right side of the cloth is also included.

One-crossing-one Styles.—The method of designing for structures in which one end crosses one end is illustrated in Fig. 285. (These examples show the jacquard development of the styles given in Fig. 282.) A in Fig. 285 represents a harness and doup-heald draft, in which the ends are transposed in pairs—2, 1, 4, 3, etc.—in order that the standard and crossing ends, which respectively form the odd and even ends in the plain and figure portions of the cloth, will correspond with the odd and even spaces respectively of the design paper. The plans B, C, and D illustrate the designing of a plain weave figure on gauze ground, such as is represented in Fig. 283, while E, F, and G show the designing of a warp (or weft) figure—surrounded by plain weave—on gauze ground; this style corresponding with Fig. 284. The lifts of the doup and doup heald are indicated at the side of the plans, and in both styles, on the even picks, all the crossing ends are raised by the doup heald on the right-hand side of the standard ends. The picks—odd or even—on which to form the crossed sheds is determined by the position of the plain marks on the even ends; thus, if the plain weave had been indicated in the reverse position in the plans B and E, the lift of the doup heald would have occurred on the odd picks.

Fig. 284.

The plan B in Fig. 285 represents the form of a plain weave figure as actually required in the cloth, while C shows the effect indicated in full for the card-cutting. Since the doup heald, on the even picks, lifts all the crossing ends on the right of the standard ends, no ends are raised by the harness on these picks, the cards for which are blank except where holes are cut for the purpose of lifting the doup heald. On the odd picks the standard harness lifts the standard ends where the plain figure is required, as shown by the full squares in C; while the crossing harness lifts the crossing ends in the gauze ground, as indicated by the crosses. The blank picks need not, however, be included in the design, as the cards for these can be obtained by repeating, hence the drafting of a gauze and plain combination may be simplified by designing for the open sheds only, as shown at D. In this case the outline of the figure is first drawn in the ordinary manner on design paper, the counts of which is in the proportion of the ends per inch to the picks per inch

divided by two. Then the odd vertical spaces are filled in where the plain weave is required, as shown by the full squares in D, and the even vertical spaces for the gauze effect, as indicated by the crosses. The ends require to be followed in pairs, 1 and 2 together, 3 and 4 together, etc., and an examination of D will show that the full squares and crosses always succeed each other. Where there are two marks or two blanks alongside each other on the same pick, they belong to different pairs of ends.

When the system of designing, shown at D in Fig. 285, is employed for a combination of plain weave and gauze, very little advantage is gained by using the transposed harness draft A, as compared with a straight harness draft, as the only difference is that with the straight draft the plain effect is indicated on the even vertical spaces and the gauze on the odd vertical spaces. In the case of designing a warp (or weft) figure, however, the transposed draft is much more convenient than the straight draft, as with the latter it is necessary in the figure for the working of the odd ends to be indicated on the even vertical spaces, and of the even ends on the odd vertical spaces. This has been illustrated in Fig. 282, so that no further reference is necessary. In Fig. 285 the plans E, F, and G show, step by step, the process of drafting a figure, assuming that the transposed harness draft A is employed. In this style it is necessary for every card to be cut from the design, because certain standard ends require to be raised on the doup sheds, in addition to the crossing ends. The figure, with two or more threads of plain weave surrounding it, may first be indicated in full in the ordinary manner, as shown at E, the floats of the figure being carefully arranged to fit with the plain weave. The insertion of plain weave round the figure is necessary in order that the change from the firm gauze

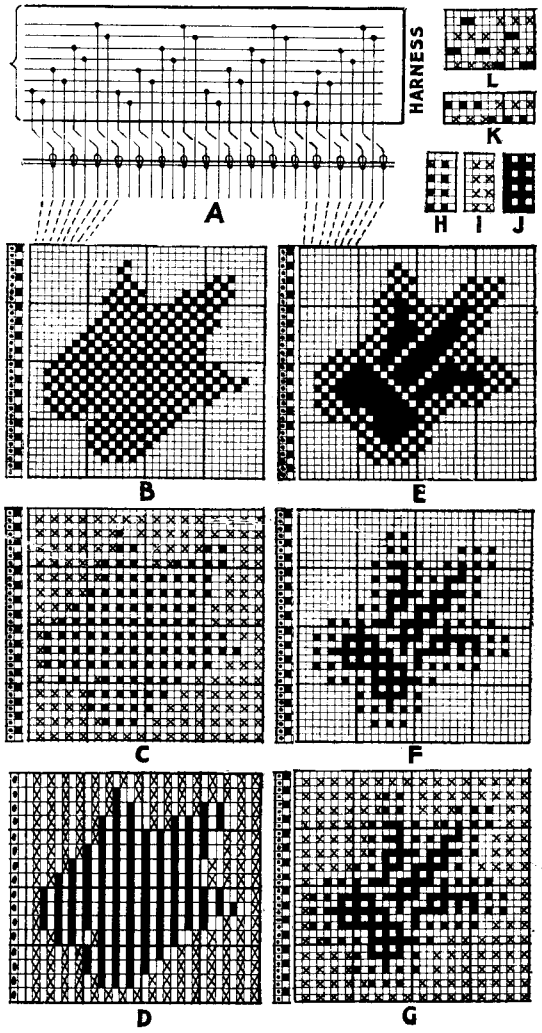

Fig. 285.

structure to the loose figure will be gradual, and so enable the threads to spread. The next stage, shown at F, consists of taking out (or indicating in a different colour) the marks where the even ends and even picks intersect, as these lifts are produced by raising the doup heald. In the final stage, shown at G, the ends are followed in pairs, and marks are inserted on the odd picks where the crossing ends require to be raised by the harness in forming the gauze ground, For convenience, the jacquard weaves which produce the three effects are shown separately at H, I, and J, the plain weave being formed by H, the gauze by I, and the warp figure by J, the doup heald being raised in each case on the even picks. It will be seen in J that where a crossing end, in forming the figuring floats, is raised by the harness on the odd picks, the accompanying standard end is also raised, so that no binding of the ends takes place. The blank spaces on the even picks of J correspond to warp float because the crossing ends are raised by the doup heald at these places.

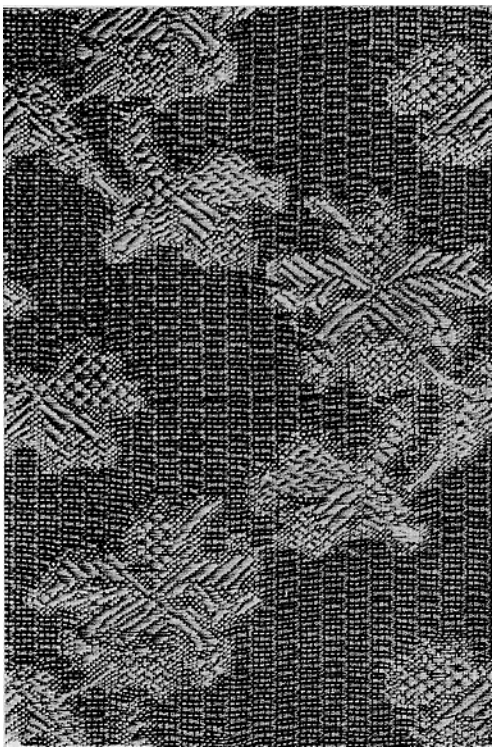

Fig. 286.

Special Ground Weaves.—With the pure gauze ground only very open structures can be produced, and sometimes sufficient picks cannot be inserted to form a good structure in the figured portion of the cloth. Examples of ground weaves are given at K and L in Fig. 285, which enable more picks to be put in, as each pair of ends only forms the crossed interlacing once in every four picks. By using the first four ends of either weave a ground structure is formed in which three picks of every four are readily grouped together, while by employing the full weaves a kind of spider's web ground effect is produced, similar to the styles illustrated in Figs. 277 and 278 (p. 254).

A figured fabric, in which a spider's web ground is formed, is represented in Fig. 286, while the order in which the threads interlace in the ground, together with the harness and doup draft, is given in Fig. 287. The system of preparing the design for the card-cutting, is illustrated in Fig. 288, in which the portion lettered A shows the figure indicated in full, and that lettered B, one complete repeat of the ground weave. In a portion of the figure diagonal marks are shown which represent figuring marks taken out where the even ends intersect the even picks, in order to prevent the crossing ends from being raised at the same time by both the harness and the doup heald. The following are suitable particulars for a cloth in the one-crossing-one style :

Warp 2/60's to 2/80's cotton, 40 to 48 ends per inch. Weft 16's to 20's mohair, 40 to 44 picks per inch.

If the crossing and standard ends are similar the best results are obtained by placing both series of ends on the same warp beam, but it is advisable to distribute the gauze structure as uniformly as possible in a design in order to equalise the strain on the ends.

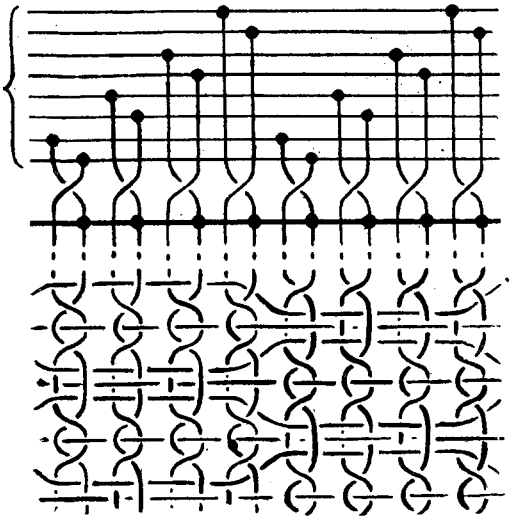

Fig. 287.

One-crossing-two Styles.—The styles which are illustrated in Figs. 283 and 284 are also readily woven with one end crossing two ends, and different methods of producing the effects on this principle are illustrated in Fig. 289. The figure indicated at A, which resembles the form represented in Fig. 285, is used as the motive in each case in order that comparisons may be made. B shows a harness and doup-heald draft, and C the card-cutting plan for producing an opaque figure on gauze ground similar to the effect given in Fig. 283. This style also corresponds with the dobby pattern illustrated in Fig. 280 (p. 255). The doup heald lifts on the even picks, and there are therefore two picks and three ends in each group, so that in indicating the design in full, as shown at C, each small square in the motive A is taken to represent two picks and three ends. The standard ends work plain throughout, and in the plan C, in order to show the form clearly, the weave is represented by full squares in the figure, and by dots in the ground. The crossed interlacing is formed in the ground by lifting the crossing harness on the odd picks, as shown by the crosses.

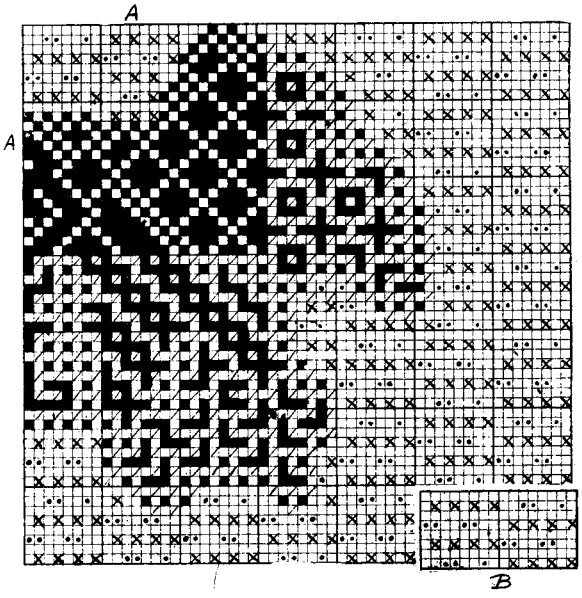

Fig. 288.

In the figure the crossing ends interweave in plain order on the crossed side of the standard ends, but these lifts are not indicated in C, as they are due to

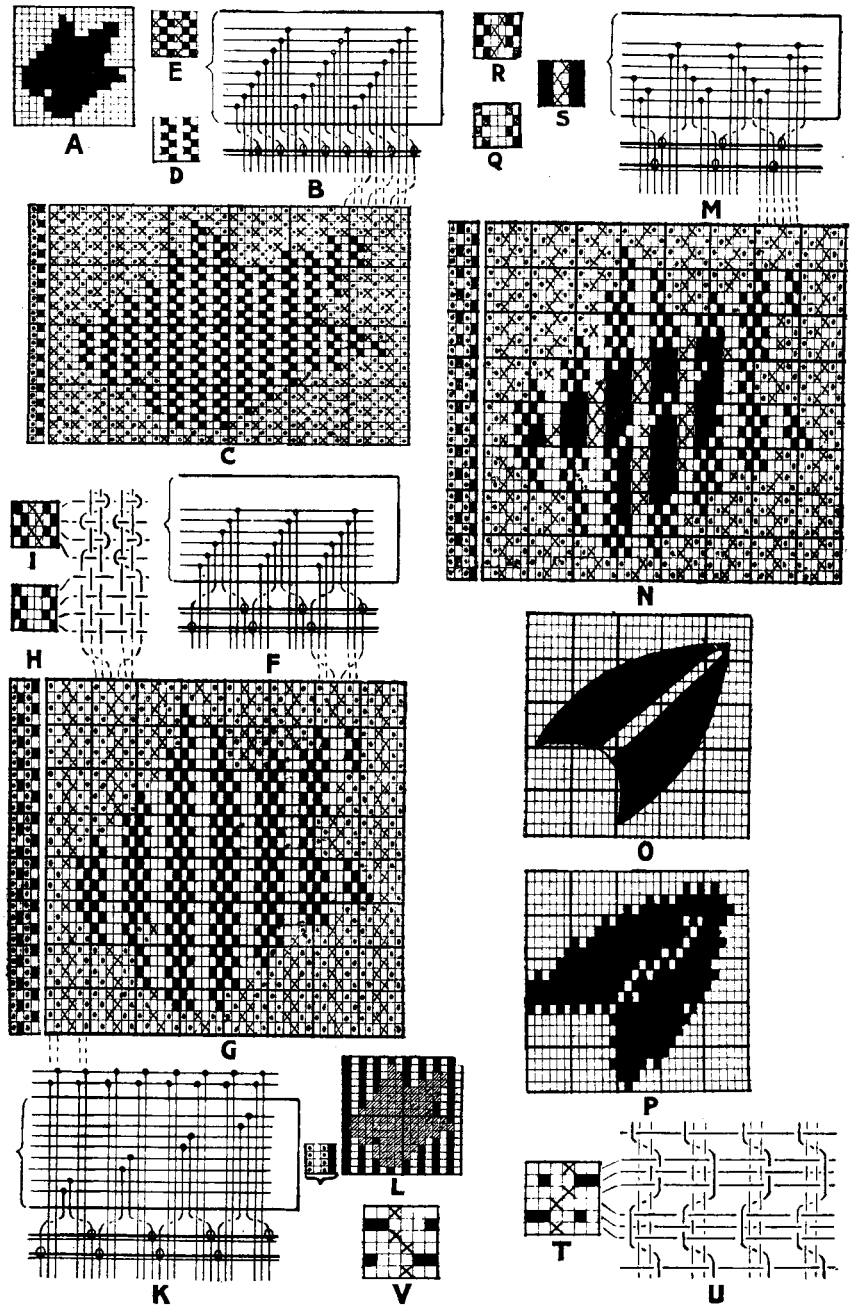

Fig. 289.

the doup heald being raised on the even picks. The respective weaves for the figure and gauze are shown separately at D and E in Fig. 289.

Use of Two Doups.—With the draft given at B in Fig. 289 pure plain weave cannot be formed in the figure, as the first and third ends of each group of three work alike. By using two doup healds, however, with the crossing ends drafted in opposite directions, as shown at F, a figure may be formed in perfect plain weave. The repeat of the draft is on six ends, and in F the harness is represented with the two back rows of cords cast out. All the rows of the harness may, of course, be employed, but the arrangement shown is convenient if the sett of the harness is sufficiently fine. Design paper is then used, which is ruled to correspond. Thus, in G, which shows the complete card-cutting plan to coincide with the motive A, the counts of the paper is 6 by 4 to correspond with a cloth counting, say, 66 ends and 44 picks per inch. The first doup heald lifts on the odd picks, and the second on the even picks, as indicated at the side of G. The standard ends work in plain order continuously, and in the gauze ground the crossing harness is raised where indicated by the crosses. The separate weaves for the plain and gauze are given respectively at H and I, alongside which the interlacing of the threads is represented. The drafting of a design for the card-cutting is simple, as it is only necessary to indicate plain on the design paper, except where the centre two of every six ends are left blank in the plain weave sections of the design. The threads should be followed in groups of three ends and two picks, and a somewhat steppy outline is given to the figure. It should be kept in mind that in the figure the crossing ends do not work plain where the two blank vertical spaces are shown in the design, because the doup healds lift them in plain order in the centre of each group of four standard ends.

An alternative system of drafting, for the style indicated at G, is given at K in Fig. 289, where the plain standard ends are shown drawn on two healds placed behind the harness. A similar draft may be arranged for the single-doup design given at C. An advantage of this arrangement is that, as only the crossing ends are drawn on the harness, a large figure can be produced in a small jacquard ; also the designing and card-cutting are very much simplified. Thus, for the style given at C, a figure may be designed solid, as shown in the motive A. The blanks are then cut if an opaque figure is required on gauze ground, whereas the marks are cut in producing a gauze figure on an opaque ground. The cards cut from the design represent the picks on which the crossing harness is raised (the odd picks in the plan C), and these are laced alternately with the cards for the doup-heald sheds, which are blank, except where holes are cut for the purpose of operating the healds and easer.

In producing the style given at G in Fig. 289, with the draft K, however, all the cards require to be cut from the plan, because in forming the gauze a portion of the crossing harness is raised on the odd picks, and another portion on the even picks. The system of designing, illustrated at L, may be employed, in which the plain effect is indicated by a wash of colour, as represented by the shaded squares; then in the gauze sections alternate vertical spaces are filled in solid in a second colour, as shown by the full squares. The doup lifts may be indicated alongside, as shown in the bracketed portion on the left of the plan L. Two cards are cut from each horizontal space, the blanks being cut in the first card, and the full squares in the second, while the dots alongside, which indicate

the lifts of the half-healds, are cut in every card. The ordinary healds, placed at the back of the harness, are operated in plain order throughout. In designing a figure in the manner shown at A and L the counts of the design paper is in the proportion of the ends per inch ÷ 3 to the picks per inch ÷ 2.

If the standard ends are drawn on healds it is only possible to form combinations of gauze and plain weave. In weaving warp (or weft) figure it is necessary for all the ends to be drawn on the harness. The six-row draft, shown at M in Fig. 289, may be employed which varies from the draft F in that the crossing ends are drawn on the opposite side of the standard ends. This is in order that where figure is formed the position of the crossing ends will be the same in the design and cloth, viz., the third and fourth in each group of six. Assuming that a warp figure, similar to that indicated at O, is required to be introduced on the plain shape shown at G, the full card-cutting plan will be as shown at N. The crosses in N show where the crossing ends are raised by the harness, and the chief points to note are: (*a*) Not to lift a crossing end by the harness at the same time that it is raised by a doup heald; (*b*) to lift both the accompanying standard ends where, in forming warp figure, a crossing end is raised by the harness. The latter condition is necessary in order to prevent the crossing ends from being bound in on the open shed side of the standard ends, and it will be found that the floats of a figure must be slightly modified to suit. Thus, the form shown at P will result from the card-cutting plan given at N. The respective weaves for the plain, gauze, and warp figure are shown separately at Q, R, and S in Fig. 289.

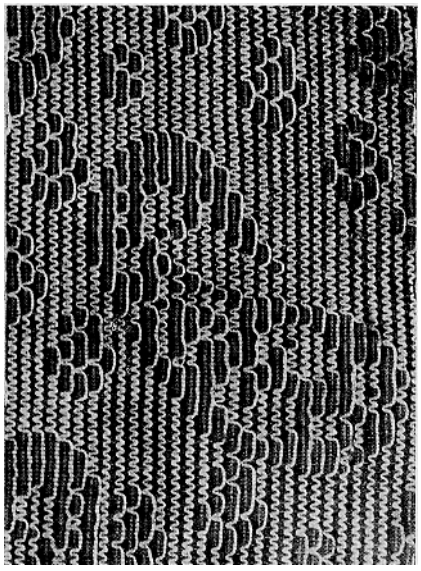

Fig. 290.

Modification of Gauze Ground.—The plan T in Fig. 289 is given as an example of how the gauze structure may be modified in order to enable a larger quantity of yarn to be put into a cloth. The interlacing of the threads is represented at U, and it will be seen that the picks are in groups of three, which makes the gauze formation much more open at the same time that more picks per inch can be inserted. The crossing harness is raised in the order represented by the crosses, and the standard harness as shown by the full squares in T, while the first doup heald is raised the on even picks and the second on the odd picks, as indicated at the side of N. The standard ends interweave somewhat loosely, but the grouping of the picks is largely due to raising both standard ends on the centre pick of each group at the same time that the accompanying crossing end is raised by the doup heald. Each crossing end is thereby caused to interlace for three picks on one side, and then for three picks on the other side of the standard ends. The plan T is arranged to coincide with the draft M, but the same gauze structure may be employed in combination with a purely plain figure, and in that case,

if the draft F is employed, the order of lifting will be as shown at V. The plan V coincides with the interlacing of the centre six ends of U, the two doup healds lifting as indicated at the side of G. The ends per inch of these styles may range from 60 in cotton yarns to 100 or more in fine silk yarns, but the picks per inch should not exceed from 40 to 50.

Net-leno Figured Styles.—In forming an *open* gauze structure in the one-crossing-two arrangement all the ends should be similar, and should be brought from one warp beam in order that they will bend equally. By bringing the doup ends from a separate beam that is more lightly weighted than the standard warp beam the crossing ends will be traversed distinctly from side to side of the standard ends which will lie straight. If, moreover, yarn of a special character is employed for the crossing ends, figured net-leno effects, similar to the style shown in Fig. 290, may be formed on the principles illustrated at C and G in Fig. 289.

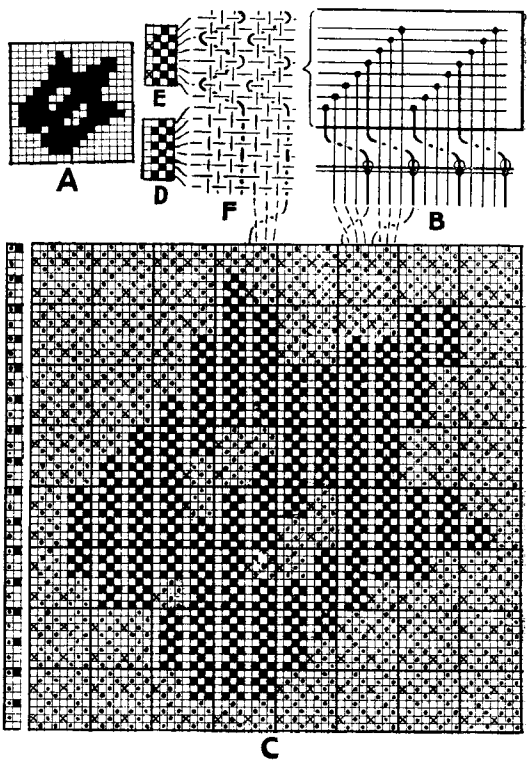

Fig. 291.

One-crossing-three Patterns.—A more prominent pattern, however, is obtained by employing more than two standard ends in each group, and the examples given in Fig. 291 illustrate the production of a figured structure in which one end crosses three standard ends. This style corresponds with the dobby pattern, shown in Fig. 276 (p. 253). The figure indicated at A, which is similar to the form previously shown, is used as the motive, and the harness and doup-heald draft, for producing the cloth wrong side up, is given at B. One doup heald is employed, which is raised on every fourth pick, and in the complete plan of the effect given at C each small square in the motive A is taken to represent four ends and four picks. The standard ends work plain throughout, and the crossed interlacing in the ground is formed by raising the crossing harness on the second of every four picks, as indicated by the crosses in C. The respective weaves of the figure and ground are shown separately at D and E in Fig. 291, while F represents the interlacing of the threads to correspond. In the figure the crossing ends are interwoven in 3-and-1 order on the crossed side of the standard ends by the lifting of the doup heald. Other arrangements of the crossing and standard ends and other orders of lifting may be similarly drafted and designed, but in most

cases the working out of a design in full is unnecessary. Thus an examination of C will show that the only picks which vary are the second in each group of four, so that only these picks need be indicated for the card-cutting, the cards for the remaining picks being obtained by repeating. Further, it is possible for the plain standard ends to be drawn on healds, in which case the figure would be indicated solid, as shown in the motive A.

Combinations of Twill and Gauze.—The harness and doup-heald draft, shown at B in Fig. 291, may be employed in combining 2-and-2 twill ordinary weave with gauze two picks in a shed. The style is illustrated in Fig. 292, in which D shows the method of indicating a design for the card-cutting, while E represents how the threads interlace in the bracketed portion of D. This system of grouping the ends and picks in the gauze structure is suitable in producing an open effect when the yarns are somewhat thick and fibrous. The crossing ends are raised by the doup heald on the first and fourth of each group of four picks; in the figure the standard ends form 2-and-2 twill in conjunction with this order of lifting, while the crossing harness is left out of action. In the gauze ground the standard ends are left down, but the crossing ends are raised by the crossing harness on the second and third of each group of four picks. Warp (or weft) figure may be introduced, as in the previous examples, by arranging the floats to fit with the lifts formed by the doup heald.

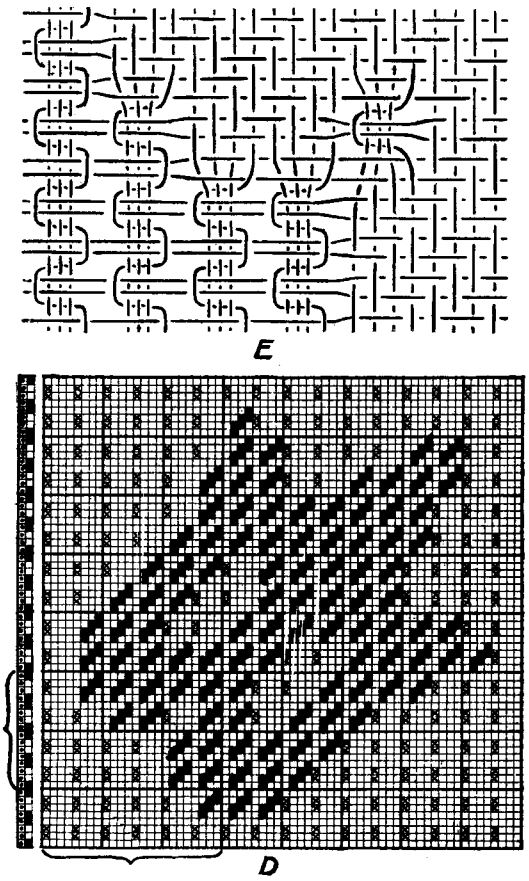

Fig. 292.

The draft, 1-crossing-3, given at B in Fig. 291, may also be used for combinations of 1-and-3 twill weave with gauze in which the picks are grouped 1-and-3. In addition, drafts may be arranged to suit other weaves, as, for instance, 1-crossing-2 for three-thread, 1-crossing-4 for five-thread, and 1-crossing-5 for six-thread effects.

The foregoing examples show that there is considerable scope for producing variety of effect by means of ordinary harness and doup-heald drafts. There are, however, certain limitations in the designing of all-over patterns because the ordinary

weave and the gauze must be considered in relation to each other. Thus, gauze—two picks in a shed—may be combined with 2-and-2 warp rib, but it cannot be used along with plain weave because in forming the latter the doup heald must be raised on alternate picks. Weft figure can only be formed in bottom douping by weaving the cloth wrong side up, and it is impossible to produce a figure in both warp and weft float.

THE SPECIAL GAUZE JACQUARD AND HARNESS

A form of this mounting, as made by Messrs. Devoge & Co., is illustrated in Figs. 293 and 294. In place of a doup heald a portion of the harness is used for the douping, and as many independent doup mails are provided as there are groups of crossing and standard ends in a repeat of the machine. Each figuring harness mail in a repeat, as well as each doup mail, may be operated separately, so that in this case there is scarcely any limitation to the different forms and combinations of crossed and straight interlacing that can be produced.

Arrangement of Harness, Hooks, and Needles.—The harness may be divided into three parts, viz., the douping harness A, Fig. 294, the figuring harness B, and the easing harness C. The hooks may similarly be divided into three parts, viz., the douping hooks D, Fig. 293, the figuring hooks E, and the easing hooks F. The needles, however, are only in two series, the top and bottom needles G, each of which controls both a douping and an easing hook, and the central figuring needles H. There are two griffes, the ordinary griffe I, which carries the knives that lift the douping and figuring hooks, and a smaller griffe J, by which the easing hooks are raised.

System of Drafting.—The draft of the ends that is mostly employed, and for which the machine is best adapted, is represented in the lower portion of Fig. 294. An ordinary half-heald or doup K is mounted in front of the harness. The ends are drawn straight over on the mails of the figuring harness B, but the crossing ends are first passed in pairs through the mails of the easing harness C. Each easing mail is provided with two eyes so that the ends are kept separate. Then, in bottom douping, which is represented in Figs. 293 and 294, each pair is drawn under the accompanying standard ends and through the loop of a doup leash which passes loosely through the eye of a doup harness mail A. The half-heald K wears out much more quickly than the harness, and it is in order that the former may be readily replaced that the loose form of doup leash (shown at C in Fig. 236, p. 221) is employed. By comparing the draft with the arrangement of the jacquard and harness it will be seen that in each short row there are 12 hooks, 12 harness cords, and 10 needles for every 8 ends, so that a machine with a capacity of 400 ends requires 500 needles and 600 hooks.

Method of Douping and Easing.—The jacquard is single lift, and the lath of the doup K, Fig. 294, is connected by cords to the griffe I, so that it is lifted on every pick. This enables the crossing ends to be raised either by the doup harness or the figuring harness, while the doup leashes, through which the crossing ends that are not raised pass, simply hang slack beneath the bottom line of the shed. Spiral springs L are employed to reverse the movement of the half-heald. The doup harness cords are passed through a separate comber-board M, Fig. 294, which is placed a short distance in front of the figuring harness, in order to reduce the

strain on the crossing ends when a crossed shed is made. The mails of the doup

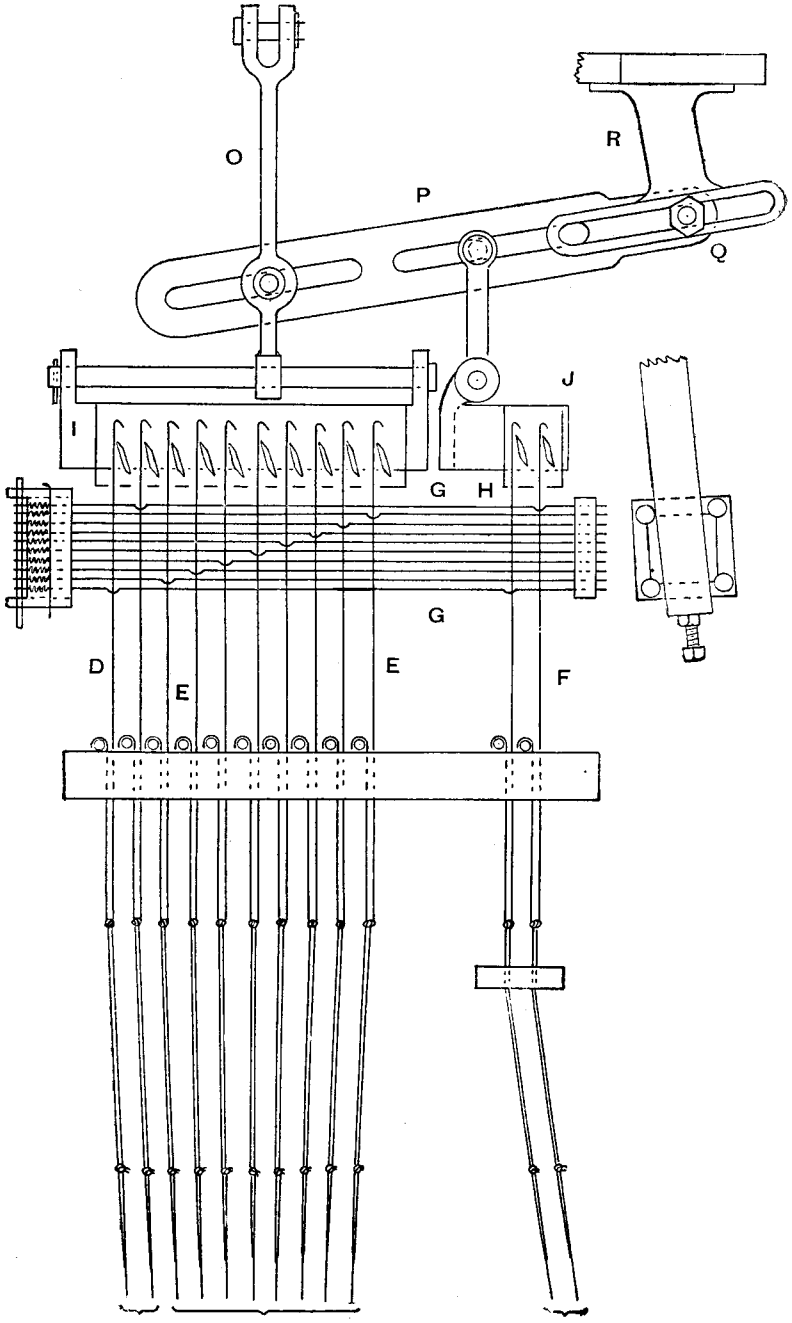

Fig. 293.

harness A are tied up about $\frac{1}{4}$ inch lower than the mails of the figuring harness B, and they have eyes large enough to enable the doup leashes to slide through them without undue friction.

The griffe I, Fig. 293, which lifts the douping and figuring harness, is operated in the ordinary manner, but to the connecting rod O a slotted lever P is pivotally attached, from which the griffe J is suspended. The lever P is fulcrumed on a stud Q, which is carried by a bracket R supported on the frame of the machine. The rising and falling motion of the rod O imparts a corresponding, but smaller, movement to the griffe J ; the extent of the movement of the latter may be regulated

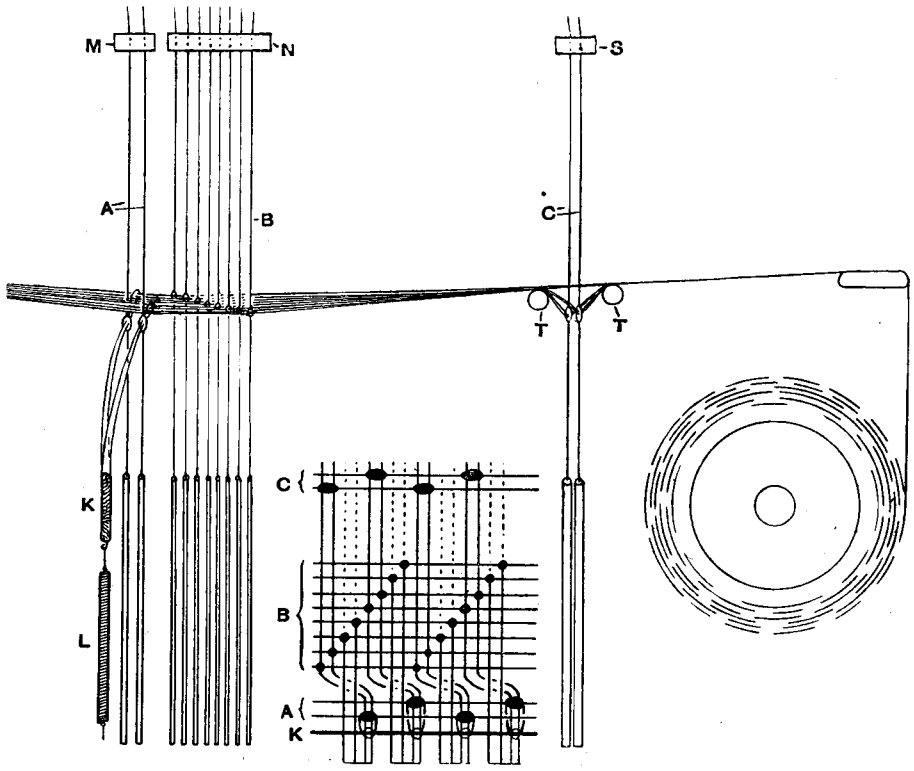

Fig. 294.

by adjusting the studs in the slots of the lever P. The knives of the griffe J are placed rather higher than those of the griffe I, in order that the lift of the easing harness will be slightly in advance of that of the douping and figuring harness.

The easing harness cords are passed through a comber-board S, Fig. 294, about 10 inches behind the figuring harness, and the mails are tied up so as to depress the crossing ends between two adjustable rods T. Where the easing harness is raised the corresponding crossing ends are, therefore, slackened, and as a douping hook also controls an easing hook, an easing harness cord is raised whenever the corresponding doup harness cord is raised. A length of the crossing warp is, therefore,